NORGES HANDELSHØYSKOLE Norwegian School of Economics and Business Administration

Coordinated Action in Reverse Distribution Systems

BY
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DISSERTATION SUBMITTED TO THE DEPARTMENT OF STRATEGY AND MANAGEMENT AT THE NORWEGIAN SCHOOL OF ECONOMICS AND BUSINESS ADMINISTRATION IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DR.OECON.
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July 2006

In memory of

Farmor

men sjøl Newton ødela mang en
vakker aften
på grubling og bruk av fyndord
- sikkert grove
for å finna det han visste han visste:
tyngdekraften
og det som sko te va å få et eple i
hove
så det e håp for nåken og einkver
så lenge det fins epletrær

Fra Trøstesang
Bjørn Eidsvåg 2002

ABSTRACT

Reverse distribution systems are the topic of this thesis. The term 'reverse' refers to the collection of products at end-of-life for the purpose of recovery and waste management. We specifically study the area of electrical and electronic product waste. Such distribution systems are becoming a more visible and commercially significant part of the modern business environment, and this makes them interesting to study.

The importance of understanding the interaction effects between the coordination mechanisms of two crucial flows, physical flows and commercial interests, in distribution systems is the main thrust of this study. This is something that has largely gone unnoticed in the distribution literature because these flows are essentially explored in two different research traditions. Physical flows have been the focus of attention in the logistics and supply chain management literature, while commercial interests have been tackled by the governance literature. A major theoretical contribution of this thesis, therefore, has been to reunite these complementary aspects of the distribution system in order to make sense of how the two flows work together to create coordinated action, which in turn enables system goals to be achieved.

Therefore, our problem statement is: *How do the coordination mechanisms for physical flows and commercial interests interact in order to achieve coordinated action in reverse distribution systems?*

A case study research strategy has been chosen because we are dealing with a relatively new phenomenon that is studied in its real life context. We use three cases, which relate to three different reverse distribution systems – all of which deal with electrical and electronic (EE) products at end-of-life. Each case covers a five-year period, which starts out from the time the initiative was introduced in Norway (1999). The data collection consists of interviews with the different types of actors that take part in the systems and different sources of secondary data. The system has been our unit of analysis, which we believe is a contribution in its own right and another reason for utilizing the case study strategy.

Our results show that there are interaction effects between the coordination of physical flows and commercial interests. The choice of coordination mechanisms is interdependent between the two types of flows. We argue that each flow addresses different categories of costs and provides different categories of service and value to the end-consumer segments. In one case we are able to highlight that a lack of coordination across the flows increases costs and reduces service and value, and thus does not achieve coordinated action in the reverse distribution system. In contrast, another case shows that coordination across the flows contributes to lower costs and higher service and value, which suggest that the reverse distribution system achieves coordinated action. Each of three systems has chosen different combinations of coordination mechanisms, which have resulted in different levels of costs, service and value in the reverse distribution systems.

To conclude our study, we summarize our findings as a set of propositions. We also discuss at length two particularly interesting matters that arise from the study, which are the role of a coordinator in the systems and the significance of the collection function. These present opportunities for further research.

ACKNOWLEDGEMENTS

I must admit this is a section that, on many occasions, I believed I would never come to write: the acknowledgements of a complete dissertation. All the struggles, the hard work, the emotions, the sacrifices and the long, long hours are beyond my capacity to express in words. However, here I am, at almost one o'clock in the morning, July 1st 2006, writing these lines. Not an unfamiliar working hour, it must be said, but a moment I have hardly dared to dream.

I realize I have made some decisions along the way that haven't made things easy. I decided to stay physically at BI, Oslo, whilst being enrolled in the program at NHH, Bergen. Being a logistics person at heart, I wanted to be a part of the logistics 'gang' at BI. This was after I had been employed at Møller Logistics, Oslo, for a year – a job which I continued part-time during the dissertation process. I also engaged in a few related projects at BI, as they were helpful with respect to my own project. However, in spite of all of my good will and enthusiasm, I have learned the hard way that fewer tasks are better. On the other hand, I know that I have had some priceless experiences during my time at Møller Logistikk. At BI, I have been part of the logistics group, an environment that has given me an important frame of reference. This, combined with the education from NHH, means that I am confident that my dissertation resembles the vague ideas I had when I started the process. Put briefly, I have lived and learned coordinated action.

On finding myself at this "moment in time", there are a few people who deserve acknowledgment and my great gratitude. First, my supervisors, Sven and Lars Erik, who together have pushed me through this process and I know I wouldn't have made it without them. Sven talked me into continuing at times when I was certain I wouldn't make it. Lars-Erik restored my lost confidence in writing, by reading and commenting on the manuscripts over and over again. Thank you both for believing in the project and me.

I want to thank Anita, who has been a wonderful friend and discussion partner during this process. I found inspiration in your dissertation on how to write and structure my own, and thank you for the numerous hours we spent discussing theory, the dissertation and, not least, life itself.

At BI, there is Marianne. Thank you for opening the doors of the academic world to me. It's been a painful journey but it has also been a journey where I have had some experiences that have changed my life for the better. Thank you for including me at BI and in the projects, as well as introducing me to your family, for the many fun times we have had together, and for becoming a friend.

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My project is based in the empirical world of electrical and electronic waste. I want to thank the companies and people I have interviewed for their cooperation. In particular, I want to thank Gunnar Murvold at RENAS AS for sharing his knowledge with me and taking an interest in my work.

I also want to express my thanks to my colleagues, the administration and friends at BI and NHH, who have supported me during this process. Thank you for the cooperation and company! Siv Marina and Ingunn for sharing times both at BI and NHH. Nina and Leif for your friendship and for introducing me to spinning! Bengt and Pål for many a-Friday night beer drinking and problem solving. Fred, thank you for reading a version of my thesis and providing me with invaluable comments. Thanks also to Kenneth for taking time to discuss theoretical matters with me, and to Aksel for starting me off and taking part in the committee. Thanks to NETLOG and DNET for funding, and to all of you who are part of these projects for sharing discussions and social happenings.

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Sophie! Thank you for the proofreading!

Finally, I want to express my gratitude to my family and friends who have borne with me over the years. It has taken me some time to complete the dissertation. Now it's finished, and I am looking forward to being able to spend more time with you!

Bente, July 1st 2006

Snart held regnet opp
Då kan tinga turke

Tormod Haugland
På Øya

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1. INTRODUCTION

Reverse distribution systems are becoming a more visible and an increasingly important aspect of the industrial world. The term 'reverse' refers to the collection of products at end-of-life for the purpose of recovery and waste management. These activities are becoming a part of society's consumption pattern, as the need to sort out specific products at end-of-life and to take them back to specific collection sites for proper environmental handling increases. Products at end-of-life include deposit bottles, glass and metal waste, paper, plastics, and electrical and electronic products. The latter forms the topic of this thesis. Reverse distribution systems are a fairly new phenomenon and there remains a lack of theory to understand the area sufficiently. This thesis seeks to contribute to the knowledge about reverse distribution systems.

In a reverse distribution system, end-consumers are the producers and suppliers of products that are distributed in reverse to waste management facilities, which means that the production facilities become the final consumers. The roles of participating actors in reverse distribution systems are, in other words, different from those in forward distribution systems. The activities in reverse distribution systems are also somewhat different from forward distribution systems, for example, the collection and dismantling vs. the manufacturing and bringing of products to the end-consumer. Thus, it is necessary to understand explicitly how coordination is achieved in reverse distribution systems, where the roles of actors and activities have a different content from those in the forward distribution systems. This coordination challenge for the reverse distribution system is exacerbated because it incorporates both the industry of the manufactured products and the industry that handles the products at end-of-life[1].

This thesis is based on the idea that the principles of coordination in a reverse distribution system are similar to the principles of coordination in a forward distribution system. Thus, although we are investigating a fairly new area (reverse distribution systems), we believe that we can readily depart from the theory base on forward distribution systems, by adapting these theories to the specific needs of the reverse[2]. In particular, our study is about *coordinated*

[1] We return to these industries in more detail in chapter 2.
[2] Occasionally we use 'reverse' as a short form of reverse distribution system(s). This occurs throughout the thesis.

action in reverse distribution systems. Coordinated action is a term taken from earlier research on distribution (Alderson 1954), where it is stated: "Only when someone ... takes responsibility for co-ordinated action can it be expected that anything more than routine operations will be carried out effectively." (p25). Thus, in the way that we interpret this statement, we believe that gains can be made in reverse distribution systems when coordinated action is achieved.

Distribution is about *management of flows*. Flows represent the content of the transfers that are conducted in distribution systems. Examples would be physical, information, payment, ordering, negotiation, ownership, risking and financing flows (Stern and El-Ansary 1992). Intuitively then, it is the coordination of these flows in a distribution system that contribute to coordinated action. One reason to study the concept of coordinated action is that the literature on distribution has become detailed and fragmented, where specific flows have become the subject of different streams of research in the extant literature (Gripsrud 2004). In particular, it is argued that the research on physical flows and commercial interests in distribution systems are researched in two different streams of literature. Knowledge about coordination of physical flows is developed in the logistics and supply chain management literature, while knowledge about coordinating commercial interests is found in the governance literature. Thus, the literature on coordination of physical flows has been limitedly concerned with commercial interests, and the literature on coordination of commercial interests has been limitedly concerned with physical flows. We argue, therefore, that there is a need to reunite these areas of distribution research because there are interaction effects between the coordination mechanisms for the separate flows. It is known from research on distribution that coordination and integration are achieved within different dimensions of the systems (Mattson 1969). Our thesis is that real achievement of coordinated action in reverse distribution systems is dependent on these interaction effects, in addition to well-adapted coordination mechanisms for each type of flow.

In the following sections we provide an overview of the content of the thesis, starting with some more background and the problem statement of the study.

1.1 Background and problem statement

Reverse distribution systems are an empirically interesting and relevant phenomenon. A number of reverse distribution systems have been established in Norway, as the Norwegian government has been at the forefront of working with sustainable development. The government has given increased responsibility to the actors in trade and industry to find ways to handle waste products[3]. A specific outcome of this has been that the government has entered into industry agreements with industry trade organizations, where trade and industry formally commit to taking on this responsibility.

The cooperation between the industry and government has resulted in the establishment of waste management companies. A waste management company is an organization that has been given the operative responsibility on behalf of the industry to manage the industry agreements. Management of the agreements involves setting up collection systems for products at end-of-life and to administer a number of stakeholders that are affected by the agreement, i.e. to manage reverse distribution systems.

We understand 'reverse' as an aggregated term for a research area where products are returned for recovery and waste management. The literature on reverse distribution systems has to a large extent been occupied with clarifying "what reverse is", and have come up with specific definitions for reverse, activities and functions. As reverse issuesare more or less a result of modern consumption, this is not a very old field of interest. The earliest references we have identified are from the 1970s[4]. A characteristic of the research on reverse issues is that it has often departed from knowledge on 'forward' issues, which are about bringing products and services to end-consumers. It has also been identified that such an approach is fruitful (Fleischmann et. al. 2000). In line with this approach, we depart from the literature on coordination in forward distribution systems when we investigate coordinated action in reverse distribution systems.

The theory on coordination is taken from literature on distribution systems and, as already mentioned, we have identified some challenges in this field of research. Flows have been categorized into three main types of physical, ownership and information (Gripsrud 2004),

[3] Producer responsibility.
[4] Note that we focus on research in business, management and administration.

each of which constitutes a part of the total flow in a distribution system. However, it is also argued that the literature on coordination is fragmented because the flows are studied separately (Gripsrud 2004). In this thesis, we want to understand more about coordination across these flows. We particularly seek to bridge a gap between research on physical and ownership flows.

Why is it relevant to make such a contribution? The physical flow is a significant part of a (reverse) distribution system. However, in the distribution *channel* literature it is not viewed to be a part of the channel (Rosenbloom 1995). Rather, the ownership flows are viewed as defining the channel, while the physical flow is viewed as facilitating the ownership flows. However, the physical flows may indeed take different paths compared to the ownership flows. This is particularly relevant in reverse distribution systems, as the collection activities can be separated from the producers who are responsible for the products at end-of-life. For example, the end-consumer can return products at end-of-life to locations other than those of the original manufacturer and retailer, i.e from where the product was bought originally. In this manner, there is a distinct division between the flows. It is not obvious that the coordination of the ownership flows automatically achieves coordination of the physical flows.

Distribution systems have become more specialized and differentiated (Gadde 2000). An increasing number of actors are involved in distribution systems. The reverse distribution system also shows evidence of such characteristics, not least because two industries are basically merging together. That is, the manufacturing industry for the particular product in question and the waste industry that is involved in the collection system. The complexity of having a large number of actors involved in the reverse distribution system therefore deepens the coordination challenge.

Physical flows are specifically addressed in the logistics and supply chain management literature, where the focus is on activity structures (Lambert et. al. 1998, Persson 1995). It is a general understanding of this literature that highly coordinated activity structures lead to higher performance than less coordinated activity structures. However, the literature on physical flows is not clear about the coordination mechanisms that bring about the coordination. We therefore draw upon Thompson's (1967) insights from variations in technology, arguing that the same types of variations underlie activity structures in physical flows. Thompson argues that each technology has a specific logic for coordination, and proposes three coordination mechanisms. The three coordination mechanisms are presented as the coordination mechanisms of the physical flows in our study.

Coordination of ownership flows is addressed in the literature on governance (Heide 1994). The literature has been particularly successful in explaining coordination of exchange or transactions between organizations, and thus coordination in distribution systems is a particular subset of the area. However, in addition to ownership, transactions often include aspects such as negotiation, risking and financing (Gripsrud 2004). In this respect, we have categorized these types of flows as *commercial interests*: Governance mechanisms are implemented in order to coordinate commercial interests in distribution systems. The insight from this line of research is that there needs to be a combination of formal and informal governance mechanisms in order to achieve effective coordination of commercial interests in distribution systems.

The challenge for distribution systems, therefore, is that the different flows are coordinated with different types of mechanisms, and there is limited knowledge on how the mechanisms correspond to one another. In a bid to gain further insight into coordinated action in reverse distribution systems, we investigate the following problem statement in our study:

How do the coordination mechanisms for physical flows and commercial interests interact in order to achieve coordinated action in reverse distribution systems?

The flows in distribution systems have separate aims and, correspondingly, coordinated action is identified to be a concept composed of several variables. Investigating the specific aims of physical flows and commercial interests leads us to the content of coordinated action for this study. Physical flows are coordinated in order to achieve *integration of activities* across the distribution system (e.g. Lambert et. al. 1998). It is assumed that highly integrated activity structures lead to improved performance in the physical movement of products. That is, the integration of activities is a means of minimizing costs in the physical flow at a certain service level (Lambert and Stock 1993). The commercial interests, however, are coordinated in order to *align behavior* of the transacting actors in the distribution system. It is assumed that the exchange leads to higher performance when the actors have agreed on the commercial interests of the transactions. Transactions incur costs and governance is a way of economizing on the transaction costs (Milgrom and Roberts 1992). That is, the more it takes to align behavior and come to an agreement, the higher the transaction costs. Also, the commercial interests contribute to some level of transaction value (Zajac and Olsen 1999). The coordination mechanisms for both flows contribute to *cost minimization* for a certain value function (defined for each flow). In interaction, we expect that the means and outcomes of the coordination mechanisms of each flow contribute to system performance in the distribution system. We argue that a well-adapted choice of coordination mechanisms leads to coordinated action in the distribution system.

The goal in reverse distribution systems is to collect products at end-of-life and the system performance, therefore, is reflected in the collection rate. For our particular study, we have identified a context (collection of electrical and electronic-products at end-of-life) where the system performance level is explicit. This is because the Norwegian government expects the industry to achieve a collection rate of 80 %, which is measured against the annual sales (of the electrical and electronic products). Through the empirical analysis of the study, we disclose whether the reverse distribution systems achieve a sufficiently high collection rate, and to what extent the coordination mechanisms of the flows contribute in explaining the level of collection rates. This reflection brings us forward to the methodological considerations of the thesis.

1.2 Empirical setting and case study approach

In order to study our problem, we have to identify reverse distribution systems, and the collection of electrical and electronic (EE) products at end-of-life provides an excellent research context. In Norway, industry agreements for the collection of waste have been entered into one area at a time (e.g. paper, glass, plastics, batteries, etc). In the mid-90s, the government started working with waste from electrical and electronic equipment. Regulations were issued about the electrical and electronic products (EE-Regulations) and an industry agreement was entered with the electrical and electronics industry (EE-industry) in 1998. The reverse distribution systems for electrical and electronic products (EE-products) at end-of-life became operative in 1999, and the authorities initiated a trial period of five years (until 2004) in order for the industry to demonstrate that they could handle the responsibility of taking care of waste from EE-products at end-of-life. We chose this setting for our research because it was the first of its kind in the world[5]. Also, due to the establishment of the EE-Regulations

[5] Source: A press release from the Norwegian Pollution Control 1998.

and the industry agreement between the authorities and the electronic and electrical industry, a number of reverse distribution systems were developed from scratch, which provided a nice, readily available empirical opportunity.

The industry agreement between the government and the industry organizations represents the starting point for the commercial interests in the systems, which are operationalized in the establishment of waste management companies. The waste management companies established collection systems by issuing contracts to waste actors, which operate the physical flows in the system. In this manner, the commercial interests are represented in the EE-industry, with the physical flows being located in the waste industry. The flows in the reverse distribution system are separated, which creates a challenge for achieving coordinated action.

A case study research strategy has been chosen for the study, and we have identified three cases. One case represents one reverse distribution system. The timeframe for the study has been five years. We have a single embedded case study design, with a within case comparison at time one and time two, and also comparison across the cases. The unit of analysis is the system, and data collection includes interviews with all the different *types* of actors within the reverse distribution systems. The physical flows and commercial interests are described for each case and the coordination in the cases is analyzed. The level of coordinated action in the cases is evaluated to be the extent to which the systems achieve the collection rate of 80 %.

1.3 Outline of the study

The thesis consists of 10 chapters. After this introductory chapter, we describe the research context in which the study is based - the collection of EE-waste. In that chapter, we provide an introduction to the main actors in the context, and detail how this area has been structured and organized. We also comment on the EE-regulations.

In the third chapter, we explore the concept of coordinated action. Our theoretical basis is framed within the area of distribution and we start, therefore, with contributions from the literature on reverse distribution systems. The chapter continues with theory on physical flows and coordination, together with commercial interests and coordination, before we look at the content of the explanatory variable of coordinated action. In chapter four, the research model, analytical framework and operationalizations are presented. The research model is developed from theory on (forward) distribution systems, while the analytical framework incorporates concepts from reverse distribution systems. Chapter five covers methodology, where we state our reasons for choosing a case study research strategy, and explain our research design. We provide an overview of the data collected and set out the structure of the data analysis. The chapter concludes with an evaluation of the research quality.

Chapters six, seven and eight pertain to the case studies. Each case is presented using a similar structure. This has been done in an effort to make them as comparable as possible. Each case centers on a different reverse distribution system, which is described and analyzed accordingly. The cross case analysis is contained in chapter nine.

Chapter ten includes discussion and implications, and concludes the thesis. Our conclusions are summarized as a set of propositions. We also discuss in depth the significance of the collection function for a reverse distribution system and the role of the coordinator. These provide particularly interesting areas for further research on reverse distribution systems. The chapter concludes with implications, limitations of the study and suggestions for further research. The figure below provides an overview of the thesis' structure, illustrating that chapter 2 details background information on the study.

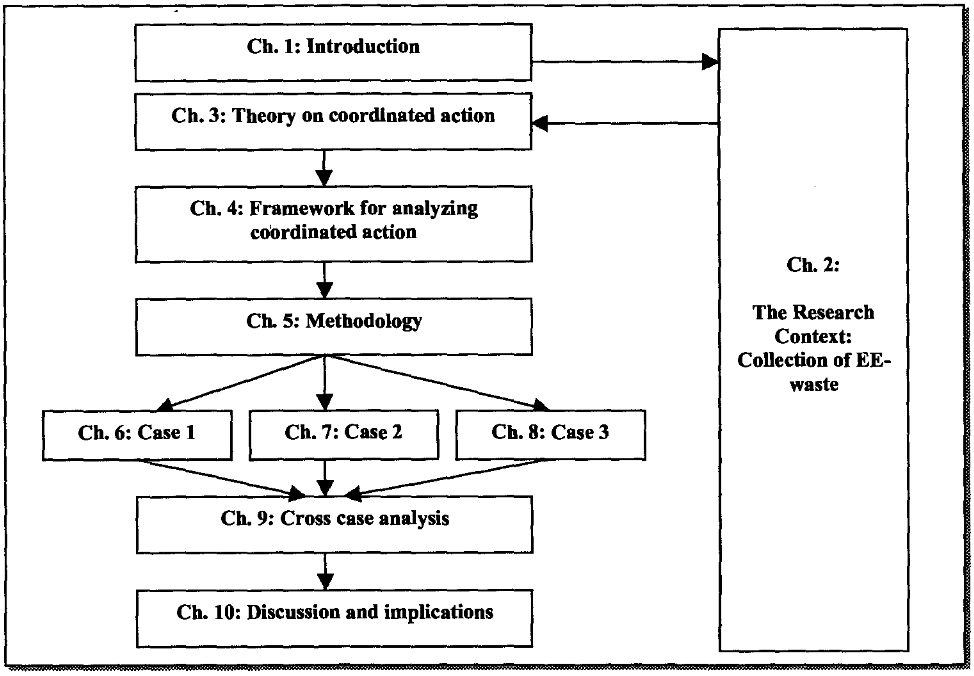

Figure 1.1: An overview of the thesis' structure

2. The research context: Reverse distribution systems for electrical and electronic products

In March 1996, the Ministry for the Environment (ME) in Norway published a report entitled "The collection and handling of waste from electrical and electronic (EE) products"[6] (ME 1996). The report maps the volumes, contents and handling alternatives of waste from EE-products. The total amount of annual waste is estimated to be approximately 145,000 tonnes (Hjellnes Cowi 1996). Two years later, on March 16th 1998, the ME passed 'Regulations regarding scrapped electrical and electronic products' (EE-Regulations)[7]. In the EE-Regulations, the actors involved in importing, manufacturing (domestic), distributing and sales of EE-products were given responsibility for collection, recycling and proper treatment of EE-products at end-of-life (EE-waste). Based on the EE-Regulations, end-consumers were allowed to deliver EE-waste free of charge to distributors of EE-products and to municipalities. Manufacturers and importers of EE-products were given the responsibility to establish regional collections sites, to transport the collected volumes, and to reprocess and recycle the volumes.

In order to ease the work which resulted from the EE-Regulations, the ME also entered into an agreement with the EE-industry on March 16th 1998 (the industry agreement). It was agreed that the industry would take on the responsibility to set up national system(s) for collection and reprocessing of EE-waste and to achieve an 80 % collection rate. The EE-Regulations and the industry agreement came into force on July 1st 1999. The Ministry for the Environment passes regulations, and the Norwegian Pollution Control Authority (SFT) administers and controls the regulations.

In this chapter we present the study's research context. We include an introduction on the industry agreement, the EE-regulation and the 'industry for collection of EE-waste'. The press releases and other sources referred to in this chapter are listed in appendix C. We use a number of denotations when describing the research context and these definitions are listed in the table below:

[6] The report is printed in Norwegian and has the title "Innsamling og behandling av avfall fra elektriske og elektroniske produkter" (Miljøverndepartementet 1996/ T-1135).

Table 2.1: Definitions of denotations used when referring to the context

Denotation:	Definition:
EE-products:	Electrical and electronic products
EE-companies:	Importers and manufacturers (domestic) of EE products
EE-industry:	All companies within the electrical and electronic industry
EE-waste:	EE products at end-of-life
Waste company:	A company that specializes in handling waste
Waste management industry:	The industry of companies that specialize in handling waste
Waste management company:	An administrative business unit that manages waste streams

2.1 The industry agreement

The agreement was established between a number of EE-industry organizations and the ME. The agreement resulted in the establishment of three waste management companies – Elektronikkretur AS and Hvitevareretur AS, which were set up in 1998 and RENAS AS[8], which were set up in 1997. Hjellnes Cowi (1996) identified 18 main groups and 218 subgroups of EE-products (cf. appendix A). The waste management companies are responsible for their respective product categories: one for consumer electronics (Elektronikkretur AS), one for white goods and household appliances (Hvitevareretur AS) and one for general electric products (RENAS AS). The table gives an overview of the categories of products:

Table 2.2: The categories of EE-waste for each of the waste management companies

RENAS AS		Hvitevareretur AS		Elektronikkretur AS	
Category no	*Type of products*	*Category no*	*Type of products*	*Category no*	*Type of products*
4	Cabling and wiring	1	Vending machines, jukeboxes and amusements	3	Brown goods
7	Heating, air conditioning and ventilation	2	White goods	5	Computer equipment
8	Lighting	15	Clocks and watches	6	EE-toys
10	Equipment for measurement and control			9	Medical equipment
12	Electronic tools			11	Office equipment
18	Electro equipment			13	Telecommunication
				14	EE-components
				16	Batteries
				17	Security equipment and smoke detectors

7 In Norwegian: 'EE-forskriften'

8 We will continue using the Norwegian names throughout the thesis.

Industry organizations within these product ranges are owners of the waste management companies. The figure below shows the owners and their shares, as of 2003, in the waste management companies:

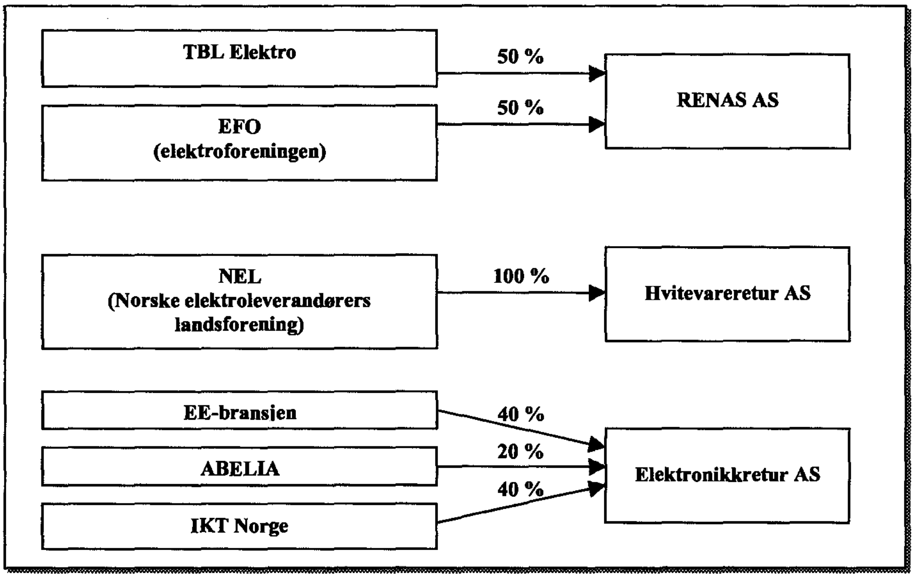

Figure 2.1: Ownership structure of the waste management companies[9]

For RENAS, EFO is a professional body for Norwegian electro manufacturers, agents and wholesalers, and TBL Elektro is an association of electro-manufacturers.

For Hvitevareretur, NEL represents the trade of white goods and household appliances. NEL is also a member to 'EE-bransjen', which is one of Elektronikkreturs' owners.

In Elektronikkretur's case, EE-Bransjen (Electro and Electronics Trade) is responsible for organizing all actors within the trade. The actors are specialized traders/dealers, chain stores, suppliers (importers/agents) and service workshops. 'ABELIA' is the association of Norwegian ICT - and knowledge-based enterprises. The organization is a trade and employers association, which is linked to Norway's leading employers organization, the Confederation of Norwegian Business and Industry (NHO). 'IKT-Norge' represents companies within the ICT industry, which works to improve the general terms and conditions of the industry.

[9] Source: The waste management companies

The waste management companies are responsible for handling the demands of the EE-Regulations on behalf of the industry. A waste management company can be described as the operative consequence of the industry agreement. Responsibilities include setting up collection systems for their respective product categories, as well as managing the stakeholders of the systems. A collection system involves collection, transport and recycling of all EE-products at end-of-life. Such systems are given directives from the EE-Regulations and these are to be looked at more closely in the next section. Each system has a number of stakeholders, who have their own particular interests. It is the waste management companies' task to facilitate fulfillment of these interests. Stakeholders include the industry organizations (i.e. the owners), the end-consumers, the EE-companies and the authorities.

The *industry organizations*' aim is to fulfill the industry agreement. The industry organizations represent the interests of the EE-companies and, if the agreement is not fulfilled, sanctions are made towards the EE-companies. The waste management companies are given the responsibility on behalf of the industry organizations. As owners of the waste management companies, they are directly involved with and have direct influence on the waste management companies. The *end-consumers* are the suppliers of volumes of waste. The end-consumers need to receive information about the collection systems, and how and where to return their EE-waste. The waste management companies are dependent on the end-consumers in order to achieve high collection rates. A third stakeholder group is the *importers and manufacturers (domestic)* of EE-products (the EE-companies). The EE-companies need a collection system to handle the EE-products at end-of-life. They can either establish their own systems or become 'members' of the waste management companies. The waste management companies provide collection systems for their members. The waste management companies are funded by their members and therefore it is necessary for them to recruit members. Information and promotion is an activity the waste management companies perform towards the EE-companies. The *authorities* are also a stakeholder group of the waste management companies. The authorities' focus is on a high collection rate. In this respect, the waste management companies have to demonstrate to the authorities that they are able to achieve this goal (i.e. 80%). A high collection rate is the means to secure the safe handling of the hazardous materials in EE-waste. In addition to collection rates, the waste management companies need to report and demonstrate that they are able to sort out the hazardous materials from the collected EE-waste, and that it is disposed of in environmentally friendly ways.

Norway is the first country in the world to implement a national broad scale system for the collection of EE-waste (SFT 1998). The systems are structured on an industry level and are provided as a service to the industry as a whole. The relation between the government, represented by the ME, and the industry, represented by the industry organizations, is illustrated below:

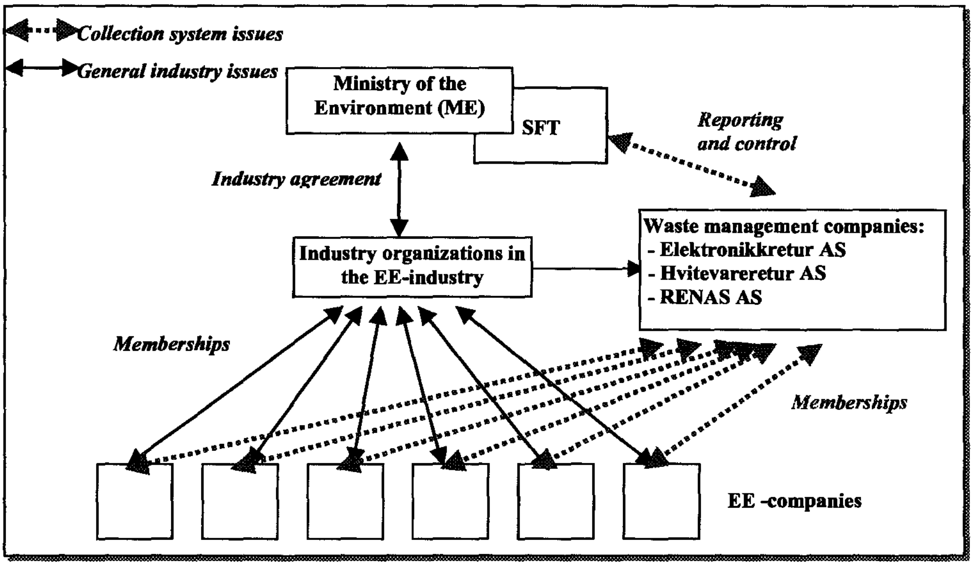

Figure 2.2: ***The relationships within the industry agreement***

The authorities use a set of policy instruments and measures for handling waste[10]. Important principles are that (1) the cost of handling waste reflects the cost for society; (2) industries and municipalities are given extended responsibilities (producer responsibility and extensive collection systems); and (3) investment is made in knowledge about waste handling. A principle of the authorities is to develop solutions for handling waste in close dialog with the involved parties, both local authorities and private companies. The industry agreement is a consequence of such a principle. The authorities use these principles in a number of waste areas, and EE-products are just one of many. The government has stated that 'it is an

[10] The information in this section is taken from St.meld.nr. 8 1999-2000 (Parliament white paper – report to the Storting) "The Government's Environmental Policy and the State of the Environment".

advantage for trade and industry[11] to have the greatest amount of freedom possible in deciding how to handle their own waste' (St. meld. nr.8:91). As a consequence, trade and industry is also legally responsible for their waste. This responsibility was previously placed with the municipalities (local authorities). The municipalities are responsible for household waste and may compete as waste companies to serve trade and industry. The change of responsibility implies that the municipalities' obligation to have the capacity to handle waste is reduced, and that private waste companies are also established in the marketplace to handle waste.

Voluntary[12] is, in other words, a key issue for the authorities in establishing collection systems for EE-waste (and other wastes). This is tied to the principle of producer responsibility[13]. The "producers" are given the responsibility to handle their products at end-of-life. In order to find effective and efficient solutions for this responsibility, it is a principle for the authorities that each company *individually* decides how to solve their challenges. The EE-companies therefore decide whether they want to become members of the waste management companies, and to which one. They could also establish their own systems as an alternative. In this case, they have to provide the authorities with evidence that they are actually collecting and handling 80% of their share of the EE-products at end-of-life.

Within the EE-waste area, a few waste management companies have been established in addition to Elektronikkretur, Hvitevareretur and RENAS. We refer to these waste management companies as representatives of "independent systems", as they are not a part of the industry agreement (cf. appendix B for an overview of such systems per 2003).

One such company, Eurovironment, has specialized in taking back ICT[14] equipment. It is a privately owned company but represents a number of ICT companies (i.e. follows the same model as the industry agreement). ICT equipment is the responsibility of the waste management company Elektonikkretur and therefore Eurovironment is a competitor. It was established because a branch of EE-companies decided to establish a collection system which consisted of different activities from those within the El-retur reverse distribution system[15].

[11] Norwegian word: Næringslivet
[12] Voluntary refers to the fact that each EE-company individually are given the legal right to decide how to solve the collection responsibilities for EE-products at end-of-life.
[13] Companies are given the responsibility for their own waste according to the Norwegian Pollution Control Act and Product Control Act. See also St.meld.nr. 8 1999-2000.
[14] ICT = Information and Communication Technology.
[15] We will return to this issue in the cases later on.

A second independent waste management company is RagnSells, which takes back all categories of EE-products but concentrates on consumer electronics. RagnSells is, in this manner, a competitor to all the other waste management companies. RagnSells' rationale for operating in this area is that it had a system prior to the industry wide initiative, with an already established customer portfolio (i.e. members). When the collection of EE-waste became prioritized, RagnSells saw this as a business opportunity.

Thirdly, there is Batteriretur AS. This company specializes in the collection of car batteries, which have an electronic component. This particular system is directed at car importers/manufacturers in Norway, and not EE-companies. Since our study focuses on the EE-industry, we do not include Batteriretur AS.

A few companies operate in-house collection systems and, as a result, have been registered with the authorities as waste management companies. These companies collect their own products and are considered marginal systems (in terms of volume). These systems are also not included in our study.

In summary, we focus on five waste management companies within the collection of EE-waste. These companies have established four different collection systems. Elektronikkretur AS and Hvitevareretur AS jointly established a collection system, which is referred to as 'the El-retur system'. RENAS AS developed a collection system for their products, which we refer to as 'the Renas system'. Collection systems outside the industry agreement are referred to as 'the independent systems', and this includes 'the Eurovironment system' and 'the RagnSells system'. "Outside the industry agreement" means that while they do not have a direct responsibility for product categories (cf. table 2.1), they do have established systems that collect the same products as the systems within the industry agreement.

The authorities introduced a trial period of five years (1999-2004) in order for the industry to demonstrate its capability to take on the responsibility of the industry agreement. During this time, the waste management companies have set up collection systems and worked systematically with the stakeholders. We come back to these issues in our case studies later. Now, we take a closer look at the regulations that relate to scrapped EE-products.

2.2 The EE-Regulations

The EE-Regulations' primary function is to prevent hazardous materials from damaging the natural environment. Waste from EE-products is assumed to contain large quantities of hazardous materials. The table below gives an indication:

Table 2.3: Estimated poisonous chemicals in EE-waste on an annual basis

Poisonous chemicals:	Volume (annual):
Lead	462 tonnes
Lead oxide	264 tonnes
Cadmium	61 tonnes
Mercury	1,6 tonnes
Bromated flame retardants	300 tonnes *
PCB	9,3 tonnes

Source: Hjellnes Cowi AS, 1996
* Adjusted according to material analysis from SFT 2003

With this point of departure, the EE-Regulations regulate collection, sorting and recycling of EE-products at end-of-life. Obligations for the involved parties are also defined in the Regulations, which provide the frame for the logistics operations (collection systems). The retailer[16] is obligated to receive and arrange the sorting, storage and forwarding of EE-waste, as well as to provide the end-consumer with information about the disposal of EE-waste. The obligation of municipalities is identical to that of the distributor.

The manufacturer (domestic) and/or importer are obligated to collect, receive and arrange for sorting, recycling and other proper treatments of EE-waste. In addition, the manufacturer (domestic) and/or importer must report annually on the activities to the authorities, and provide information to the end-consumers on how they can return products.

The EE-Regulations allow importers and manufacturers to take on the obligation by becoming members of a waste management company. The industry agreement represents this dimension in the EE-Regulations. The waste management companies have therefore needed to establish logistics operations (collection systems) on behalf of the EE-companies, and cooperate with the distributors and municipalities.

[16] In the EE-regulations the retailers are referred to as 'distributors'.

2.3 Adaptation of the EE-Regulations

The Norwegian system is considered to be successful because large volumes of EE-waste have been collected[17], and handled in an appropriate manner (SFT 2004). However, challenges have been identified, which have required the authorities to revise the EE-Regulations[18]. In particular, the following four challenges were identified (SFT 2004):

1. A large share of "free riders" among the EE-companies[19]

SFT has estimated that there are approximately 12,000 EE-companies in Norway, which account for all EE-products (SFT 11th Dec. 2002). RENAS' estimated share of all the EE-companies is approximately 7,300 and the share of El-retur's members is approximately 4,700. The waste management companies report the number of memberships to the authorities each year. The table below sums up the different waste management companies, the collection systems, the number and share of members, and the estimated share of volume:

Table 2.4: An overview of the waste management companies, collection systems and memberships

Waste management company:	Collection system:	No. of memberships (June 02):	No. of memberships in % (estimate):	Members' estimated share of the total volume (average):
Elektronikkretur AS	The El-retur system	455 companies	9.7 % *	85 %
Hvitevareretur AS	The El-retur system	150 companies	3 % *	85 %
RENAS AS	The Renas system	1300 companies	18 % **	85 %
Eurovironment AS	The Eurovironment system	22 companies	0.5 %*	85 %
RagnSells AS	The RagnSells system	79 companies	1.7 % *	85 %

* Share of 4,700 EE -companies.
** Share of 7,300 EE -companies.

The volume of products is not equally represented across the companies. SFT has assumed that free riders account for approximately 15 % of the volume (i.e. members account for approximately 85% of the volume).

[17] Compared to the 80 % collection level.
[18] Comes into force in 2005.
[19] A free rider denotes EE-companies that import and/or produce EE-products but do not have a collection system or are members of one of the waste management companies. As a consequence, waste from these companies is collected by other collection systems, which are paid for by other EE-companies.

From the numbers, we can see that approximately 10,000 companies have not become members of any of the waste management companies. SFT assumes these to be the potential group of free riders. The value is not spread equally across the companies and it is assumed that free riders represent 10 % of the imported value. From this perspective, the problem is not large but it is still assumed to create some challenges. First, free riders are assumed to gain a cost advantage. It is assumed that free riders have the potential to save approximately NOK 40 million each year. It is not possible to differentiate between the products being collected and, therefore, the members of the waste management companies pay for the free riders' waste handling. Second, the free riding might undermine the collection system, which could lead to hazardous waste not being taken care of, which could cause damage to the natural environment.

2. The information to the end-consumers is not satisfactory

Distributors and municipalities have been given the role of collection sites. As part of this task, they are obligated to provide the end-consumers of EE-products with information on where they can return products at end-of-life. However, from monitoring the 'collection sites', it is evident that this information is not provided (SFT Oct. 9th 2002, Nov 19th 2003, March 18th 2004). If the end-consumers do not get this information, the authorities fear that hazardous materials may go astray.

3. The operations are not performed according to the EE-Regulations

The authorities controlled a group of EE-companies and found that they did not operate according to the EE-Regulations (SFT Feb. 6th 2001, Oct 8th 2001). The controlled companies did not have systems that could cope with this responsibility. The retailers were also cheating on the Regulations to some degree in relation to the activities of collecting and handling returned EE-waste (SFT March 18th 04). Retailers did not provide end-consumers customers with sufficient information about the collection systems, have proper storage areas for the collected material and some retailers did not receive products from end-consumers as was anticipated by the regulations.

4. The authorities have found it difficult to control the fulfillment of the EE-Regulations

As a result of working with the EE-Regulations and the industry agreements (i.e. the waste management companies and the collection systems), the authorities have identified difficulties in securing high quality control (SFT Jan. 14th 2003). The authorities have mainly focused on controlling the EE-companies. However, when EE-companies have become members of the waste management companies, it is also necessary for the authorities to control the collection systems to ensure that the obligations are fulfilled. To control a large number of companies is resource-demanding and rather controlling the collection systems than each EE-company increases the efficiency of control.

Based on these challenges, which arose from the 1998 EE-Regulations, revisions were suggested. The issues were linked to the fact that the obligations from the EE-Regulations were rather difficult to understand. As a consequence, different practices and understandings exist and, therefore, these make the systems difficult to control and follow up. In addition, the WEEE-directive[20] from the EU needed to be incorporated into Norwegian law. The new EE-Regulations were implemented August 13th 2005.

The revisions are expected to enable the following consequences (SFT 2004):

- Simplification of the regulation of importers and manufacturers. EE-companies are obligated to join a *certified* collection system, either an industry system or an individual system. As long as the systems are certified, the authorities are better placed to control free riders (the EE-companies need to provide a certification document).
- The authorities need to implement specific demands (specific criteria) on the collection systems (i.e. the waste management companies) rather than towards on the importers and manufacturers. The authorities expect that certification of the collection system will encourage compliance with the demands (specific criteria).
- The demands on distributors and municipalities are to continue as they are but they need to be made clearer and easier to understand. The mandate to control these actors is placed on the local authorities[21].
- Incorporation of the WEEE directive. The directive covers fewer products than the Norwegian regulation and, therefore, Norway has been allowed to keep the broad scope of products in the EE-Regulations.

[20] Waste from Electrical and Electronic Equipment – directive 2002/96.

- The directive demands a realistic possibility for the producers and importers of EE-waste to choose between an individual or collective system. Continuance of the industry agreements secures collection systems for all kinds of EE-waste. The industry is expected to provide a realistic possibility to set up competing and individual systems. The demand of an 80% collection rate is continued.
- The directive demands a register of all importers and manufacturers, which includes imported volume, collected volume, recycled volume and exported volume. Registration should make it easier to detect free riders and identify the correct volume statistics.

Reading between the lines of the EE-regulations, it sounds as if the collection systems and the waste management companies are to be the main focus for the future. The collection systems have been given a greater number of direct obligations, plus the responsibility of managing the cost of these obligations. At the same time, however, the WEEE directive provides an opening for importers and manufacturers to take greater individual responsibility. Such a development may cause a tension towards the collection systems, as these systems have a collective responsibility.

The authorities are demanding that collection system have certification, and are in this manner also increasing control. This means that indirect control is to replace direct control. The level of control is to increase in total because distributors and EE-companies that do not fulfill their obligations are given increased focus. The authorities argue that the new way of controlling makes it easier to control but also gives increased control (SFT Jan 14th 2003).

The challenges with and adaptations of the EE-Regulations have shown that there is room for interpretation in the system. Therefore, the waste management companies have an important role in administrating the collection systems and stakeholders. The next section addresses the different sectors in the industry which we refer to as "the industry for the collection of EE-products at end-of-life".

[21] In Norwegian: Fylkesmannen.

2.4 The industry for the collection of EE-products at end-of-life

In order to study coordination in this context, it is necessary to understand the 'industry for the collection of EE-products at end-of-life', and we have included a brief empirical analysis of the industry. It is our argument that this industry consists of four 'sectors'. The first of these sectors are the *authorities*. The authorities have developed the EE-Regulations that sanction the need for the systems. The regulations are operationalized through the industry agreement, where the EE-industry takes on the responsibility to organize the systems. The *EE-industry* represents a second sector. The EE-industry is represented by the industry organizations and each EE-company is involved indirectly. The EE-industry has determined that the waste management companies should administer the industry agreement. The *waste management companies* are the third sector in 'the industry'. The waste management companies have engaged actors in the waste management industry to perform the operations in the collection systems. The *waste management industry* represents the fourth sector. The sectors are illustrated below:

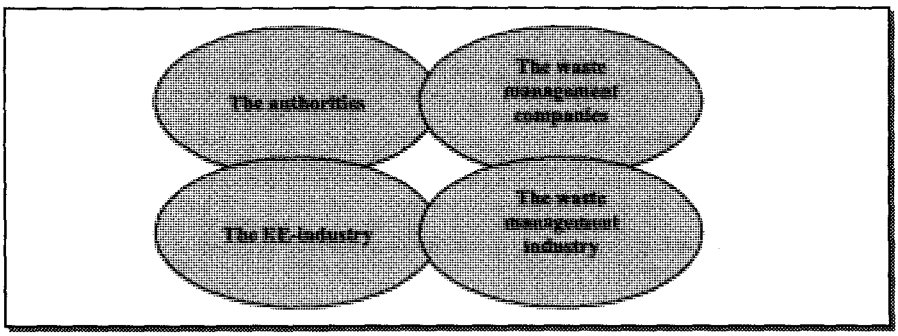

Figure 2.3: The four sectors in 'the industry for the collection of EE-products at end-of-life'

The sectors represent a picture of how flows are organized in the industry. The commercial interests are based in the EE-industry and involve the authorities, but the waste management companies administer them. The physical flows, however, are organized in the waste management industry. In this sense, there is a division of work between the actors, and it is reasonable to argue that the waste management companies administer the flows in that they coordinate the physical flows and the commercial interests. Related to a reverse distribution system, the waste management companies coordinate the funds and regulations from the stakeholders on one side and the collection system, which produces collection rates, on the other. This is illustrated below:

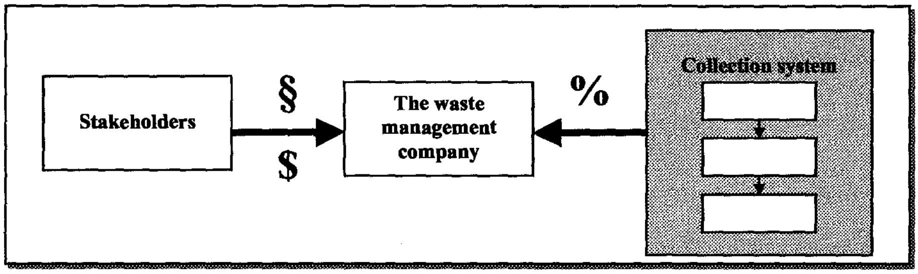

Figure 2.4: An illustration of the flows in the industry for collection of EE waste

In the table below, we show an overview of volumes for the waste management companies, i.e. for the different systems, from 1999 to 2003 (cf. appendix A)[22]. The collected volumes reflect the extent to which the waste management companies have fulfilled their mandated tasks. The numbers also indicate the market share of the volume that the waste management companies administer.

[22] The period of our study is from July 1999 until July 2004. We have therefore included data in the table that was available for each year-end.

Table 2.5: Collected and expected volumes, and collection rates from 1999 to 2003

Expected volume	**1999**	**2000**	**2001**	**2002**	**2003**
Renas	28 145	56 290	56 290	56 290	52 198
Hvitevareretur	14 632	29 263	29 263	29 263	30 183
Elektronikkretur	14 500	29 000	29 000	29 000	29 000
Total	**57 277**	**114 553**	**114 553**	**114 553**	**111 381**
Collected volume					
Renas	3 049	12 239	28 194	35 912	45 744
Hvitevareretur	6 018	16 866	20 383	22 575	26 054
Elektronikkretur	3 360	9 510	12 063	13 211	16 376
RagnSells			461	757	1 309
Eurovironment			1 522	2 016	2 230
Total	**12 427**	**38 615**	**62 623**	**74 471**	**91 714**
Collection rates*:	**%**	**%**	**%**	**%**	**%**
Renas	10,8	21,7	50,1	64,9	90,4
Hvitevareretur	41,1	57,6	69,7	78,3	86,5
Elektronikkretur	23,2	32,8	41,6	53,0	64,8
RagnSells					
Eurovironment					
Total	**21,7**	**33,7**	**52,9**	**65,3**	**82,6**
Market shares:**	**%**	**%**	**%**	**%**	**%**
Renas	24,5	31,7	45,0	48,2	49,9
Hvitevareretur	48,4	43,7	32,5	30,3	28,4
Elektronikkretur	27,0	24,6	19,3	17,7	17,9
RagnSells			0,7	1,0	1,4
Eurovironment			2,4	2,7	2,4
Total	**100**	**100**	**100**	**100**	**100**

* Calculated by dividing collected volume over expected volume.

** Calculated from collected volume

The waste management companies within the industry agreement dominate in terms of market shares. The volumes show that the independent systems run small-scale operations in comparison. The market shares have to be understood in light of the scope of the product categories that the waste management companies are responsible for. Elektronikkretur is responsible for consumer electronics, Hvitevareretur for white goods and RENAS for general electric products. The three companies are responsible for 'the total market' according to the industry agreement, and their *responsibility share* (the share of the expected volume) is not equal. In 2003, RENAS' responsibility share was 46.8 %, Elektronikkretur's was 26.1 % and Hvitevareretur's was 27.1 %.

Eurovironment has specialized in ICT equipment. RagnSells, however, collect products within all categories. Based on these categories, we can illustrate the relationship between the waste management companies as shown below:

Table 2.6: The relationships between the waste management companies

	Elektronikkretur	**Hvitevareretur**	**RENAS**	**Eurovironment**	**RagnSells**
Elektronikkretur	Market share 2003: 17.9 %				
Hvitevareretur	Cooperators (The El-retur system)	Market share 2003: 28.4 %			
RENAS	Complementary product categories	Complementary product categories	Market share 2003: 49.9 %		
Eurovironment	Competitors	Complementary product categories	Complementary product categories	Market share 2003: 2.4 %	
RagnSells	Competitors	Competitors	Competitors	Competitors & Cooperators	Market share 2003: 1.4 %

The Eurovironment system competes with El-retur in general and Elektronikkretur in particular. Elektronikkretur is responsible for the ICT category, according to the industry agreement. The ICT category has an expected volume of 7,800 tonnes per year and in 2003 Eurovironment collected approximately 28 % of the volume, while Elektronikkretur reported a 66 % collection rate. In total, the collection rate is approximately 95 %. In relation to the natural environment and the demands from the government, the collection rate is satisfactory.

However, the rates represent the *collected* volumes and they do not reveal anything about the products' disposition, i.e. the waste management option. The chosen option within the collection systems is recycling, with one exception - the Eurovironment system also reprocesses products for reuse. The reusable products are put back into the marketplace. In principle, this means that the products return to the end-of-life stage for a second time. Thus, the waste management option may be relevant for performance evaluation of the system.

2.5 Summary

Two documents direct operations in 'the industry for the collection of EE-products at end-of-life': the EE-Regulations and the industry agreement between the ME and the EE-industry. The authorities have left the responsibility of finding the best solution with which to handle EE-waste at end-of-life to the industry, but within a legal frame of reference. The industry agreement has resulted in the development of three waste management companies and two collection systems. In addition, a few independent waste management companies and collection systems have been established, although these are small scale compared to the industry agreement systems. The authorities believe that the solutions for the collection of EE-waste have been successful but have still identified a number of challenges within the area (SFT 2004). As a result of these challenges, the EE-Regulations have been subjected to revisions and changes have been suggested.

In short, a new industry has been created and a set of reverse distribution systems has been established. The flows of distribution are split between different sectors within the industry but are administered by the waste management companies. As a result, the coordination responsibility of the systems is placed with the waste management companies. The reverse distribution systems require a high degree of coordination. A number of actors are involved in the same task of collecting EE-waste but they have varied spheres of interests. However, if the waste management companies are able to achieve coordinated action between the actors, a sufficiently high collection rate is expected (i.e. 80 %).

3. THEORY on COORDINATED ACTION

In the previous chapter, we have given an overview of a practical side to the concept of coordinated action, and in this chapter we focus on getting a theoretical understanding. Coordinated action is necessary in order to achieve high performance in distribution systems (Alderson 1954). In this chapter we discuss components of coordinated action. We investigate the physical flow of goods and the commercial interests that contribute to the trading and transfer of goods in distribution systems. Particularly, our interest is to understand *coordination mechanisms* that contribute to the trading and transfer of goods in a *reverse* distribution system. The 'reverse' refers to taking back (collecting) products at end-of-life for recovery and waste management.

In this undertaking we start with the literature on 'forward' distribution systems, where the task has been to make products or services available for consumption or use (Gripsrud 2004, Stern, El-Ansary and Coughlan 1996). The process that secures this availability is in this literature represented by the concept of flows. The "flows are a set of functions performed in sequence by the channel members" (Stern, El-Ansary and Coughlan 1996:10). The flows are argued to be essential to performance in distribution systems (Bowersox and Morash 1989). In the reversed direction, it is a question of making products available for *secondary* consumption or use. As a point of departure we expect the relationship to be the same for the 'reversed' systems. That is, to follow the same principles as the forward distribution systems, even though the content of the flows and actors involved are somewhat different.

Flows are identified in the literature (Stern and El-Ansary 1992). It has been identified that the grouping and naming of flows are somewhat arbitrary (Shaw 1994) but that the there are three categories of flows (Gripsrud 2004). One of the three flows is the *physical* that represents the movement of products between locations. A second category of flows refers to the ownership dimension, which relates to who has the legal right to the products (also named the title flow). Gripsrud argues that negotiations and risking is a part of this category. The second category also represents a set of *commercial interests* in distribution systems. We therefore use the concept of commercial interests as a denotation for this category of flows. The third category is tied to the flow of *information* in distribution systems.

It is argued that all flows in a distribution system are indispensable. This means "at least one institution within the system must assume responsibility for each of them if the channel is to operate at all" (Stern and El-Ansary 1992:13). However, actors may assume responsibility for different flows. In fact, there may be actors involved in a distribution system that never actually interact with the products in question but are still very involved in the distribution (Rosenbloom 1995). These actors are involved in the commercial interests of the distribution system. The actors that facilitate the physical flow are referred to as facilitating agencies (Rosenbloom 1995). The physical flows are concerned with the changes in form, location and time that are necessary to provide inputs to suppliers and customers, and the commercial interests concern the communication and coordination activities involved in marketing (Dixon and Wilkinson 1986).

Rosenbloom (1995) argues that it is the commercial interests, rather than the physical flows of products that determine a channel of distribution (p. 137). Facilitating agencies (e.g. transportation companies) are not included in the concept of a distribution channel. Rosenbloom (1995) argues that it is important to understand the distinction between physical and title flows because it is from the title flows (i.e. commercial interests) that the "strategic marketing issues emerge" (p. 139). In Rosenbloom's discussion, it is implicitly assumed that the physical flows are subordinate to the title flow, or that the title flow directs the physical flows. It is also assumed that the physical flows follow 'the path' of the distribution channel. The understanding within the distribution channel theory is that the commercial interests between actors have dominated the physical flows. In this perspective, it has been sufficient to coordinate the commercial interests between the actors and, implicitly, the other types of flows have also been coordinated.

However, separation of activity flows can have stand-alone specialization advantages and may facilitate alternative channel strategies (Bowersox and Morash 1989). Håkansson and Persson (2004) identify trends of differentiation and specialization. Economies are achieved when specialist companies take the responsibility for activities in a distribution system. Next, differentiation of customer segments and demands for increased performance calls for increased integration of activities across firm boundaries. The trends indicate that flows are becoming decoupled, especially where the physical flows have experienced specialization advantages. The consequence is an increased need for coordination. Physical flows are a significant element in distribution systems and we argue that coordination is needed for both commercial interests *and* physical flows.

The different categories of flow represent the trading and transfer of different elements in a distribution system. The commercial interests refer to fulfilling the transfer of rights between parties, which is the performance of an exchange or transaction. The coordination mechanisms for commercial interests are aimed at regulating the transaction. The means of coordination is well documented in the governance literature and the transaction cost theory paradigm (Gripsrud 2004, Rindfleisch and Heide 1997, Heide 1994, Williamson 1985, 1975). We depart from this literature to learn about the coordination of commercial interests in order to achieve coordinated action in a reverse distribution system. These issues are discussed in section 3.3.

The physical flows refer to the physical movement of goods between different locations in a distribution system. The coordination mechanisms for physical flows aim to ensure the execution of the necessary activities in order for the movement of goods. The logic of how activities are connected is found by identifying their interdependencies (Thompson 1967). Different types of coordination mechanisms address various kinds of interdependencies. Thus, it is our argument that the coordination of activities in the physical flow has to be addressed specifically in order to achieve coordinated action in distribution systems. The means of coordination are different from those in the governance literature and we discuss them in section 3.2.

To understand coordinated action in distribution systems we argue that it is necessary to understand coordination in the different types of flows individually. In this study we seek to understand the coordination of physical flows and commercial interests because it is reported that the research streams on physical flows and commercial interests have developed in different directions (Håkansson and Persson 2004, Gripsrud 2004). The areas have been studied separately. The commercial interests have been studied in the governance literature. The physical flows have been addressed in the logistics and supply chain management literature. It is our aim to contribute to renewed integration because we believe it is necessary to understand the interaction between both sets of flows in order to achieve coordinated action in distribution systems. We use the terminology *distribution systems* in our study to indicate that we include several of the flows, unlike the concept of distribution channel, which refers to a limited selection of the flows (Rosenbloom 1995).

'Reverse' distribution systems have distinctive features compared to 'forward' distribution systems. We start with a review of literature on reverse distribution systems in order to clarify these features, before we continue with understanding coordination of physical flows and commercial interests. The concept of coordinated action is then explicitly addressed in the last section in this chapter.

3.1 Reverse distribution systems

Distribution is a central topic to reverse issues. In the early '70s, it was stated that "recycling is primarily a channels-of-distribution problem, because the major cost of recycling waste products is their collection, sorting and transportation" (Zikmund and Stanton 1971:34). The 'reverse' dimension refers to the process of collecting products at the point of consumption for recovery and waste management (i.e. handling at end-of-life), and are referred to as recycling, collection systems, take back programs and the like. Reverse distribution systems are different from 'forward' distribution systems where products are available from producers and sorted to the consumers. In the reverse distribution systems there are activities like collection and dismantling of products. We start by investigating some definitions before we discuss reverse distribution systems in more detail.

3.1.1 Definitions

Use of 'reverse' indicates the direction of how the goods flow, so that it is not confused with 'forward' distribution. In forward distribution, goods flow from a producer through a system to an end consumer. In reverse distribution, the products flow from end-consumers through a system and 'back' to a point where they are being handled at end-of-life, i.e.:

"Reverse distribution refers to the movement of goods from a consumer back towards a producer in a channel of distribution." (Murphy 1986)

Reverse distribution systems have the same task of moving products from one location to another as forward systems, but the content of the systems have distinctive 'reverse' features. The traditional roles are turned 'upside down' where customers are counted as producers and producers are counted as final users (Ginter and Starling 1978). In this respect, definitions of reverse distribution systems imply that the actors involved have different roles (Ginter and

Starling 1978, Zikmund and Stanton 1971). Reverse distribution systems have also been defined with respect to what types of intermediaries are included, e.g. traditional middlemen, secondary material dealers, manufacturer-controlled recycling centers, and resource recovery centers (Fuller and Allen 1995, Guiltinan and Nwokoye 1975). Fuller and Allen (1995) identify that reverse systems are directed to different types of markets than forward channels (i.e. secondary markets), and that different types of activities are emphasized in reverse distribution, e.g. collection.

In addressing the management of physical flows within reverse distribution systems, a definition of reverse logistics[23] is provided from Rogers and Tibben-Lembke:

...the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value for proper disposal. (Rogers and Tibben-Lembke 1998)

The definition is in many ways a 'reversed' version of the CLM[24] definition of logistics, which indicates that even though the reverse has its distinct activities much of the logistics operations are the same. That is, managing the physical flow of products moving from one location to another. Pohlen and Farris (1992) also define reverse logistics as performing a number of key functions in order to secure the flow of products being returned. Rogers and Tibben-Lembke (1998) include the physical flow for both products at end-of-life and commercial returns (Fleischmann 2000) or merchandise returns (Minner 2001). The latter includes products that are returned from point-of-sale as a consequence of being expired and is not relevant for sale anymore[25]. In our work, we do not discuss this issue. We are concerned with products that have been used/consumed and are returned at end-of-life.

There are several waste management options for products at end-of-life (e.g. Carter and Ellram 1998, Thierry et. al. 1995). The options range from reuse and remanufacturing, to

[23] Reverse logistics is used as a term for the management of reverse physical flows, as logistics denotes management of physical flows. We return to the logistics literature in more detail in section 3.2.
[24] Council of Logistics Management – an association for individuals involved in logistics and supply chain management, which is based in the USA. CLM promotes research and publications in logistics and supply chain management. CLM is renamed to CSCMP – Council of Supply Chain Management Professionals in 2006.

[25] The distinction between products at end-of-life and commercial returns can be explained by the difference in regulation between Europe and the US. In Europe, producer responsibility has been introduced as a political principle in many countries. This has forced companies to focus on the reverse logistics of products at end-of-life. However, such a political principle is not introduced in the US, and the American companies therefore have a different focus. European companies focus to a larger extent on the natural environment, while US companies focus on cost control when discussing reverse logistics issues.

recycling and disposal, and are referred to as recovery and waste management. Several authors have provided an overview of options. It is not our purpose to discuss these in detail but to illustrate the range of options for products that are returned at end-of-life. Thierry et. al. (1995) provide a typology for recovery and waste management options:

Table 3.1: Recovery and waste management options (Thierry et. al. 1995)

Recovery and waste management options:	Definition:
Reuse	Products are reused or resold without any adjustments except cleansing.
Product recovery management	
Repair	Product repair involves the fixing and/or replacement of broken parts in a product, which are returned to working order.
Refurbishing	The purpose of refurbishing is to bring used product up to specified quality. Quality standards are less rigorous than those for new products. All critical modules are inspected and fixed or replaced.
Remanufacturing	The purpose of remanufacturing is to bring used products up to quality standards that are as rigorous as those for new products. Used products are completely disassembled and all models and parts are extensively inspected.
Cannibalization	Only a small proportion of used products are being reused. The purpose of cannibalization is to recover a limited set of reusable parts from used products or components. The parts are reused in repair, refurbishing or remanufacturing of other products or components.
Recycling	The purpose of recycling is to reuse materials from used products and components.
Waste management	
Incineration	Products are disposed of by incineration
Land filling	Products are disposed of by land filling

The categories are not mutually exclusive. The literature suggests that there is some form of step-wise sequence between these categories (Carter and Ellram 1998, Thierry et. al. 1995). Returned products may at first be subjected to a reuse option, secondly for remanufacturing, thirdly for recycling, and the last option would be disposal. These options have been referred to as the "waste hierarchy" (Carter and Ellram 1998, Jahre 1995c).

Thierry et. al. (1995) identify different characteristics of and differences between the product recovery options along dimensions such as level of disassembly, quality requirement and output. Depending on the option for the products being returned, the physical flow takes a different form (Thierry et. al. 1995). The physical flow is, in other words, directly influenced by the waste management option. The first step when products are returned at end-of-life (i.e. in the reverse process) is to identify the recovery and waste management option(s).

The option is, however, not necessarily an open decision-making variable in reverse distribution systems. Rather, the decision of what to do with the products at end-of-life can be set as a design variable for reverse distribution systems up front. That is, the systems may be designed for reuse only or recycling only, and so on. The studies listed in the table below indicate that systems have been designed for specific rather than multiple options:

Table 3.2: Examples of studies with a specific return options

Purpose of return:	Title of work:	Author(s):
Recycling	Recycling solid wastes: a channel-of-distribution problem	Zikmund and Stanton (1971)
Recycling	Developing distribution channels and systems in the emerging recycling industries	Guiltinan and Nwokoye (1975)
Recycling	Reverse distribution channels for recycling	Ginter and Starling (1978)
Recycling	Recycling: a problem in reverse logistics	Barnes jr. (1982)
Recycling	Reverse logistics in plastics recycling	Pohlen and Farris (1992)
Recycling	A typology of reverse channel systems for post-consumer recyclables	Fuller and Allen (1995)
Recycling	A two level network for recycling sand: a case study	Barros, Dekker and Scholten (1998)
Recycling and reuse	Supply loops and their constraints: the industrial ecology of recycling and reuse	Geyer and Jackson (2004)
Remanufacturing	A decision support system for planning remanufacturing at Nortel Networks	Linton and Johnston (2000)
Remanufacturing	Competition in remanufacturing	Mahjumder and Groenevelt (2001)
Remanufacturing	On the non-optimality of the average cost approach for inventory models with remanufacturing	Teunter and van der Laan (2002)
Remanufacturing	Meeting the closed-loop challenge: the case of remanufacturing	Seitz and Peattie (2004)
Remanufacturing and reuse	A hierarchical decision model for re-manufacturing and re-use	Guide jr. and Pentico (2003)
Repair	Strategic examination of reverse logistics and repair service requirements, needs, market size and opportunities	Blumberg (1999)
Reuse	Returnable containers: an example of reverse logistics	Kroon and Vrijens (1995)

An important distinction is whether the reverse distribution system is within the scope of one company or a corporation. The characteristics of the systems discussed in Thierry et. al. (1995) are that they are internal to one company. This is referred to as a *closed loop process* (Krikke et.al. 2004, Setitz and Pattie 2004, Kopicki et. al. 1993). However, reverse distribution systems are also implemented as *open loop processes*, where the collection of products at end-of-life is not subject to only one company (Kopicki et. al. 1993). In open loop processes, the manufacturers often take responsibility for reverse distribution systems but do not necessarily use the recovered materials themselves. It is reported that companies increasingly leave it to industry trade associations to establish the open loop, reverse distribution systems (Kopicki et. al. 1993). In the next section we take a closer look at the components of reverse distribution systems.

3.1.2 Components of reverse distribution systems

Studies of reverse distribution systems have focused on identifying distinct features – "what is the 'reverse'?" (Fuller and Allen 1995, Jahre 1995c, Pohlen and Farris 1992, Barnes 1982, Guiltinan and Nwokoye 1975, Zikmund and Stanton 1971). The distinction between commercial interests and physical flows is not clear in the literature on reverse distribution systems. Rather, the literature has focused on the physical flows, as this to a large extent has been the main challenge for the reverse. Reverse physical flows involve two main activities; *collection* and *reprocessing* (Jahre 1995a). Collection is the process of making returned products available for reprocessing, and reprocessing is the process by which materials are made into substitutes for primary materials (Jahre 1995a). A *collection system* links the provider of products (i.e. end-consumer) with the users (i.e. when the products are reprocessed and taken into secondary use). The collection system includes five levels: the consumer level, the collection level, the transfer level, the reprocessing level and the end-markets level (Jahre 1995a). The term collection system is thus used to denote all the levels and activities in physically moving products through the reverse distribution system. However, the commercial dimension is not normally taken into consideration in the term collection system. In this thesis, the concept 'reverse distribution system' includes both physical flows and commercial interests.

The starting point of a collection system is the consumer level, which represents the producer or manufacturer in the reverse distribution system. However, Zikmund and Stanton (1971) identified that the consumer does not consider itself as a "producer" of waste materials and is, as a consequence, not 'marketing' the products at end-of-life to any degree. As the consumer does not take an active part as the 'seller' in the reverse distribution system, authors have identified that the systems have been characterized by inherent supply uncertainty (Fleischmann 2000). The reverse distribution systems therefore have to compensate for the end-consumer's lack of incentive to "find markets" for their products at end-of-life (Barnes 1982, Zikmund and Stanton 1971). In this respect, the reverse distribution systems need to be structured to *actively* seek the products at end-of-life and motivate the consumers to return the products.

In an investigation of collection systems for household waste, Jahre (1995b) identifies that service towards consumers is complex. However, it is an important aspect because it has a direct impact on the performance of the collection system. Service aspects include dimensions like collection frequency, transportation work for the consumer, and the number of fractions to sort out (Jahre 1995b). Higher service towards the end-consumer indicates a higher collection rate in the system and this contributes to the reduction of supply uncertainty. A high service level also implies high costs for the system. It can be argued, therefore, that the systems most likely have to trade off between service and costs, and have to find a satisfactory service level for the systems.

The service level is reflected in a discussion on the establishment of kerbside versus bring collection systems (Jahre 1995b). The study finds that a more direct channel structure is implemented in systems with a high degree of separation of fractions at source, but does not conclude which system is better. In fact, it is found that the efficiency dimensions do not distinguish between the systems. It is not straightforward which is a better and worse score for one single efficiency dimension. It is identified that there is a trade off between the collection and processing costs, but that systems needs to be evaluated with more efficiency criteria than costs alone. The study contributes to the understanding of reverse physical flow and channel structure but the choice of design is dependent on a number of contextual variables.

An incentive that may be implemented in a reverse distribution system to increase the return rate is a deposit. Lambert and Towle (1980) discuss the effects of implementing a deposit and argue that the waste management option of the system has a direct influence on how to organize the deposit. The study concerns beverage containers and, to the extent that the purpose is to reduce litter, the deposit may be implemented at the retail level, where the loop for the products being returned is organized. If recycling and reuse is the purpose, it is recommended that the deposit should be implemented at the manufacturer level. In this case, the containers are returned to the manufacturers for reuse and recycling. However, it is argued that the deposit is size sensitive in order to work as an incentive.

Guiltinan and Nwokoye (1975) identify four types of reverse distribution systems based on different types of intermediaries such as traditional middlemen, secondary materials dealers, manufacturer-controlled recycling centers or resource recovery centers. The type of system chosen depends on the waste management option, e.g. reusable bottles, recycling, and the markets served, i.e. the receiver of the collected products. Guiltinan and Nwokoye (1975) indicate that the coordination is achieved through *legislation* for traditional middlemen, *vertical integration* for manufacturer-controlled recycling centers, *communication* for resource recovery centers, and *market forces* for the secondary materials dealers. Fuller and Allen (1995) have made a similar classification, identifying five types of reverse distribution systems. The systems are classified as manufacturer-integrated systems, waste hauler systems, specialized reverse dealer/processor systems, traditional forward wholesaler-retailer systems and temporary facilitator systems. In accordance with Guiltinan and Nwokoye (1975), the goal of the systems is to match collected materials with end-markets. Coordination is achieved through *vertical integration* for the manufacturer-integrated systems; *market forces* for the waste hauler systems and specialized reverse dealer/processor systems; *legislation* for the traditional forward wholesaler-retailer systems; and *voluntary contributions* in the temporary systems. The coordination mechanisms of the reverse distribution systems represent a way of coordinating the commercial interests of the system. The systems are structured based on the intermediary that is in control of the physical flow and commercial interests.

The systems are a mix between closed and open loop processes (Kopicki et. al. 1993). In addition to distinguishing between intra- and interorganizational systems, the 'open-closed' distinction refers to the waste management options. The closed loop processes include the cases where the products go back for the same original use, i.e. reuse (e.g. computers are taken back for secondary use) and to the same actors, i.e. manufacturer-controlled systems. In this sense, the closed loop processes are coordinated with vertical integration, while the open loop processes are coordinated with legislation, the market forces, communication and voluntary contribution. Open loop processes represent situations where the products are returned and recovered for options different from the original use. The actors involved are different from those in the forward flows and include types such as the waste haulers and recovery centers. In a reflection of "who organizes" a reverse distribution system, Guiltinan and Nwokoye (1975) suggest a joint venture resource recovery operation as the most likely organizer.

Intermediaries and functions are also discussed in Pohlen and Farris (1992). They argue that the types of systems suggested by Guiltinan and Nwokoye (1975) have changed and developed, and find new types of intermediaries in their study. It is argued that "the reverse channel may take several different forms depending on individual channel members' functions or ability to perform recycling tasks" (Pohlen and Farris 1992:37). Further, it is argued that "specific channels can be best understood by examining the specific functions performed by each member occurring during their reverse flow of the recyclable materials" (p.37). Rather than focusing on intermediaries (i.e. actors), Pohlen and Farris (1992) identify that functions are the proper unit of observation when examining collection systems. A framework includes eight functions that members in a reverse distribution system may perform. The functions are listed below:

Table 3.3: Functions in a reverse distribution system (Pohlen and Farris 1992)

Functions:	Definition:	Main identified challenge:
Collection	Collection is the process by which recyclable materials are diverted from the general waste stream and delivered to a processing facility or handler.	Achieve cooperation with the consumers.
Sorting	Separation of recyclables from one another.	Labor intensive and cost inefficient.
Storage	Accumulation of volume to permit economical shipment. Storage can be both outside and inside.	Outside storage connotes the image of a "dump" and requires protection. Risk of contamination.
Transport	Move collected materials or products from one site to another. Occurs at several stages within the channel.	Represent often the largest costs in the channel. Achieve a low density in the materials.
Compaction, shredding or densification	Techniques that attempt to increase the recyclable material's density to reduce transport costs.	Technical challenges and investment decisions.
Communication with buyers	Provide linkages between subsequent channel members.	The importance grows as the volume of participating actors increases.
Processing or filtration	Intermediary processing converts the recyclable commodity into a form ready for direct insertion into the retro manufacturing process.	The process varies from each recyclable commodity.
Retro manufacturing	The use of recycled commodities in a manufacturing process.	Quality in the secondary materials

The functions are one specific set adapted to the context of plastics recycling but serve as a point of departure for analyzing reverse distribution channels in general. The functions are an example of adaptation to Alderson's (1954) sorting processes[26]. However, Barnes (1982) argues that the recycling literature does not seem to put as much emphasis on assorting and allocation as the traditional forward approach does, which indicates that the functions of a reverse distribution system are of a different character from those in a forward system.

[26] See section 3.2.1.

Collection systems are analyzed within operations research. Fleischmann et. al. (1997) review quantitative models for reverse logistics and identify that reverse logistics encompass distribution planning, inventory management and production planning. They find that models for the 'traditional' forward logistics are readily applied also to the reverse issues but that some aspects within a reverse process need new planning methods. Reverse and 'traditional' forward flows have distinct differences (Fleischmann et. al. 2000).

Guide et. al. (2000) identify that collection systems have increased uncertainty compared to forward systems, and differentiate between uncertainties in supply, the materials' quality and the reprocessing. A set of tools and techniques are suggested to cope with these uncertainties. For supply uncertainty, it is suggested that forecasting, inventory control systems and decision tools indicate when products are returned, and how much and at what time they are available for reprocessing. It is also suggested that a close relationship between suppliers and manufacturers helps to reduce supply uncertainty. The study focuses on remanufacturing and the returned products, therefore, enter into a secondary production process. In this perspective, it is more important to control the quality of the returned products than for those that are returned for recycling. The disassembly is regarded as a key factor for the quality of the reprocessing because it is the input to a number of processes. The authors therefore emphasize the impact of having a high quality disassembly function. It is suggested that modified materials-requirements-planning can help manage and control dependent demand inventories. Logistics planning, matching and stochastic routing techniques are suggested in order to cope with reprocessing uncertainty for remanufacturing.

It is, in other words, evident that the 'reverse' dimension creates new coordination needs and this is amplified in a study by Krikke et. al. (2004) on coordination issues in closed loop supply chains. A closed loop supply chain consists of both the forward and reverse processes, involves a mix of reuse options and is organized within the scope of one corporation. The study argues that a reverse process consists of product acquisition, reverse logistics, sorting and disposition, recovery and redistribution, and sales. The study demonstrates that it is necessary to secure the product flow of products at end-of-life, find and identify markets for the products, and provide the reuse disassembly function with necessary product information.

Similar findings are identified in a study of a closed loop for the remanufacturing of car engines. The reverse system is often integrated with the forward system and therefore the reverse system cost is difficult to isolate (Seitz and Pattie 2004). It is further argued that the

"...remanufacturer..., has little choice but to accept what they are given,.."(p. 81). The understanding is based on the fact that the return of products is dependent on their unpredictable durability. It is also recognized that the products may not necessarily be returned to the defined remanufacturer. In this respect, the authors argue that it is crucial to maintain a relationship with the customers and, in this way, secure that the products are in fact returned. When products are returned, remanufacturing faces the challenge of a high level of product variants, and the reassembly is characterized with low batch sizes. Further, the remanufacturing is often dependent on skilled engineers rather than automated production lines. However, Seitz and Pattie (2004) identify that manufacturing makes decisions to the disadvantage of remanufacturing, and that it is necessary to have the closed loop perspective in order to improve the terms of remanufacturing.

The table summarizes the challenges that are associated with the taking back of products at end-of-life and how this product flow may be managed.

Table 3.4: Challenges and management of reverse product flows

Challenges for product flows in reverse logistics	**Management of the product flows**
• Variability in returned volume • Variability in types of returned products • Variability in the quality of the returned products	• Forecasting and inventory management • Product evaluation function • High quality disassembly function and skilled remanufacturing

These studies demonstrate the increased complexity of a distribution system when reverse issues are introduced. The flows become multidimensional and include both new and 'old' products. In this manner, it is necessary to develop new coordination techniques that incorporate this increased complexity. There is, however, a difference between handling complexity in closed loop vs. open loop systems. Even though the studies of closed loops clearly demonstrate challenges, they are administered by one corporation and at some level the corporation is in control of the system. Open loop systems face the same type of challenges for the reverse product flows, but face different types of coordination challenges. As a consequence, there have been a number of studies that have focused on clarifying how exogenous factors influence reversed distribution systems (Knemeyer et. al. 2002, Stock and Lambert 2001, Dowlatshahi 2000, Carter and Ellram 1998). However, we do not have such a focus in our study and, therefore, we do not discuss these factors further.

3.1.3 Positioning the study

Literature on reverse distribution systems has been occupied with the identification of types of actors and functions. It has clarified the complexity of the 'reverse' and suggested some coordination techniques. It is evident that the 'reverse' has its distinct challenges as compared to 'forward' distribution. On an overall basis, the products are *collected from* rather than *delivered to* consumers and they are *reprocessed* rather than *consumed.* For example, the consumer is the supplier rather than the buyer of products, the activities are designed to collect rather than deliver products, and the systems are designed to serve recycling centers rather than retailers. Various types of intermediaries can perform collection, and the type of intermediary is to a large extent defined depending on the waste management option for the returned products. The waste management option also has impact on the type of functions and activities that the actors perform. For example, whether products are reused or recycled influences the type of reprocessing activities. The literature demonstrates also that collection systems are characterized by variability in the products flows and that the end-consumer is a passive supplier in the reverse process.

The reverse distribution system has to address these challenges. The physical flow in a reverse distribution system, which is referred to as the collection system, includes five levels. The collection level, transfer level and reprocessing level link the consumer and the end (secondary) markets. In our study we focus on the activities between the consumers and the end markets.

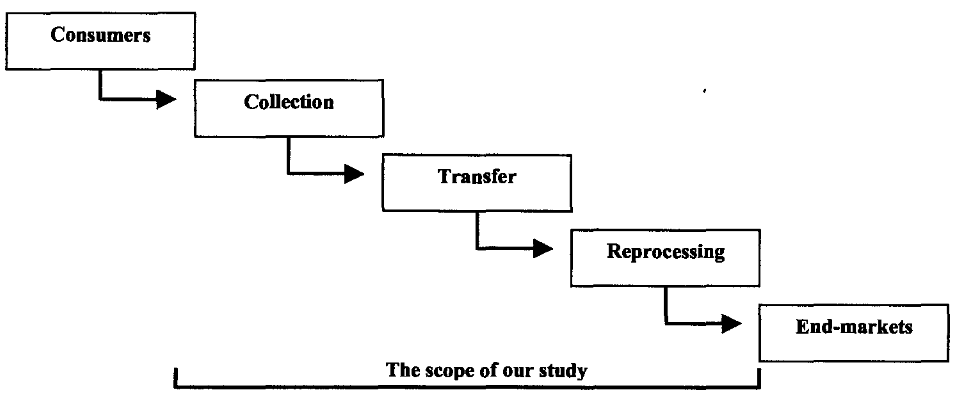

Figure 3.1: The study's scope includes the collection, transfer and reprocessing levels

The literature demonstrates a need for coordination but gives limited guidance apart from the distinction between *open and closed loop processes*. In a closed loop process, the collection and reprocessing is internal to a company, while it is interorganizational in the open loop processes. However, we have not identified any study that has addressed the coordination issues of both physical flows and commercial interests.

The literature on 'reverse' issues has indicated that it is appropriate to depart from knowledge developed from forward distribution systems, when developing knowledge on reverse distribution systems. In this respect we want to depart from insight on coordination of physical flows and commercial interests in forward distribution systems when developing knowledge of coordination in these areas in reverse distribution systems. We start by discussing the coordination mechanisms for physical flows, before moving on to the coordination mechanisms for commercial interests, which is covered in section 3.3.

3.2 Coordination mechanisms for physical flows

In this section we draw on the knowledge of coordination of physical flows in forward distribution systems. Physical flows are a significant dimension in distribution systems and this is important to consider when we seek to understand how coordinated action is achieved. Physical flows denote the movement of products. It is referred to as the physical aspect of exchange (Bartels 1988). In trying to understand physical flows, it is natural to draw on the logistics, supply chain management and distribution literature. The structuring of activities in order to secure physical movement is addressed in logistics and supply chain management. The logistics and supply chain management addresses the management of physical flows in its entirety from 'point of origin to the point of consumption' (Stock and Lambert 2001). In distribution systems, the physical flow closes the gap between production/manufacturing and consumption of products. The distribution literature addresses functions and intermediaries as a means to achieve such a task (Gattorna 1978). After having described the features of physical flows, we focus on coordination issues based on interdependencies in activity structures (Håkansson and Persson 2004, Thompson 1967).

3.2.1 Features of physical flows

In the distribution literature it is argued that various sorting processes are crucial for efficiency and effectiveness in physical flows. Alderson (1954) makes a distinction between four dimensions of sorting that are necessary for bridging the gap between production and consumption: sorting out, accumulation, allocation and assorting. *Sorting out* represents breaking down heterogeneous supply into separate stocks that are relatively homogenous. *Accumulating* denotes the bringing together of similar stocks into larger homogenous supply. *Allocation* represents breaking homogenous supply down into smaller and smaller lots. *Assorting* refers to building up the assortment of products for use in association with each other. These factors, together with routinization of transactions, represent the logic of why a sequence of marketing agencies hangs together (Alderson 1954). Alderson (1954) argues that the cost of moving goods can be minimized if the transaction can be reduced to a routine. In order for a transaction to be routinized, it must happen according to rules and both sides must understand these rules. It is in many respects a division of labor between the actors involved (Gadde and Håkansson 2001).

The activities necessary to ensure the movement of products are described and analysed in further detail in the logistics and supply chain management literature. The detailed mapping of activities in these models contributes to the understanding of physical flows (Persson 1995). That is, the activity sequences and the matching of activities, both internally and externally, to actors taking part in a system. To understand physical flows it is necessary to gain an understanding of the underlying activity structures. The mapping of activities is not limited to any specific actor or part of the physical flow but seeks to include all relevant activities in the system. There is an underlying systems view to logistics in the sense that it is an entire system of activities working with and relying on one another (Jahre and Persson 2005, Stock and Lambert 2001, Kent and Flint 1997).

The holistic approach has been a trademark of logistics and supply chain management. There are, however, some differences between how the organization of activities has been conceptualized in the logistics literature versus that of the supply chain management literature (Cooper et. al. 1997). In logistics, activities are categorized into functions, such as inventory, transport, warehousing, order management and production (Lambert 1976). In supply chain management, the activity structures are to a larger extent described in accordance with the purpose of the physical flow (Harland 1996, Lambert et. al. 1998). That is, a physical flow in supply chain management is conceptualised by using activities from all the functions of, for example, inventory, warehousing and transport at the same time, and focuses more on the sequence of activities. In addition, the activities within supply chain management are defined more broadly, and include also customer management and product development processes (Cooper et. al. 1997). In other words, the activities that are included in the logistics and supply chain management conceptualizations are to a large degree the same but they have a somewhat different view of *how* activities are organized in order to ensure movement of physical flows.

The different perspectives have resulted in different views of physical flows. Supply chain management has contributed to linking various stand-alone programs, such as just-in-time and total quality management into holistic and 'seamless' activity structures (Bechtel and Jayaram 1997). The physical flows have, in other words, experienced a change in focus from functions being looked upon in their entirety to the single activities that make up and take place in the functions (Lambert et. al. 1998, Cooper et. al. 1997, Cooper and Ellram 1993, Ellram 1990). In many respects, the breakdown of the traditional logistics functions of warehousing, inventory and transport, to stand-alone activities has made physical flows more interdependent and may explain increased levels of integration (Svensson 2002). A focus on single activities makes it easier to match them in activity structures. The physical flows may, in this way, be composed of different functions other than the traditional categorizations, such as inventory, warehousing and transportation. Recent developments focus on, for example, efficient consumer response, quick response, just-in-time (Svensson 2002) and cross-docking (Apte and Viswanathan 2000). The developments within logistics and supply chain management have, in other words, made new activity combinations more visible and demonstrate that it is important to break down a physical flow into a structure of activities.

These activities are combined into various functions that reflect the tasks of the distribution systems. These functions are allocated to various types of actors taking part in the distribution system. The actors are, in general terms, the producer/manufacturer, intermediaries and the consumer, and show how distribution systems are organized. A distribution system may be illustrated as a matrix of functions and actors. The matrix gives an indication of how the division of work can be between actors taking part in a distribution system. A typical example of such a matrix is illustrated in the table below[27]:

[27] The functions are examples rather than suggestions of a defined set from our point of view.

Table 3.5: Distribution systems consist of a combination of actors and functions

Actors / Functions	Producer/ manufacturer	Intermediary	Intermediary	Intermediary	Consumer
Production					
Promotion					
Ordering					
Transport					
Storage					
Risking					
Financing					
Payment					

Intermediaries are included in order to adjust for a discrepancy between what one single producer can offer and the more complex need of a customer. The logic is based on scale and scope economy thinking. That is, each of the intermediaries are included because it can perform functions to a larger scale than the other intermediaries and, as such, enables scope economies in the distribution system (Alderson 1954). The structure is, as such, a result of the cost curves of different functions. A shift of functions, or functional spin off, among the intermediaries generates a different performance level in the distribution system (Mallen 1973). The distribution system, as seen using a functional approach, attempts to answer two questions (Gattorna 1978): (1) what is the most efficient functional mix in a given situation, and (2) how will this functional mix affect and influence the structure of the system? It is argued that the type of intermediary is not important in itself but rather it is the specific mix of services or functions that a particular intermediary provides that counts. However, the intermediary is significant in the sense that it takes on a qualitative aspect of matching supply and demand (Alderson 1949). This aspect is taken for granted by the economist but in his discussion of the wholesaler, Alderson (1949) argues that this intermediary "manipulate[s] products which have already been fabricated and without altering them in any way except to place them in the possession of the persons who demand them" (p. 150).

The intermediaries and the functions represent two sides of the same task, in the sense that the intermediary performs functions and the functions define the type of intermediary. For example, a transport operator may only perform a transport function, while a third party logistic operator may perform transport, storage and ordering functions (Persson and Virum 2001). The actual number of intermediaries results from the number of functions each of them undertakes responsibility for, in combination with the functions and activities the producers/manufacturers and consumers perform. At one extreme, there are no intermediaries at all, if the producer/manufacturer and the consumer perform all the functions. At the other, there may be many. In distribution systems, it is the combination of functions and actors that is interesting. That is, who is going to do what? It indicates, for example, how actors have specialized and, in turn, where the integration challenges may occur. Another example is that a distribution system can be dedicated exclusively to a limited product portfolio or be open for a broad range of products. The structuring of functions and actors to a large extent defines distribution systems.

The structure of a distribution system is addressed in the literature, with reference to basic dimensions like *length*, *intensity* and *types* of intermediaries (Rosenbloom 1995). Length refers to how many different categories of intermediaries are involved and to the number of stages. For example, three intermediaries are involved in a three-stage distribution system. The length is influenced by a number of factors such as geographical dispersion and size of the customer base. If the manufacturer desires closer control of the distribution, the system is likely to involve fewer intermediaries and be shorter. The structure is also described in terms of whether it is intensive, selective or exclusive, which refer to the number of intermediaries within a particular area (Rosenbloom 1995). Intensive implies a high number, whereas exclusive implies a low number of intermediaries.

The distribution literature does not always refer to the intermediaries that are involved in the physical flow of the distribution system. That is, a transport operator is not accounted for as a stage in the distribution system. However, this is accounted for in the logistics and supply chain management literature, where it is argued that the primary members of a supply chain are "...strategic business units who actually perform operational and/or managerial activities in the business processes..." (Lambert et. al. 1998:5). In order to *manage* the supply chain, Lambert et. al. (1998) argue that it is necessary to distinguish between primary and secondary members. Secondary members are the "companies that simply provide resources, knowledge utilities or assets for the primary members" (p.5). The participating actors are involved in both physical and other activities (Lambert et. al. 1998, Cooper et. al. 1997, Cooper and Ellram 1993). The focus of our study is to separate out the physical flow specifically in order to learn the effect of this dimension on the ability to achieve coordinated action in distribution systems. It is therefore necessary to include and visualize the actors that perform physical activities as a part of distribution systems. We use the concept of intermediary because actors involved in the physical flow have an intermediary role in the distribution system, where products are moved from one location to another for the purpose of consumption.

The general trend is that there are increasing numbers and types of intermediaries present in distribution systems, as a consequence of an increasing level of functional specialization (Gadde 2000). Intermediaries specialize in a limited number of activities, which result in an increasing number of intermediaries becoming involved in the delivery of products to the end-customer (Gadde 2000). Specializations call for coordination when an increased number of actors become involved in a distribution system (Gadde 2000). The increased specialization also makes it relevant to understand coordination in more detail. This applies specifically when such specializations are compared to the coordination of distribution systems that have been promoted within the concept of vertical marketing systems, where a distribution system to a larger extent is treated as one unity (Stern and El-Ansary 1992). In differentiated distribution systems (Gadde 2000), there are correspondingly differentiated coordination challenges.

3.2.2 Coordinating physical flows

Physical flows consist of activity structures that are grouped into functions and performed by intermediaries. An example of this relationship can be given by the activities: registration of, loading, stacking and unloading of goods that may constitute a transport function, which may be a part of a logistics service provider. The need for coordination of physical flows is demonstrated in the supply chain management literature where activity structures are viewed from a focal company, and actors are linked both vertically and horizontally in several tiers (Lambert et. al. 1998). Actors are also dependent on the relations beyond their immediate partners. The activities of a focal company are dependent on activities performed by surrounding companies (Håkansson and Persson 2004). In this literature, it is demonstrated that a focal company is linked to a larger activity structure. In this respect, the understanding of key business processes and their structure is valuable. Supply chain management also addresses the fact that the focal company is highly involved in some of the relationships and thus may be contract partners with their counterparts. In other relationships, however, companies are process partners in the sense that they merely provide output/input to and from their counterparts. The relationships in a supply chain have different characteristics and it is, therefore, essential for actors to manage various types of relationships and coordinate their activities accordingly.

However, the coordination of physical flows within supply chain management is also limited by the focus on a focal company. Coordination is studied through the relationship that a focal company has with its partners. The relationships have to large extent been studied between two parties, e.g. a buyer and a supplier in a supply chain (Pagell and Sheu 2001, Shin et. al. 2000, Skjoett-Larsen 1999, Lambert et. al. 1996, Christy and Grout 1994). Supply chain partnerships have also been investigated from the point of view of one type of actor in the supply chain, e.g. the logistics service provider (Persson and Virum 2001), service provider of transport (Lai and Cheng 2003), and the warehouse (LaLonde and Maltz 1992).

The findings from these studies report that relationships are either close and enduring between one buyer and a few suppliers, or contrasted with a short-term relationship between one buyer and a large supplier base (Maloni and Benton 1997). Shin et. al. (2000) find that relationships with a supply management orientation (which is defined as a long-term supplier-buyer relationship, supplier involved product development, quality focus in selecting suppliers and reduced supplier base) improves performance. It is recognized that the relationship in a supply chain is subject to both product and process specificity (Christy and Grout 1994). However, it is not obvious that long-term relationships contribute to the coordination of the physical flow or that the coordination between the intermediaries provides an efficient coordination of the activity structure. In other words, it is not sufficient to focus on the character of the relationship (e.g. long term vs. short term) of the actors (e.g. buyer and seller) involved in the distribution system. It is necessary to coordinate specifically the activity structures in order for the processes to become well adapted (Håkansson and Persson 2004, Maloni and Benton 1997). Maloni and Benton (1997) argue that the attitudinal factors gain a coordination focus on account of the operational dimensions in supply chains.

In our study we want to address the coordination of the activity structures directly and do so by focusing on the interdependencies between activities. We argue that the activity structures within physical flows have similar variations to the technologies that Thompson (1967) suggests are the basis for organization. The technologies represent three ways in which activities are related to each other in terms of the interdependencies and contribute to the understanding of the logic of how the activity structure may be coordinated. Adapting the interdependencies to physical flows is not new (Håkansson and Persson 2004, Huemer 2004, Hammervold 2003) but the coordination issues of Thompson's technologies have not, to our knowledge, been specifically applied to physical flows. Understanding the type of interdependencies within activity structures, and ensuring the implementation of the corresponding coordination mechanisms, is a way of achieving efficient and effective physical flows in distribution systems. The basis for the different technologies is the different types of interdependencies. The technologies are referred to as long-linked, mediating and intensive, and reflect respectively serial or sequential, pooled and reciprocal interdependencies between activities (Thompson 1967). Coordination in activity structures is in this respect achieved through mechanisms that address the interdependencies.

In activity structures with serial or sequential[28] interdependencies, one activity is the input to another activity. The sequence in the activities symbolizes the long-linked technology and is exemplified by the mass production assembly line (Thompson 1967). Coordination by plan allows the establishment of schedules in order to adapt activities to each other and are appropriate for serial interdependencies (Thompson 1967). Activity structures that are characterized by pooled interdependencies, however, have the task of linking activities external to but dependent on a system. The pooling represents the mediating technology and is exemplified by a telephone company linking 'those who would call and those who want to be called' (Thompson 1967:16). An alternative example is a transportation unit, which provides pooling through its transportation capacity for people and goods, for example. Pooled interdependencies are coordinated through standardization, which allows the establishment of rules and routines according to which the activities are structured. In this manner, the activities are sufficiently stable and repetitive in order for external activities to link to the activity structure in the system without unnecessary effort. The third category of interdependencies within activity structures is the reciprocal, where the task is to solve a specific problem and the activities are adapted to the problem. The reciprocal interdependencies represent the intensive technology and are exemplified by a hospital that has to adjust the relevant activities to whatever the patients need. The coordination of the activities is in other words customized to a particular situation and the coordination mechanism is denoted as mutual adjustment.

The types of coordination mechanism incur different levels of costs because there are different needs for communication and decision (Thompson 1967). The mechanisms for standardization demand less frequent decision and a smaller volume of communication,

[28] The terms sequential and serial are used interchangeably. We will use the term serial from now on.

compared to planning and mutual adjustment. The latter mechanisms are assumed to be the most demanding.

By applying the interdependencies when analyzing supply chains and networks, Håkansson and Persson (2004) find that there are three corresponding economic rationalities for activity integration. Activities are integrated either to enjoy economies of integration, scale and scope, or innovation and agility. Economies of integration are achieved when it is possible to secure efficient physical flows composed of serial interdependent activities. Economies of scale and scope are achieved when it is possible to secure efficient physical flows composed of pooled interdependent activities. Finally, economies of innovation and agility are achieved when it is possible to secure efficient physical flows composed of reciprocal interdependent activities. The different interdependencies within activity structures drive forward different coordination schemes for the physical flows. The table gives an overview of the interdependencies, coordination mechanisms, level of coordination costs and economies achieved in physical flows:

Table 3.6: Characteristics of activity structures

Interdependencies:	Serial	Pooled	Reciprocal
Coordination mechanisms:	Planning	Standardization	Mutual adjustment
Level of coordination costs:	Medium	Low	High
Economies of:	Integration	Scale and scope	Innovation and agility

The interdependencies are also helpful in understanding the logic of the functions within physical flows. By drawing on a study from strategy and value creation, we can identify that the grouping may have an underlying logic of value chain, value networks or value shops (Stabell and Fjeldstad 1998). The traditional, well-known value chain logic used to understand value creation represents activities with serial interdependencies, and is the inherent logic in the supply chain management literature and process thinking (Huemer 2004). However, the logic of value networks, which is represented by the pooled interdependencies, distinguishes more clearly the rationale of the so-called facilitating agencies in the physical flows. The activities of physical flows create value through the linking of other types of activities.

We have identified that there are specific coordination mechanisms that can be implemented in physical flows. It is necessary to clarify the underlying interdependencies of the activity structure of a physical flow in order to identify the specific coordination mechanism. The interdependencies are also useful in understanding the type of intermediaries within a physical flow. Specifically, intermediaries that are based on activities characterized with pooled interdependencies have a network value creation logic and have as a main task the job of linking other types of actors. These other actors are in many cases involved in other categories of activities such as the commercial interests in the distribution systems. The coordination between actors with respect to commercial interests is addressed in the next section.

3.3 Coordination mechanisms for commercial interests

In this section we focus on the coordination of commercial interests in distribution systems. The insights are taken from the literature on governance of interorganizational relations. Governance is a multidimensional phenomenon, which is encompassing the initiation, termination and ongoing relationship maintenance between a set of parties (Heide 1994). Coordination is necessary in distribution systems, as they consist of dependent but autonomous actors that work together to achieve common interests. The complex coordination needs in distribution systems are specifically addressed in the political economy framework (Stern and Reve 1980). The political economy framework's main contribution lies in the combination of economic and behavioral dimensions. Stern and Reve (1980) argue "insistently" that economic and sociopolitical forces cannot be discussed in isolation for distribution systems. It is recognized that the framework is not a theory but an appropriate point of departure to discuss a 'whole' system (Stern 1988). In studying coordination of distribution systems, we choose to follow the perspective of the political economy framework and draw on literature that covers both economic and behavioral dimensions.

3.3.1 Markets, hierarchies and hybrids

Transaction cost analysis (TCA) is viewed as the main theory to explain coordination of exchange, i.e. governance of transactions (Rindfleisch and Heide 1997, Heide 1994). Exchange needs to be governed in order to control the behavior of the actors involved. In TCA it is assumed that actors are prone to behaving opportunistically (Williamson 1985) and are limited by bounded rationality (Simon 1961). The exchange parties , according to the theory, cannot be certain that the partner has behaved as agreed, and therefore the relationship needs to be governed. Alternatively, there is a risk of high transaction costs in the exchange. TCA has pinpointed the fact that there are systematic characteristics of transactions that corresponded with defined governance structures (Williamson 1975, 1979).

The characteristics are specific assets, uncertainty and frequency (Williamson 1979). The main prediction from TCA is that the characteristics affect the costs of transacting. If the costs are high, it is efficient to implement the hierarchy as a governance structure (i.e. vertically integrate). As such, TCA explicitly views the firm as a governance structure, which is the theory's dependent variable (Rindfleisch and Heide 1997). In the hierarchy, coordination is achieved through the mechanism of authority. If the costs of transacting on the other hand are low, there is no need for further control and coordination is achieved through utilization of the market as a governance structure. The price mechanism coordinates transactions that are conducted in the markets. The prices are assumed to carry full information to the actors in the trading arena.

TCA's original framework posed the governance question as a discrete choice between market exchange and internal organization (Williamson 1975, 1985). The discriminating alignment hypothesis to which transaction-cost economics owes much of its predictive content holds that transactions, which differ in their attributes, are aligned with governance structures, which differ in their cost and competencies, in a discriminating (mainly transaction-cost-economizing) way (Williamson 1991). Rindfleisch and Heide (1997) pose that the basic premise of TCA is that if adaptation, performance evaluation and safeguarding costs are absent or low, economic actors favor market governance. If these costs are high enough to exceed the production cost advantages of the market, firms favor internal organization.

Vertical integration, or the make-or-buy decision, has been described as the paradigm problem of TCA and much of the earlier empirical work addresses this topic (Shelanski and Klein 1995). Later work, however, explicitly acknowledges that features of internal organization can be achieved without ownership or complete vertical integration (Rindfleisch and Heide 1997). A variety of hybrid organizations have been identified in the literature, such as contractual provisions, equity arrangements and joint ventures (Houston and Johnson 2000, Hu and Chen 1993, Osborn and Baughn 1990, Borys and Jemison 1989, Joskow 1987). Studies have examined the antecedents of hybrids, and have also found support for the theoretical propositions of TCA within this type of governance (Rindfleisch and Heide 1997). The various governance structures can be illustrated along a continuum from market to hierarchy with hybrid structures in between. As one moves from the market to the hierarchy, the governance structures are combined with an increasing level of authority. The figure below illustrates this:

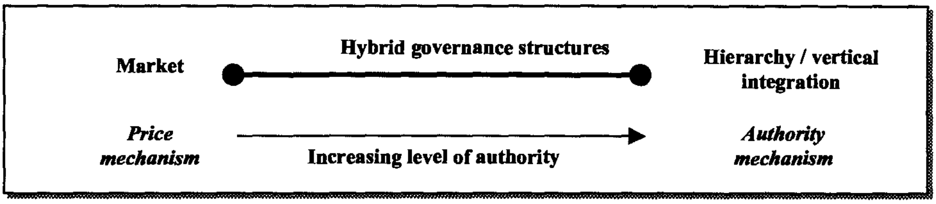

Figure 3.2: The scope of governance structures as argued in TCA

TCA has contributed to the understanding of how to characterize transactions and implement the necessary institutional arrangements to coordinate exchange. However, it is necessary to differentiate the hybrid governance structures in order to identify the proper manner in which to regulate e.g. vertical relationships. In distribution systems and vertical relationships, it is not an issue of *having* control per se but achieving coordinated action. Governance is implemented to discipline actors in order to make sure that they perform in accordance with the common interests of a distribution system and, at the same time, are able to achieve self-interests. In vertical interorganizational relations, the companies stay as separate organizations but still seek to *behave* as one unit, i.e. secure coordination. Distribution systems are characterized by consisting of independent but coordinated agencies (Alderson 1954), and are referred to as superorganizations (Reve and Stern 1979), social action systems (Van de Ven 1976), interorganizational collectivity (Reve and Stern 1979, Van de Ven, Emmet and Koenig 1974) or domesticated markets (Arndt 1979). The fact that vertical relationships consist of independent actors that are tied together in a system makes it difficult to govern them within the form of 'market' or 'hierarchy', as the actors are neither autonomous (in markets) nor internal (in hierarchies). Hybrid governance structures are relevant for the governance of transactions in vertical relationships (Rindfleisch and Heide 1997).

Research has demonstrated that authority is achieved in hybrid governance mechanisms. Of specific relevance for this is the work of Ouchi (1979), where it is demonstrated that control in organization is achieved through the market, bureaucratic and clan mechanisms. The choice of market and bureaucratic mechanisms depend on the organization's ability to measure output and/or behavior. If neither is possible, however, it is argued that clan control is the proper form of governance. Thus, three distinct types of control can be implemented in the organizations to achieve governance. Market mechanisms are used when output is easily identified and easily compensated (e.g. internal pricing). Bureaucratic mechanisms are used when behavior needs to and can be observed and are compensated accordingly (e.g. wages). Clan mechanisms are used when the performance is subtle and ambiguous, and dependent on socialization processes.

Ouchi (1979) demonstrates that variations in organizations need different types of control and he specifies the available governance mechanisms. However, the same conditions are demonstrated to exist *between* organizations, and studies have found that the mechanisms also apply to interorganizational relationships (Macneil 1980, Stinchcomb 1985, Bergen, Dutta and Walker 1992, Eisenhardt 1989). In the next section, we address the mechanisms that are implemented to achieve coordination between organizations.

3.3.2 Authority, incentives and relational norms

The governance structures of markets, hierarchies and hybrids are developed further into governance mechanisms. The study by Bradach and Eccles (1989) has paved way for this development, breaking the governance structures into mechanisms of price, authority and trust and arguing that these are independent mechanisms that can be combined and played off against each other in a variety of ways. It is recognized that the mechanisms may be implemented to govern transactions both internally and externally (Bradach and Eccles 1989, Stinchcomb 1985). Distribution systems represent interorganizational collectivities that need to be administered (Etgar and Valency 1983). The administration of these collectivities is achieved through various types of contractual relations that combine hierarchical mechanisms, market mechanisms and relational mechanisms. In the following, we discuss each category of mechanisms.

Authority in interorganizational relationships is achieved through hierarchical mechanisms. Hierarchical mechanisms are developed from organization theory (Wollnik and Kubicek 1981, Pugh et. al. 1968, Pugh et. al. 1963) and are applied to interorganizational relationships (Van de Ven 1976, Stern and Reve 1980). Hierarchical mechanisms are part of the formal elements in contractual relations and, specifically, formalization and centralization of vertical relationships are considered ways of vertical coordination (Haugland and Reve 1993, Dwyer and Oh 1988, Van de Ven 1976). The effect of bureaucratization is that governance is achieved without a direct authority (John and Reve 1982). Rather, the authority is represented in the rules, policies and procedures (formalization) in contracts (Van de Ven 1976). Centralization refers to the locus of decision-making in a collectivity and reflects authority to the extent that the autonomous members of the collectivity respect the decisions made for the system as a whole (Van de Ven 1976). These formal elements of a contractual relationship represent the structure in an interorganizational relationship (Van de Ven 1976). The concepts approximate the formal dimensions of a hierarchical governance structure.

To the extent that interorganizational relationships are formalized and centralized, it is expected that the members of a distribution system align their behavior to the benefit of the whole. However, John (1984) identifies that hierarchical mechanisms may in fact lead to misalignment of member behavior in a distribution system. In order for hierarchical mechanisms to be effective in aligning behavior of a collective, they have to be combined with mechanisms that also encourage the members to behave according to some common interest. The governance mechanisms influence, in other words, the *motivation* of the exchange partners (John 1984). The hierarchical mechanisms imply how discipline is achieved in a collectivity but governance mechanisms have to ensure both control and motivation. Members of a distribution system are implicitly motivated to align their behavior to the common interest of the system – i.e. it rests on the logic of joining the collectivity in the first place and the notion of reciprocity (Nevin 1995). However, the behavioral assumptions within these lines of theories demand explicit governance effort (Williamson 1985), and rightfully so, as research has disclosed that misalignment of behavior exists (Wathne and Heide 2000). Thus, for contracts to be effective in regulating relationships, they need to balance hierarchical mechanisms with market mechanisms and relational mechanisms.

The market mechanism represents an obvious motivation factor in relationships, as it implies the compensation or reward that partners receive from transacting. It represents in other words the *incentive* for companies to engage in relationships. In a clear-cut market-based relationship the incentives are represented in the negotiated price (Williamson 1975). However, a market-based relationship is per definition conducted "sharp in by clear agreement, and sharp out by clear performance" (Macneil 1974:738), and does not represent on-going relationships. Thus, in on-going contractual relationships the incentives can be tied to factors other than mere price. An example could be sales bonuses. Incentives are relevant in distribution systems as the actors to some extent have a longer-term relationship. However, incentives make it necessary to be able to evaluate the actors' performance. Thus, the contracts need to be outcome based (Bergen, Dutta and Walker 1992, Eisenhardt 1989) and reward is tied to the observation of the actors' performance. The goal is to make it profitable for the actors to engage in actions consistent with the common interest of the distribution system.

In relationships, however, it is not always possible to formalize every element (Noordewier et. al. 1990). Contracts often involve a large share of informal dimensions, expectations or norms (Heide and John 1992). It rests on the bilateral nature of relationships (Heide 1994). In fact, the contracts are often ignored in transactions (Macaulay 1963). The informal elements of contracts are referred to as relational mechanisms and are detailed in relational exchange theory (Macneil 1978, 1980). Relational contracting refers to situations in which pressures to sustain ongoing relations have led to the spin-off of many subject areas. Thus, the progressive increase of the duration and complexity of the contracts has resulted in contractual adjustment processes that are more thoroughly transaction specific and administrative in nature (Macneil 1978). The relational mechanism is represented through various types of relational norms, which denote an expectancy of how the partners are going to behave in the relationship. Heide and John (1992) argue that discrete norms denote individualistic orientation, and relational norms reflect collective orientation. Discrete exchange represents a situation with autonomous transactions and competitive interaction, and no expectation of mutuality. Relational exchange, on the other hand, represents expectation of mutuality of interest and an enhancement of the well being of the relationship.

Norms can be represented on a continuum that runs from single transactions and discrete contracts, to integrated transactions and continuous relational contracts (Robicheaux and Coleman 1994). With the increasing existence of norms of conduct to govern exchange, contracts have longer horizons and develop against a "polar pattern" of relational, i.e. continuous, contracting. Such a continuum is illustrated as follows:

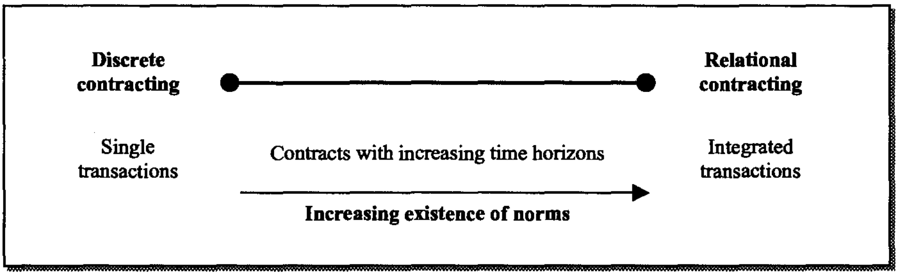

Figure 3.3: The scope of contractual alternatives in relational exchange theory

The theory of relational exchange is recognized as a logical complement to Williamson's approach (Robicheaux and Coleman 1994). It is argued that relational exchange based analysis captures more information about the dimensions of relationships than TCA does. The concepts are argued to be quite useful in measuring the global effects of relationalism but Robicheaux and Coleman (1994) argue that their assessment suggests a need for selectivity when the structure of an exchange relationship is of primary interest. The authors point to the fact that relational mechanisms are not sufficient in coordination of commercial interests, rather they need to be complemented with hierarchical and market mechanisms. Findings from the literature disclose that hierarchical mechanisms in isolation have a negative effect on alignment of behavior (John 1984), but a relationship does not balance behavior on norms alone either (Robicheaux and Coleman 1994, Heide and John 1988). Together the mechanisms balance the need for control and motivation in distribution systems. In the next section we go into further detail on the dimensions within these types of mechanisms that regulate vertical relationships.

3.3.3 Coordination mechanisms for vertical relationships

Our focus is on the coordination of distribution systems where the relationships are of a vertical nature. The actors in such relationships are dependent on each other, but still keep their autonomy (Buvik and John 2000). The governance literature has shown that interorganizational relationships are coordinated with hierarchical, market and relational mechanisms. In this section we review empirical studies of coordination in vertical relationships.

Hierarchical mechanisms establish formal control in vertical relationships and constitute the specific terms of trade in the relationship. Empirically studied dimensions include *centralization* and *formalization* (Silkoset 2004, Dwyer and Oh 1988, John and Reve 1982). Centralization refers to the locus of decision-making and reflects to what extent one member is able to implement decisions that affect the whole system. Formalization on the other hand refers to the extent to which rules and procedures are implemented to govern the relationships. These hierarchical mechanisms allow for the implementation of authority to vertical relationships (Stinchcomb 1985). In this way, the actors signal that they do in fact agree to the common interest of the distribution system. Heide (2003) supports this argument when finding that hierarchical mechanisms are used as a screening device when buyers select suppliers and vice versa, as signaling when the supplier chooses to work with defined buyers. However, Heide (2003) argues that these mechanisms are time dependent in the sense that they do not cope with aligning behavior ex post the relationship initiation. Hierarchical mechanisms are in this sense important when establishing vertical relationships but not sufficient to govern the ongoing motivation of the actors. Dwyer and Oh (1987) find this effect for centralization but not for formalization. Formalization seems, on the other hand, to enhance the quality of the relationship. As a consequence, Dwyer and Oh (1987) summarize that when studying hierarchical mechanisms careful attention has to be given to each dimension separately.

Even though participating actors have agreed to formalities of relationships, the effort they put towards the common interest may vary. It is therefore necessary to explicitly implement some form of *incentive* design in vertical relationships to stimulate participation (Murry and Heide 1998). Incentives are reported to induce relationship-oriented behaviour (Heide and Miner 1992). Incentives are ways of rewarding compliance to the common interest of distribution systems and represent the market governance mechanisms. However, Murry and Heide (1998) find that some incentive programs may have detrimental effects on the relationship. It is argued that performance-based pay may be viewed as signals of distrust. However, the performance-based pay method is perceived as formal control rather than as an incentive. In this perspective, the finding is in line with John's (1984) argument that hierarchical governance mechanisms induce misalignment of behaviour. Alternative incentive programs such as incentive premiums, on the other hand, induce compliance with the common interests (Murry and Heide 1998).

The study reveals that incentive design is a vital element in the coordination of commercial interests and that close attention to the choice of incentive design in vertical relationships is necessary. For example, the evaluation of resellers is reported as one way of determining the choice of incentives (Gilliland 2003). An evaluation is expected to reveal motives in relationships (Bergen, Dutta and Walker 1992, Eisenhardt 1989). The ability to screen and evaluate partners is a valuable contribution when it comes to structuring relationships (Lassar and Kerr 1996). It is found, however, that personal relationships have a positive effect on the participation in relationships and that "it does not diminish the effect of incentives" (Murry and Heide 1998:65). The finding illustrates that incentives have a complementary role in regulating relationships. It also demonstrates that informal dimensions influence the coordination of commercial interests.

The informal dimensions regulating vertical relationships are *relational norms* mechanisms. Relational norms denote the expectations in business relationships, while personal relationships reflect expectations on an interpersonal level (Bradach and Eccles 1989). It is recognized that relational norms are a means of coordinating commercial interests (Heide and John 1992). The relationships, however, have certain characteristics. Lusch and Brown (1996) report that bilateral dependency in the relationships leads to more reliance on normative contracts. In addition, they find that there is more reliance on relational behavior in long-term relationships. The finding is consistent with the inherent characteristics that norms materialize over time (Axelrod 1984, Macneil 1980). However, it is also reported that a certain expectation of continuity exists ex ante exists in some relationships, and the norms of reciprocity are argued to represent an up front motivation for joining collectivities (Nevin 1995).

Relational norms can be thought of as a single higher order construct (Noordewier, John and Nevin 1990). However, the authors recognize that norms can be defined operationally in different dimensions and argue that the concept has to be adapted to the context of specific exchange. Macneil (1980) provides a conceptual listing of dimensions. Some dimensions of relational norms have been empirically investigated. Heide and John (1992) find that the dimensions of flexibility, information exchange and solidarity reflect relational norms in buyer-supplier relationships. Flexibility is defined as the willingness to make adaptations as circumstances change. Information exchange defines a bilateral expectation that parties proactively provide information useful to the partner. Solidarity defines a bilateral expectation that a high value is placed on the relationship. Gundlach and Achrol (1993) operationalize the relational norms into five different dimensions, which include the already mentioned solidarity and flexibility, as well as mutuality, role integrity and harmonization of conflict. Mutuality refers to trust as an element in monitoring transactions. Role integrity reflects whether roles are more complex than the specific transaction in question. Harmonization of conflict covers the dimension of whether partners are able to settle conflicts informally. The authors find that these dimensions represent relational norms and found that the norms are developed based on increasing interaction (Gundlach and Achrol 1993). The brief examples of relational norms demonstrate that various dimensions are relevant in different relationships.

Relational norms are considered to be efficient mechanisms in coordinating commercial interests, in *combination* with hierarchical and market mechanisms. Dahlstrøm and Nygaard (1999) investigate how formalization and cooperation align behavior (influence opportunism) in a franchise relationship over time. They identify that formal controls effect opportunism over the period but that the norms only influence opportunism negatively towards the end of the period. This is in line with the knowledge that relational norms are informal and need time to materialize. Dahlstrøm, McNeilly and Speh (1996) investigate how formal controls and relational norms are employed in different governance modes (market based, unilateral and bilateral exchange). They find that formalized exchange is important for market based exchange and has little influence on relational norms, while participation enhances relational development and performance for bilateral exchange relations. Further insights are found when Frankel et. al. (1996) identify that formal contracts are important in the initiation of an alliance and that informal contracts underlie long term relationships. Expectations of continuity lead to higher cooperation between buyer and supplier (Bensaou 1997). Poppo and Zenger (2002) report that formal contracts and relational contracts are complementary, and contribute positively to exchange performance. In addition to the governance mechanisms being complementary, there is also value in understanding the interplay between the mechanisms (Olsen et. al. 2005). It has been found that the proper use of one type of governance mechanism leads to a positive interplay with the other two types and vice versa, in terms of the improper use of a governance mechanism leads to a negative interplay between the mechanisms. Thus, this study demonstrates the importance of how governance mechanisms are combined and linked in specific ways. Cannon et. al. (2000) indicate that relational elements are more important to relationships that face higher levels of uncertainty. Where lower levels of uncertainty exist, explicit (or formal) contracts are reported to yield enhanced performance.

The complementarities in governance mechanisms are also investigated in sequentially dependent vertical relationships. Wathne and Heide (2004) identify that the dimensions of supplier qualification programs and incentive design based on bilateral hostages in one dyadic relationship, create flexibility (maintain autonomy) in a linked dyadic relationship. The authors identify that a mix of governance mechanisms does not necessarily have to apply to the same relationship within the distribution system in order to align behavior. A related finding is documented in Heide and John (1988), where they identify that a principal's control over an agent motivates the agent to engage in bonding behavior with the customer in order to ensure alignment of behavior in the distribution system. Berthon et. al. (2003) find that norms do not have an effect on the governance mechanisms in a relationship with high specific assets, and propose an explanation that the extended network of relationships limit the actors to behave opportunistically. The extended network of actors is suggested to constitute a governance mechanism in its own right (Berthon et. al. 2003).

The empirical studies on coordinating commercial interests in distribution systems demonstrate that better governance is achieved when the mechanisms are combined. The studies report that hierarchical mechanisms are important when there is little experience in a relationship, and that relational norms are important mechanisms in regulating behavior over the longer term. Incentives, on the other hand, are reported to induce participating actors to put extra effort into the relationships. In combination, the governance mechanisms ensure both control and motivation of the actors that participate in distribution systems, inducing them to fulfill both common and self-interests. The studies reveal that the governance mechanisms may be accountable for different relationships in distribution systems, indicating that the total composition of governance mechanisms is relevant. The exact combinations of governance mechanisms that are implemented in relationships vary, which indicates that the specific distribution systems and behavior situations determine the specific combinations of mechanisms. The effect of the governance mechanisms chosen to coordinate the commercial interests of a distribution system will result in some system performance level. In the next section we continue by looking at the effect of coordination, including the effect it has on both physical flows and commercial interests.

3.4 Coordinated action

Coordinated action is a concept used to describe the actors' ability to operate as an entity in a distribution system. Alderson (1954) argues, "only when someone in the marketing channel takes responsibility for *coordinated action*[29] can it be expected that anything more than routine operations will be carried out effectively" (p.25). The concept implies that if actors are able to adapt to each other they achieve increased performance. In this section of the theory we look at the dimensions we argue constitute the concept of coordinated action.

We have argued that the coordination of flows is the means to achieve coordinated action and have specifically focused on coordination of physical flows and commercial interests. In the previous two sections of this chapter, we have looked at the mechanisms used to coordinate these flows. Our argument is that if these coordination mechanisms are implemented in distribution systems, the precondition to achieve coordinated action is in place. Coordinated action is in this respect a composite concept, which draws on performance dimensions for both coordination of physical flows and commercial interests. In this section we look at these performance concepts specifically. In our study we consider vertical relationships in distribution systems, where the performances of one actor (output) give the premises for the performances to the next actor (input). We do not consider co-producing networks (Silkoset 2004), where the actors contribute to the same output in parallel.

For physical flows, we argue that the coordination mechanisms aim to integrate the activities necessary to ensure movement of products between locations in the distribution system. Therefore, *integrated activities* are one of the dimensions we address. Integrated activities are not an end in themselves, but the means to achieve minimization of operations costs for a defined level of customer service. In this respect, the performance variables *minimization of operations costs* and *customer service level* are two dimensions of coordinated action. For commercial interests, on the other hand, we argue that the coordination mechanisms aim to align behavior between the actors in the distribution system in order to ensure the execution of transactions. Consequently, *aligned behavior* is one of the dimensions in coordinated action. In the same way as for physical flows, alignment of behavior is a means to an end, which is to

[29] Emphasis added.

secure minimization of transaction costs and generate a certain level of transaction value. Therefore, the performance variables *minimization of transaction costs* and *level of transaction value* are assumed to be dimensions of the concept of coordinated action too. The dimensions are summarized in the figure below:

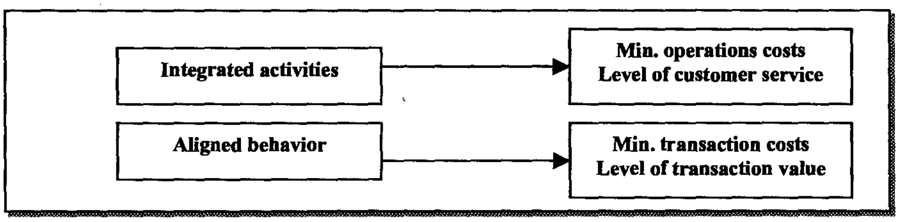

Figure 3.4: Dimensions of the coordinated action concept

The figure provides an overview of what we discuss in the rest of this section. In the following we discuss each of these variables explicitly. The section is divided into four parts in accordance with our dimensions and we start with the dimension of integrated activities. Then we discuss operations costs and customer service level, as the performance variables that reflect coordinated action in physical flows. We then continue with the dimension of aligned behavior, before discussing transaction costs and transaction value as the performance variables that reflect coordinated action in coordinating commercial interests.

3.4.1 Integrated activities

In section 3.2, we argue that the physical flow may be composed in different ways, and we argue that there are several coordination mechanisms to handle the movement of goods. The coordination mechanisms in physical flows aim to *match and integrate activities* in distribution systems (Håkansson and Persson 2004, Gadde 2004, Lambert et. al. 1998).

The supply chain management literature has shown that activity structures have to be matched across a number of tiers in physical flows (Lambert et. al. 1998). To one (focal) company a number of activities in the system may not be of direct relevance, and Lambert et. al. (1998) distinguish between activities that are managed, monitored and included in the system, and those that are linked but not included. The activities have differentiated importance to the actors that are involved in the distribution system. The actors are therefore expected to concentrate on the activities that have higher significance to their performance. However, despite the fact that some of the activities have lower significance, the system is dependent on the actors to include and execute activities that are viewed as less important as well (all activities are important to the whole system but some are of lower importance to specific actors). In this respect, all the activities in the physical flows are attended to.

We have learned from the concept of interdependencies (Thompson 1967) that there is a logic to the activity structures. The activities need to be integrated in serial, pooled or reciprocal manners[30]. Activities are grouped into functions, and receive differentiated focus (Lambert et. al. 1998). In this sense, these segmentations have to be explored and identified in the knowledge that alteration of the components of an activity structure, its structural context or the management components change the performance of the physical flow (Persson 1995). The key to secure integration is to identify the relevant interdependencies in a given activity structure. Within one distribution system, all of the interdependencies may be represented (Håkansson and Persson 2004).

The concept of a holistic activity structure does not distinguish between levels of integration. Bask and Juga (2001) argue that holistic integration in systems are too ambitious and that efforts need to be focused towards semi-integration. They argue that the idea of 'more is better', which is implicit in supply chain management, is problematic because real life processes are subject to pressures of de-integration, divergence and differentiation.

The conceptual idea in physical flows, however, is that *integrated activities* contribute to increased performance. The exact matching needs of each activity link vary depending on the interdependencies. Also, we have learned that the involved actors within a distribution system have more or less focus on the holistic activity structure. The integration needs may vary between functions and intermediaries. Integration of activities, however, has increased importance in distribution systems because of increased complexity in modern distribution systems (Gadde 2004). Matching and integration of activities are therefore expected to contribute to coordinated action because it is assumed that integration leads to better performing activity structures. However, integration is not a purpose in its own right and in the next section we look at what this actually implies.

[30] Cf. chapter 3.2.2

3.4.2 Performance variables: Operations costs and customer service level

Achieving performance in physical flows is a matter of minimizing costs of operations for a certain customer service level (Stock and Lambert 2001). The total cost concept was one of the initial understandings of logistics (Gadde et. al. 2002, Kent and Flint 1997). The total cost of logistics is assumed to accumulate in the place dimension, which is present in marketing's 4Ps model (Lambert 1976). In this definition, place represents the customer service level in logistics terms and examples include on-time delivery, high order fill rates and consistent transit times (Stock and Lambert 2001). Customer service level needs to be adapted to the specific customer segments the distribution systems are serving (Mentzer et. al. 2001). In some systems, the customers need fast deliveries and, therefore, a well-coordinated transport system may be important. In other systems, the customers need low cost deliveries and the willingness to wait for a longer period of time is higher. The customer service level is to a large extent a relative element and is defined in accordance with the relevant goal of the distribution system.

The total cost perspective represents finding the optimal combination between cost components, which are expected to minimize the operations cost of physical flows. In evaluation of total costs in logistics, it is assumed that a key factor is that of making trade-offs among cost alternatives (Stock and Lambert 2001). The model consists of five major cost components – namely, inventory carrying costs, lot quantity costs, order processing and information costs, warehousing costs, and transportation costs. In addition to these cost components, it is argued that customer service costs (backorder and lost sales) and quality costs (failure, appraisal and prevention) are part of the logistics cost (Kenderdine and Larson 1988).

In principle, this requires an activity structure to be configured in a certain way, where activities are represented in functions. The functions are traded off against each other. For example, transport costs may be reduced through lower frequencies, which increases the warehouse and inventory costs as a result but the total cost of the physical flow is reduced. The total costs model address in this sense an important aspect about the goal of the physical flow, which is to avoid sub-optimization. If the cost of some activities increases (i.e. inventory) when others are reduced (i.e. transport), it is implicitly a sacrifice for the benefit of the total system. The total cost model also pinpoints the cost elements of a physical flow, such as transport, warehousing, inventory, and ordering costs. It is the costs of moving products between locations, from production to consumption. Overall, integration is expected to yield lower levels of total costs in logistics operations (Larson 1994).

A challenge with the total cost model is the lack of process orientation. The cost components are treated as aggregates in functions and are not distinguished on the activity level. The model of activity based costing (ABC), however, traces costs to the activities performed (Pohlen and La Londe 1994). In this perspective, ABC is a methodology (Raffish and Turney 1991) and does not distinguish particular cost components as the total cost model does. Thus, the ABC methodology and the total cost model in logistics are complementary. Using an ABC model for cost calculations the activities are allocated to the processes such as purchasing, inbound, outbound and sales operations (Dekker and van Goor 2000, Manunen 2000). In particular, items per order lines are identified as a cost driver (Manunen 2000). The ABC methodology gives an understanding of how the activities cumulate in a hierarchy (e.g. from unit to batch, and to product and factory level) and focuses on profitability in the process (Cooper and Kaplan 1991).

Despite different cost allocation models, the aim of activity integration is a minimization of the overall operations costs for a certain customer service level. It is not our aim to distinguish a model of how to calculate the costs of a physical flow. However, these models show that logistics costs are allocated in functions (e.g. transport, warehouse) or in processes (e.g. purchasing, distribution).

The coordination mechanisms therefore influence and, to a large extent, create the cost structure of the physical flow. Activities are integrated differently depending on the choice of coordination mechanisms and, as such, functions and processes are different as a result. As a consequence, the cost components therefore vary across the physical flows of distribution systems and the trade-offs are different. That is, in some distribution systems there may be more transport costs in comparison to inventory, while in other systems the inventory may carry a larger sum of costs than the transport function.

In summary, the operations costs and customer service level are a result of how physical flows are coordinated and the levels are influenced based on the extent of activity integration.

3.4.3 Aligned behaviour

The coordination mechanisms of commercial interests are presented in section 3.3. We have argued that the coordination mechanisms for commercial interests aim to achieve aligned behavior between the actors involved in the distribution system. In this part of the theory we explain in more detail what we mean by aligned behavior.

We argue that actors join a distribution system due to some common interest with a number of other actors (e.g. to be part of a profitable distribution system), but at the same time each participating actor in a distribution system has some self-interest (e.g. to make a higher profit, enter a new market, product development). If a company has joined as a member to a system, it is because it expects higher performance as compared to not being a member (Anderson and Weitz 1992). As such, the company has an interest in making the system work as an entity. However, the company also seeks to secure their own interests (Iyer and Bergen 1997). Thus, a company has both a common interest and self-interest in becoming a member of a system.

The concept of aligned behavior is said to reflect the extent to which the common interest and self-interests of the participating actors can be aligned with each other. This is not to say, of course, that the self-interest is of little importance because a company always focuses on its ability to secure individual performance. The key is to ensure that self-interests are not in conflict with the common interest. The coordination mechanisms are in this respect implemented to ensure that the self-interests are aligned with the common interest. Self-interested behavior represents the motivation of each participating actor and is characterized by obedience and faithfulness to promises, and an effort towards joint profit optimization (Ghoshal and Moran 1996). Self-interest has been given much focus in interorganizational research. However, the focus has been on how coordination mechanisms *prevent* self-interest seeking *with guile* or opportunistic behavior (Wathne and Heide 2000).

The theory of transaction costs, in this respect, is aimed specifically at this effort – opportunistic behavior is one of the assumptions of the theory (Williamson 1985). Opportunism is strategic behavior (Ghoshal and Moran 1996), which is defined as "the making of false or empty, that is self disbelieved threats and promises in the expectation that individual advantage will thereby be realized" (Williamson 1975:26). In distribution systems, therefore, it is necessary to take an active role (with governance mechanisms) in securing that each actor aligns behavior for the common good. Opportunistic behavior represents the extent to which the actors do not contribute to the common interest in a distribution system, when they pursue self-interests at the cost of the system as a whole.

The challenge for distribution systems is that if the participating actors fear that other actors are not aligning behavior as planned, opportunities may be lost. It may result in imperfect commitment as fear of opportunistic behavior may deter parties from relying on each other as much as they should for efficiency (Milgrom and Roberts 1992). It may have the consequence that parties to a contract face the challenge of the hold-up problem, where one of the partners has been forced to accept a poorer contract because it has sunk investments in the relationship (Milgrom and Roberts 1992). Other examples include that actors are potentially subject to withholding or distorting information, and shirking or failing to fulfill promises or obligations (John 1984). However, self-seeking interest in terms of hard bargaining is not opportunistic. Actors are expected to seek self-interest when it is feasible and profitable.

The consequence of such potential diverging behavior is that it becomes necessary to implement coordination mechanisms to coordinate the commercial interests (Dahlstrom and Nygaard 1999, Rokkan 1995). John (1984) finds that it is necessary to control opportunism both through administrative controls and the social contract. Dahlstrom and Nygaard (1999) have tested the relationship between control structures and opportunism and found a negative relationship. They specifically argue that the nature of the structure is important, rather than the structure itself. Thus, how a distribution system is governed is important (Wathne and Heide 2000). According to Wathne and Heide (2000), monitoring, incentives, selection and socialization are means of preventing opportunism. In their discussion, they differentiate between passive and active opportunism, in the sense that actors can "engage in or refrain from particular actions" (p. 41).

Opportunism, however, has been questioned. Ghoshal and Moran (1996) question the assumption about opportunism and argue that there is a difference between attitude and behavior. Their interpretation is that opportunism, as defined by Williamson, is a self-fulfilling prophecy. That is, if opportunistic behavior is assumed, it leads to opportunistic behavior. Other authors, however, have questioned the assumption about opportunism and have argued that the economic actors are not a priori opportunistic (Johanson and Mattsson 1987). Williamson (1996) argues that some individuals are opportunistic some of the time and that it is costly to ascertain differential trustworthiness ex ante. Following this reasoning, it is assumed that actors may both act and not act opportunistically, if the logic for the theory is to be maintained (Ulvnes 2004, Noorderhaven 1996).

For our purposes, we rest on the insight that there is a possibility that actors participating in a distribution system may engage in behavior that does not contribute to the common interest. In this respect, it is necessary to implement coordination mechanisms to ensure aligned behavior in the distribution system. However, the aligned behavior is not an end in itself, it is means to ensure performance in the distribution system. In the next section we address the performance variables of coordination of the commercial interests.

3.4.4 Performance variables: Transaction costs and value

In this section we discuss the performance variables that reflect whether the coordination mechanisms of commercial interests are able to align behaviour in distribution systems. The performance variables are represented in terms of transaction costs (Milgrom and Roberts 1992) and transaction value (Zajac and Olsen 1993). The goal of governance mechanisms is to minimize the cost of exchange, i.e. transaction costs (Williamson 1991). Recently, it has also been argued that governance needs to be designed in order to stimulate value creation (Ghosh and John 1999, Dyer and Singh 1998, Zajac and Olsen 1993). We start with the transaction costs and then discuss the argument for value creation.

There are costs in carrying out transactions (Milgrom and Roberts 1992, Coase 1937). Transaction costs are independent of the price of goods or services but are determined by the nature of the exchange (Robins 1987). The execution of a transaction has, in principle, four dimensions. Firstly, there is a *pre* period before the transaction is executed, where parties prepare for exchange. Secondly, there is the *actual* execution of the transaction and how the exchange is conducted. Thirdly, there is a *post* sequence after the transaction has been executed, where the exchange parties experience the transaction. Fourthly, there is the idea of an *alternative* to the transaction, which refers to other possible transaction the exchange parties could have conducted instead. These four dimensions are cost drivers and incur what is known as ex ante, ex post, direct and opportunity costs respectively. Dahlstrom and Nygaard (1999) refer to this as the multiple facets of transaction costs. In studying the coordination of commercial interests, the transaction costs influence the performance of the distribution systems. In the table below, we have included some key definitions of transaction costs:

Table 3.7: Definitions of transaction costs

Authors	Definition of transaction costs	Types of transaction costs
Williamson (1985)	Comparative costs of planning, adapting and monitoring task completion under alternative governance structures.	Ex ante transaction costs: costs of drafting, negotiating and safeguarding an agreement. Ex post transaction costs: the maladaptation costs, the haggling costs, the set-up and running costs, and bonding costs.
Milgrom and Roberts (1992)	Transaction costs are the costs of running the system; the costs of coordinating and of motivation.	Coordination costs: The need to determine process and other details of the transaction, to make the existence and location of potential buyers and sellers known to one another, and to bring the buyers and sellers together to transact. Motivation costs: Costs generated from information incompleteness and asymmetries, and from imperfect commitment.
Rindfleisch and Heide (1997)	Transaction costs are the costs of running the system, and include such ex ante costs as drafting and negotiating contracts, and such ex post costs as monitoring and enforcing agreements.	Direct transaction costs: Costs of crafting safeguards, communication, negotiation and coordination costs, screening and selection costs (ex ante) and measurement costs (ex post). Opportunity costs: Failure to invest in productive assets, maladaptation costs: failure to adapt, failure to identify appropriate partners (ex ante) and productivity losses through effort adjustments (ex post).

Transaction costs has been an area of some confusion but currently the nature of these costs is much better understood (Rindfleisch and Heide 1997). Still, transaction costs are often difficult to quantify. However, this is mitigated when transaction costs are assessed in a comparative institutional way, in which one mode of contracting is compared with another. Accordingly, it is the *difference between* rather than the absolute magnitude of transaction costs that matters (Williamson 1985). Thus, it is argued that simpler arguments suffice to demonstrate an inequality between two quantities than are required to show the conditions under which these quantities are equated at the margin (Simon 1961). Empirical research in transaction costs hardly ever attempts to measure such costs directly (Williamson 1985). Houston and Johnson (2000) give such an indirect comparison when comparing the efficiency of joint ventures, with contracts based on shareholder value post the relationship announcement. There is, however, a lack of empirical research concerning how governance mechanisms influence transaction costs (Dahlstrom and Nygaard 1999, Rindfleisch and Heide 1997).

Governance is also viewed as a vehicle to create value (Ghosh and John 1999, Zajac and Olsen 1993). The studies question a static transaction cost perspective, where a given (governance) situation is optimized. Rather, the authors argue that it is possible to influence a relationship once it is 'running'. Zajac and Olsen (1993) particularly point out that relationships have two parties and argue that traditional transaction cost analysis views a relationship from one side. It is assumed that adjustments in relationships are made, as parties seek to maximize the value of their business opportunities. In their view, there is a transaction process and they "...view the exchange partners in interorganizational strategies as primarily concerned with how to estimate expected value over the expected duration of the interorganizational strategy, how to create that value with the partner firm, and finally, how to claim that value" (Zajac and Olsen 1993:137). The partners in cooperation create *joint* value. Ghosh and John (1999) challenge the reduced form of transaction cost theory by questioning the exogenous choice of an ex post situation. It is expected that ex post transaction costs rise if changes and/or opportunistic action take place in an agreement. Thus, in fear of such a situation, the parties to the agreement may forego the opportunity. However, in the argument of Ghosh and John (1999), the exchange characteristics are not exogenous during the execution of an agreement. The parties may contribute with strategic choices that rearrange the situation during a later stage in the execution period. Thus, it is argued that there is an interaction between the creation and claiming of value, and the *positioning* and *resources* influence the choice of governance mechanisms (Ghosh and John 1999).

The transaction costs perspective argues that exchange incurs costs, however, an initiated exchange may also offer additional value opportunities. Diverging behaviors from the common interests in distribution systems may, therefore, increase costs but also contribute to added value. In evaluating the performance of distribution systems, it is necessary to classify whether or not behavior is aligned in accordance with the agreement. If not, the behavior has to be evaluated as to whether it is contributing to added value for the distribution system or whether it is incurring added cost. The evaluation discloses whether the coordination mechanisms for the commercial interests are contributing to coordinated action in the distribution system.

3.5 Summary

Our thesis is that each flow in the distribution system needs to be coordinated specifically but that there are also interaction effects between the flows that contribute positively to coordinated action. We expect there to be a pattern between the coordination mechanisms. In this thesis, we have concentrated on the *physical flows* and *commercial interests*. In the literature on distribution, we have found that coordination mechanisms address each of the flows but not specific insights into how these coordination mechanisms interact. Our aim is to contribute to this knowledge.

In order to ensure the physical movement of goods in a distribution system, it is necessary to coordinate *activities* in an activity structure. We have learned that interdependencies in the activity structure determine the choice of coordination mechanisms. We have argued that the activity structures are subject to the same type of variations as Thompson's (1967) technologies. Therefore, the coordination mechanisms of *standardization*, *planning* and *mutual adjustment* are argued to apply as coordination mechanisms of activity structures in order to ensure high performing physical flows. The coordination mechanisms are implemented to secure *integrated activities*, as it is assumed that a higher level of integration results in increased performance in physical flows. Performance for physical flows is measured in terms of *operations costs* and *customer service level.*

Contracts coordinate commercial interests in distribution systems. We have learned that the contracts need to be able to both control and motivate the actors that take part in the distribution system. The contracts need, therefore, to incorporate both formal and informal governance mechanisms, which include *hierarchical mechanisms*, *incentives* and *norms*. The three types of governance mechanisms balance control and motivation. The goal of the contract and the governance mechanisms is to ensure that the actors taking part in distribution system actually *align their behavior* with the common interest of the system. If the contracts are not effective in achieving this goal, actors are expected to seek self-interests at the expense of the other actors taking part in the distribution system. If the commercial interests are well coordinated, the self-interests and the common interests are aligned. The evaluation of how well contracts are able to achieve aligned behavior is reflected in the performance variables *transaction costs* and *transaction value*. These variables reflect to what extent there are actors with diverging behavior in the system.

In summary, our argument is that well-adapted coordination mechanisms of both physical flows and commercial interests contribute to a higher probability to achieve coordinated action in a distribution system. The arguments that we have made are isolated for each of the flows. In the next chapter, we continue with the development of a framework to analyze how the sets of coordination mechanisms interact.

The logic of the theory is developed based on distribution systems in general. Our interest is to understand coordination in *reverse* distribution systems. In the introductory section of this chapter, we have shown that there are specific features to reverse distribution systems. Such features include activities like collection and reprocessing but also characteristics, such as that end-consumers have a passive behavior as suppliers in reverse distribution systems. We have shown that there are certain waste management options (e.g. reuse vs. recycling) and that reverse distribution systems may be coordinated in either a closed or open manner. However, despite the specific reverse characteristics, we argue that the analysis of reverse distribution systems departs readily from theories that are applied to the understanding of forward distribution settings.

As 'the reverse' is a relatively new and empirically interesting area, it is our primary interest to understand how coordinated action is achieved in reverse distribution systems. Taking the components of theory in this chapter further we continue by developing a framework for analyzing coordinated action.

4. FRAMEWORK FOR ANALYZING COORDINATED ACTION

Our research interest is to understand how to achieve coordinated action in reverse distribution systems. For this reason, we have reviewed literature on reverse distribution systems, coordination of physical flows and coordination of commercial interests, and performance variables. In this chapter we draw on this theory as we develop a research model and an analytical framework.

The literature review on reverse distribution systems disclosed that they are somewhat different from forward systems. In reverse distribution systems, products are collected and reprocessed rather than manufactured and delivered to the end-consumer. The principles of distribution, however, are found to apply to both 'directions'. Thus, our starting point is that the theories for coordinating forward distribution systems are readily applied to reverse distribution system that take back products at end-of-life.

The physical flows and commercial interests have been investigated within two different streams of research, namely the logistics and supply chain management literature, and the governance literature. It is argued that these streams of research have, in fact, developed from the same starting point but have become disentangled and 'live their own lives' (Gripsrud 2004). Each area has been occupied with the identification of how to coordinate activities and transactions respectively, and to achieve high performing distribution systems. When flows are disentangled it is not obvious whether physical flows dominate commercial interests or vice versa. Our argument is that it is not sufficient to coordinate only one flow in a distribution system, which is what the distribution literature implies (Rosenbloom 1995). Our thesis is that each flow needs to be coordinated separately, and that positive performance effects result from finding interaction patterns across the flows. Knowing that 'once upon a time' the flows were studied as one area provides us with a promising point of departure.

We develop a research model that reflects our theoretical argument and an analytical framework that guides the analysis of our study.

4.1 The research model

The previous chapter discussed coordination mechanisms for physical flows and commercial interests. The physical movement of goods is coordinated with mechanisms that address interdependencies in activity structures. To realise the commercial interests of the parties involved in distribution systems, transactions need to be coordinated with a combination of governance mechanisms. How the coordination mechanisms for physical flows and commercial interests are combined are expected to influence the level of system performance. The combination of coordination mechanisms constitutes the basis for achieving coordinated action, and the degree of coordinated action is dependent on how well the coordination mechanisms are adapted to the needs of the distribution system. As a concept, coordinated action in our model consists of integrated activities for the physical flows, aligned behavior for the commercial interests and system performance. We argue that there is an interaction effect between the coordination mechanisms for physical flows and commercial interests that influence system performance. We have developed a research model, as illustrated below, and our argument for the model follows.

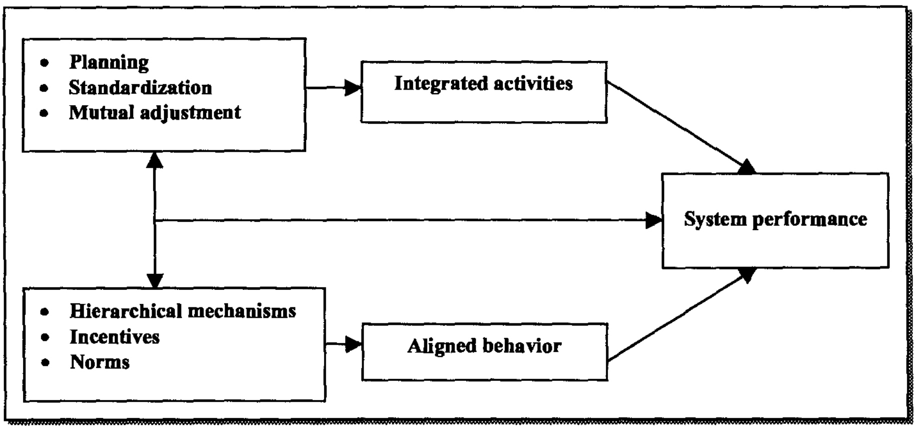

Figure 4.1: The components of coordinated action in distribution systems

Physical flows represent the activities necessary to move products across distribution systems. For products to move from one location to another, they are dependent on the coordination of activities, and the type of interdependencies between the activities indicate the rules of coordination (cf. chapter 3.2.2). If the logic of the activity structures is serial interdependencies, the coordination mechanism is *planning*. If the logic of the activity structures is pooled interdependencies, the coordination mechanism is *standardization*. And, if the logic is reciprocal interdependencies, the coordination mechanism is *mutual adjustment*. Coordination of physical flows across the distribution system aims at "making the flow of goods semiautomatic even though the successive units are autonomous" (Alderson 1954:23). In this respect, it is not only a question of coordinating activities, but a matter of achieving *integrated activities* in distribution systems. A higher level of integrated activities are expected to secure higher performance compared to activities with a lower level of integration

For serial interdependencies, the output of one activity is the input to the next activity. To achieve integration, it is necessary for the output of one activity to occur at precisely the moment it is needed as the input for the next activity. An example of this is transport. The expectation is that some form of transport leaves a given location at a time which enables it to arrive at another location in due time with the right type of goods. In other words, activities have to be planned to coincide with departure and arrival times. For pooled interdependencies, activities are dependent on a third activity. Thus, the means to achieve integrated activities is to utilize the third activity. Again we take the transport example, where pooled interdependencies reflect capacity. In order to achieve efficient transportation, transport capacity needs to be filled and goods have to be coordinated to ensure that capacity is utilized. The transport has a standard capacity level and the volume of goods loaded is adapted to this capacity. For reciprocal interdependencies, the activities are mutually related. For integration to be achieved, the activities have to be executed at the same time. Staying with the transport example, reciprocal interdependencies are represented in terms of the combination of locations, transport scheduling and capacity. In order for the goods to move from one location to another, they are dependent on the way in which the sites, volume and transport are combined in the transport system. The elements of the systems need to be mutually adapted when the system is organized. Express-transport services provide an alternative example. Not knowing the exact transport needs, the transport companies have some available transport capacity that can be adjusted to the need of the customers when the exact transport commission is ordered.

Coordinating activities in physical flows are reflected in *operations costs* and *customer service level.* The performance is expected to increase with the level of integrated activities. Consequently, integrated activities are expected to lead to minimization of operations costs in a distribution system because the flow of goods is routinized and relatively automatically executed. In a physical flow with integrated activities, the need to attend to every transfer of goods is not necessary. Activity structures may, as we have seen, be coordinated in different manners. Thus, differently coordinated activity structures create different cost structures, and different customer service levels. The different coordination mechanisms, in this respect, lead to physical flows in distribution systems with a certain level of integrated activities, cost and customer service.

Integrated activities, as a means of achieving high performing physical flows, are in many ways what the logistics and supply chain management literature is all about. However, integration of activities in distribution systems is not straightforward because commercial interests are involved. We argue that the commercial interests between actors influence the physical flows and vice versa. We have drawn on governance literature to learn about coordination of commercial interests. Our argument is that the coordination mechanisms for physical flow and commercial interests need to interact in order to achieve superior optimum system performance. Before going into more detail on how we perceive this connection, we state our argument about the coordination of commercial interests.

The commercial interests are the exchanges that take place in distribution systems. In order to secure the coordination of commercial interests, it is necessary to implement governance mechanisms to guide exchanges. In the theory, we clarified that *contracts* guide exchanges in distribution systems, and that contracts need a mix of formal and informal governance mechanisms (Heide and John 1992, John 1984). The governance mechanisms constitute a combination of *hierarchical mechanisms*, *incentives* and *norms*. The governance mechanisms are a means to ensure *aligned behavior* of the commercial interests in the distribution system. It is necessary to align behavior because the distribution systems comprise a mix of interests. The governance mechanisms seek to ensure that there are no conflicts of interests between the individual actors' self interests and the overall common interests of the distribution system. On one side, the governance mechanisms aim to prevent actors from being tempted to seek self-interests that may conflict with the common interests and, thus, would be detrimental to the overall distribution system - i.e. behave opportunistically (Williamson 1985). On the other side, the governance mechanisms are a means of ensuring that the actors are motivated to contribute positively towards the common interests of the distribution system.

Hierarchical mechanisms create a formal relationship in the coordination of commercial interests in distribution systems. In distribution systems, formalization and centralization represent the hierarchical mechanisms (Klein 1989). Formalization establishes the rules of the relationship (Van de Ven 1976), and centralization establishes the locus of decision-making (Heide and John 1992, Van de Ven 1976). In this manner, the actors formally agree on how transactions are to be executed and who is entitled to make decisions. It is reported that these hierarchical mechanisms align behavior in distribution systems (John 1984). However, at the same time, it is reported that these mechanisms may influence alignment of behavior negatively (John 1984). It is therefore necessary to combine the mechanisms with incentives and norms (Dahlstrøm and Nygaard 1999, Heide and John 1992). The findings are different for the two dimensions, centralization and formalization, and it is argued that each dimension needs separate attention (Dwyer and Oh 1987). From the literature, there are indications of such combinations. Incentives are expected to be effective in aligning behavior in distribution systems where there is a centralized decision maker (Gilliland 2004), as these mechanisms are typically unilateral in nature (Heide 1994). Norms, on the other hand, are bilateral in nature (Heide 1994) and are expected to be effective in distribution systems where the centralized decision maker is dependent on cooperation from the other actors (Heide and John 1992). Formalization is assumed to combine effectively with norms when it regulates complex or customized relationships (Poppo and Zenger 2002). Incentives, however, combine effectively with formalization when it is difficult to disclose partner motivations (Dahlstrøm and Nygaard 1999).

Combining the governance mechanisms in an effective manner ensures aligned behavior in distribution systems and premium system performance. As with physical flows, it is expected that the coordination mechanisms ensure that transactions are executed according to the contract, and demand a minimum of amount of attention for every transfer. That is, it is not necessary to control every transaction for divergent diverging behavior. Performance as a result of effective coordination of commercial interests is reflected in *transaction costs* and *transaction value*. It reflects the extent to which divergent diverging behavior in the distribution system incurs higher transaction cost in comparison to an expectation. Performance also reflects the opposite when diverging behavior in the distribution system generates greater value than what was expected.

The coordination mechanisms of physical flows and commercial interests in distribution systems are in place in order for the transfer of both goods and interests to be routinized and semiautomatic even though the actors in the flows are autonomous. The coordination mechanisms, therefore, contribute to coordinated action but in different ways. For physical flows, the aim is to integrate activities, while for commercial interests, the aim is to align behavior. The performance variables reflect the extent to which the coordination mechanisms of distribution systems actually contribute to coordinated action.

Coordinated action of the distribution system is achieved when the flows contribute to an integrated whole (Alderson 1954). We therefore hypothesize that there are interaction effects when flows in distribution systems are viewed as 'a whole'. To achieve coordinated action in distribution systems, we argue that it is necessary to coordinate across the flows as well: The structuring of the activities in the physical flow is not unrelated to the type of governance mechanisms implemented to coordinate commercial interests and vice versa. If the interdependencies between activities are represented in terms of a serial, pooled or reciprocal logic, we expect that it is not irrelevant what type of governance mechanism that is implemented between the actors in the distribution system. In this respect, we expect that the coordination mechanisms for the flows adapt to each other in a systematic manner. For example, if activities are integrated by planning, the commercial interests would be expected to be governed by a particular combination of mechanisms. An example of where this discussion is reflected is the question of purchasing goods, where the contracts may be either ex-works (EXW) or delivery ex-quay (DEQ)[31], which would result in a different activity structure for the physical flow. The contract influences the coordination of the activity structure, but it is not certain that such an activity structure provides the best performing physical flow. Likewise, if an activity structure is optimized, it is not certain that the actors are satisfied with the commercial interests in the distribution system. The interaction effect is included in our research model and, in our study, we explore how the coordination mechanisms are linked. The relationship between these two types of coordination mechanisms has not been studied previously (Gripsrud 2004). This development constitutes the main theoretical contribution of this study.

We therefore argue that the effect of coordinating across the flows is reflected specifically in system performance as some form of *system goal*. In the literature on distribution systems, it is argued that organizations are involved in interorganizational relationships in order to attain goals that would be unattainable by organizations acting independently (Reve and Stern 1979). In this manner, we argue that distribution systems that are able to match coordination

[31] When goods are purchased ex-works the buyer controls the goods starting from the factory. When goods are purchased delivered ex-quay the goods are delivered to the retailer or sales-outlet by the manufacturer.

mechanisms across the physical flows and commercial interests achieve premium system performance in comparison to those that do not.

4.2 An analytical framework

The research model is developed from theory on distribution systems in general. In this section we adapt the model to the reverse setting. We concretize the research model into an analytical framework that serves to guide further analysis.

Reverse distribution systems are organized to take back products at end-of-life for recovery and waste management. 'Reverse' is used in order to differentiate the system from a forward system, which brings products to the end-consumer. However, a reverse distribution system is not the 'opposite' of a traditional forward distribution system, as it has its own distinctive features. The research on reverse distribution systems has developed an understanding of the characteristics of these systems but there is still limited knowledge of how coordination is achieved. Our thesis is that the coordination mechanisms and the effect on system performance apply to reverse distribution system in the same way as to forward distribution system. In the analytical framework we integrate the features of reverse distribution systems with the knowledge of coordination from forward distribution systems.

The analytical framework includes functions of the reverse distribution system and we have illustrated how the coordination mechanisms for physical flows and commercial interests influence the system. The coordination mechanisms for the physical flows seek to influence the level of integrated activities, while the coordination mechanisms for commercial interests seek to influence the degree of aligned behavior. How the coordination mechanisms are adapted to the reverse distribution system is reflected in the performance variables. The performance is represented separately for each flow. However, we expect the interaction effect of the coordination mechanism to be reflected in a system goal. The analytical framework is illustrated on the following page. We continue with the argument afterwards, explaining which dimension we use to analyze reverse distribution systems empirically.

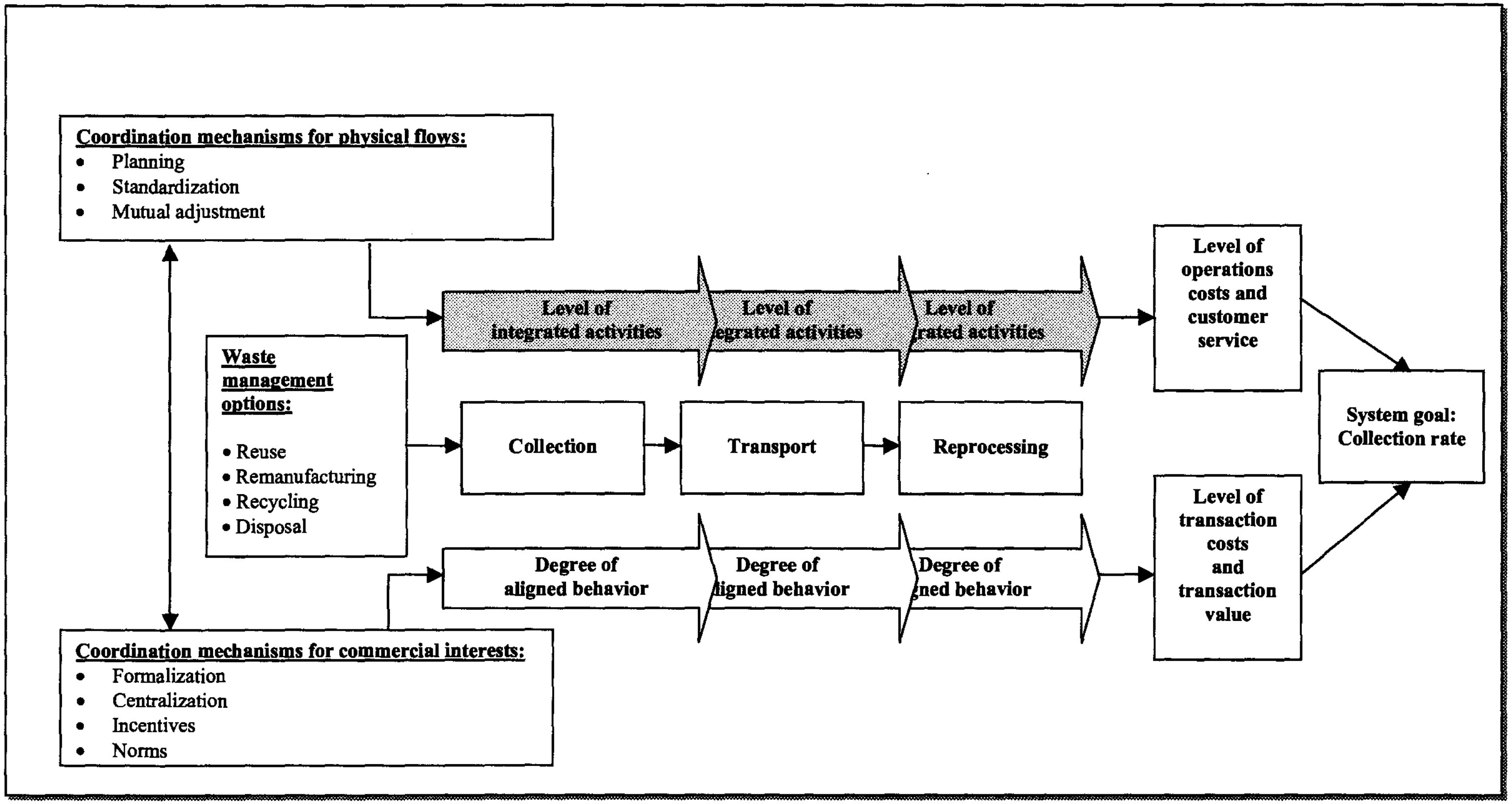

Figure 4.2: An analytical framework for analyzing coordinated action in 'reverse' distribution systems

One feature with reverse distribution systems is that there is a *waste management option* when returning products, which is an important starting point. Research has shown that this is likely to have a substantial impact on the design of the system (e.g. Thierry et al. 1995). In this respect, we expect that the waste management options influence the type of physical flows and commercial interests of the systems. This feature has been illustrated in the framework as input to the functions. It is a decision that is made up front when organizing reverse distribution systems and serves as an information input when analyzing the systems.

A second feature is that products that are taken back at end-of-life have distinct activities within the functions of collection, transfer and reprocessing. In the *collection* function, the products have to be collected from end-consumers and accumulated at a collection site. The activity is reversed from that of a forward distribution system where products are sold and delivered to end-consumers. The transfer level represents moving the collected products from the site of collection to the site of reprocessing. The transfer level is concretized as *transport* in our analytical framework and it reflects the movement of goods. In many respects, transport is the same activity (in both the forward and reverse systems) despite the direction of goods but the character of the products influences the handling operations. The products are used and not necessarily packaged in the same manner as when they are new. It is therefore necessary to adjust the transport handling operations to reverse distribution systems. The *reprocessing* is the opposite of what one finds in the forward system, in that products are dismantled rather than manufactured. Our analysis includes the collection, transport and reprocessing functions. These functions represent the reverse distribution tasks of coordinating 'production' and 'consumption' in time, distance and diversity of products (Alderson 1949).

Our job is to analyze how the coordination mechanisms within these two flows contribute to integrated activities and aligned behavior in the reverse distribution system. The reverse distribution system is concretized into three functions. The performance variables reflect how well the coordination mechanisms are adapted to the system. We have illustrated that each flow has separate performance variables, as well as that overall system performance is reflected in a system goal. The system goal reflects the interaction effects between the coordination mechanisms, thereby showing how the reverse distribution system works as 'a whole'. Next we specify the empirical dimensions we use when analyzing the reverse distribution systems in our study.

We start with the coordination of physical flow. We have identified that physical flows are coordinated either through standardization, planning or mutual adjustment (Thompson 1967), or a combination of the mechanisms (Håkansson and Persson 2004). Physical flows that are coordinated with standardization have organized the activities according to specific routines and rules. If physical flows are coordinated through planning, however, the activities are adapted to each other in a specific manner each time products are being returned. When mutual adjustments are used to coordinate the physical flow, the products being returned define how the activities are combined. By interpreting Thompson, we analyze the coordination mechanisms by using the following empirical dimensions:

Table 4.1: Empirical dimensions for coordination mechanisms for physical flows

Concept:	Empirical dimension:
Standardization	The extent to which collection, transport and reprocessing activities are adapted in a stable and repetitive manner, which follow specific routines or rules.
Planning	The extent to which collection, transport and reprocessing activities are adapted to each other when products are returned at end-of-life.
Mutual adjustment	The extent to which collection, transport and reprocessing activities are combined specifically to each situation of returning products at end-of-life.

Coordinating physical flows is expected to contribute to coordinated action. In physical flows this is a combination of integrated activities and performance variables. In the literature on coordination of physical flows, it is assumed that the more that activities are integrated the better (Lambert et. al. 1998). In our study, we evaluate the degree to which collection, transport and reprocessing activities are integrated. Therefore, we evaluate the integration of activities in a relative manner from high to low, that is, the *level* of integrated activities. It constitutes an evaluation of how well activities are adapted to each other. For example, when products are collected in cages, how well is this activity adapted to the transport activity in terms of size and capacity? If activities are highly integrated, they are closely adapted to each other. If activities are characterized by a low level of integration, then the collection and transport activities can be described as limitedly adapted to each other. The performance variables in physical flows are identified as operations costs and customer service level. These factors are difficult to evaluate specifically, as physical flows are to some extent unique in their configuration. However, it is possible to evaluate the costs and customer service level in a relative sense as high or low. Thus, we measure the variables that reflect the concept of coordinated action from the physical flows in the following manner:

Table 4.2: Empirical dimensions for coordinated action in physical flows

Variables:	Empirical dimension:
Integrated activities	The level of integrated activities
System performance	The level of operations costs The level of customer service

Turning to the commercial interests, transacting products at end-of-life has also been shown to have specific characteristics. It is not straightforward how the end-consumers can be stimulated to return products at end-of-life because end-consumers largely lack the incentive to initiate the transaction (Barnes 1982). Therefore, the reverse distribution system has to compensate for this lack of incentive. The coordination mechanisms need to ensure the initiation and fulfillment of the commercial interests throughout the system. Coordination is achieved through the utilization of contracts, together with a combination of the hierarchical mechanisms (Klein 1989, John 1984), incentives (Gilliland 2004, Dahlstrøm and Nygaard 1999) and norms (John and Heide 1992, Noordewier, John and Nevin 1990). We utilize the formalization and centralization dimensions to represent the hierarchical mechanisms. The empirical dimensions used in the analysis are as follows:

Table 4.3: Empirical dimensions for coordination mechanisms for commercial interests

Concept:	Empirical dimensions:
Formalization	The extent to which transactions in the reverse distribution system are governed by a contract with fixed policies, rules and procedures.
Centralization	The extent to which transactions in the reverse distribution system are under the decision control of one firm.
Incentives	The extent to which transactions in the reverse distribution system are governed by an outcome-based contract.
Norms	The extent to which transactions in the reverse distribution system are governed by relational norms such as flexibility and information exchange.

As for the physical flows, the coordination of commercial interests is expected to contribute to coordinated action. This is reflected in the aligned behavior and performance variables. Aligned behavior reflects the extent to which governance mechanisms stimulate the actors to align self-interest behavior with the common interests of the systems. The contracts to a large degree specify the expected behavior. Therefore we empirically evaluate the degree of aligned behavior among the participating actors. The evaluation is measured against the specified contracts and agreements. For example, if the contracts specify how a certain activity is expected to be performed, and the participating actor does not comply, the degree of aligned behavior is expected to be low. Oppositely, if the participating actor does comply and is performing the activities as agreed, the degree of aligned behavior is high. The degree of aligned behavior is reflected in the performance variables of transaction costs and transaction value. It is the relative size of the costs and value that is measured (Williamson 1985). Thus, when evaluating the performance of the coordination of commercial interests, we evaluate the opportunity costs (Rindfleisch and Heide 1997) and opportunities gained (Ghosh and John 1999). Therefore, the performance variables are measured relative to an expectation level. The coordinated action concept for the commercial interests part of the distribution system is measured as summarized in the table below:

Table 4.4: Empirical dimensions for coordinated action in commercial interests

Variables:	Empirical dimensions:
Aligned behavior	The degree of aligned behavior
System performance	The level of transaction costs compared to an expectation level The level of transaction value compared to an expectation level

We expect that the interaction between the coordination mechanisms for physical flows and commercial interests influence the overall system goal. In the reverse distribution system, the system goal is reflected in a *collection rate* – i.e. how much volume the reverse distribution system is able to 'produce', or the volume of products at end-of-life that has been collected, transported and reprocessed. In other words, the extent to which the coordination mechanisms match across the flows in reverse distribution systems, we expect the systems to be able to produce a sufficient collection rate. The empirical dimension of the system goal is therefore the percentage of collected products:

Table 4.5: Empirical dimension for coordinated action on a system level

Variables:	Empirical dimension:
System goal	The percentage of collected products

4.3 Summary

In this chapter, we have presented a theoretical argument and a research model, which is concretized to an analytical framework. The analytical framework is adapted to our research context on reverse distribution systems. It also illustrates that we work with systems, as several functions are part of the framework. In the following chapter, we argue in greater detail for our methodological choices, before we continue the case descriptions and analysis, which are structured in accordance with the analytical framework.

5. METHODOLOGY

In this chapter we present the research strategy and design of our study. We have chosen the case study as a research strategy. The choice of strategy is based on the argument that the collection systems for EE-products at end-of-life are contemporary phenomena, which are difficult to separate from their real life contexts. The research design is a single embedded case study, where three cases have been studied longitudinally over a five-year period. Our unit of analysis is system, which means that our data is taken from multiple sources, based both on primary and secondary sources. The primary data include interviews and site visits with different types of actors, and the secondary data are written documents ranging from regulations, contracts and presentations, to brochures. We evaluate the overall research quality to be good but also realize that there are some challenges with this research, which we will discuss later in this chapter. The study has been very interesting both in content and form. In particular, it has been exciting to work with the system as the unit of analysis, which we believe is a specific contribution of this study.

5.1 Research strategy and design

Our overall aim with this study is to understand how reverse distribution systems are coordinated[32], i.e. how systems are organized to take back products at end-of-life for recovery and waste management. The research problem is motivated by the fact that such systems have only relatively recently been established in Norway. We then further identified that we wanted to explore the problem within the specific context of EE-waste.

An appropriate *research strategy* for our study is the case study. The case study allows for a research question of a 'how' character. It does not require control over the studied events and it is a strategy that allows for focus on contemporary events (Yin 2003). Or, as Eisenhardt (1989b) puts it: "a research strategy which focuses on understanding the dynamics present within single settings" (p.534). Our study has these characteristics. Two elements that promote a case study strategy are the need for depth and the desire to trace information over time (Yin 2003). The study is also an investigation of a contemporary phenomenon in its real

[32] Used as a short version of our problem statement.

life context. In this respect, the relevant behaviors cannot be manipulated and the case study is a preferred research strategy (Yin 2003). In such situations, the researcher is dependent on the direct observation of the events being studied and the interviews with the people who have been involved in the events (Yin 2003).

Our study also researches a fairly new phenomenon. Reverse systems in general have been around for some decades (Barnes 1982), but the systems for collection of EE-waste in Norway are the first of their kind in the world (SFT 1998). In this sense, our research is exploratory in character. Yin (2003) argues that the case study research strategy is not the only or necessary choice for exploratory research. The aforementioned elements (how, contemporary and lack of control) are decisive, especially the *combination* of all three elements. However, the case study involves qualitative research, which is preferable to quantitative research when little is known about the phenomenon being studied (Strauss and Corbin 1990). This strengthens our choice of the case study as a research strategy.

The case study research strategy represents a process with a number of stages (Eisenhardt 1989b). The stages are presented in a stepwise sequence with defined start and end points. However, the case study research process does not always allow for this type of structured procedure. Rather, it allows one to move back and forth between the different stages of the process. This alternation has been referred to as *systematic combining* (Dubois and Gadde 2002). "Systematic combining" is a process where the theoretical framework, empirical fieldwork and case analysis evolve simultaneously. It is argued to be particularly useful for the development of new theories" (Dubois and Gadde 2002:554). Systematic combining enables two processes: 'matching theory and reality' and 'direction and redirection'. This is, in many respects, the nature of the case study research strategy – it allows for these types of adjustments (Yin 1994). The systematic combining methodology is based on abduction, which represents the investigation of the relationship between everyday language and concepts (Dubois and Gadde 2002). This involves developing theory, in that existing theories are refined and modified, as compared to grounded theory that involves theory generation (Glaser and Strauss 1967).

Theory development is an essential part of the research design phase in case studies (Yin 2003). In order to understand "how reverse distribution systems are coordinated" we need to relate to theory that addresses systems and how they are organized. We have found guidance from three theoretical perspectives. First, there is a line of research that specifically addresses reverse distribution systems. Second, research on physical flows has guided the development of our framework. The third theoretical perspective is taken from the governance literature. From working with these theories we have understood that the goal of a system is to achieve coordinated action, and the ability to do so is achieved through coordination mechanisms. We have discovered that coordination mechanisms are different across different types of flows in a system, but it is not clear from the theory how these mechanisms apply to reverse distribution systems. As a result, we have developed a general research model that addresses coordination of distribution systems, and an analytical framework that specifically addresses the dimensions of reverse distribution systems.

Throughout our work on this study, we have utilized *a research process* described as systematic combining. The theoretical framework has been developed as an iterative process between theory and the empirical world, which is referred to as matching. We have used theory to understand the study's context and we have used the context to develop the study's framework. As such, the framework has been based on theory but the combination of theories and concepts have been identified in light of the context. This process has been divided into two phases. First, we have proposed a framework suitable for analyzing our cases. Second, we have analyzed the cases in order to refine the concepts and understanding within the framework. However, this process is also a reflection of the learning that has taken place during the study. It reflects both *what* we have learned and *how* we have learned. The latter is an important but often ignored part of the research process (Dubois and Gadde 2002). The systematic combining process pays closer attention to the iterative process than traditional case study research.

The *research design* is the logic that ties the research questions and the empirical data together, and allows for the conclusions of the study. The research design is in effect the project plan of the study (Yin 2003) within given constraints (Ghauri and Grønhaug 2002). When deciding on a research design it is important to pay close attention to the research questions and the aim of the study. The research design is an overall strategy to get the desired information (Ghauri and Grønhaug 2002). Yin (2003) argues that the five components that are important in designing case studies are: the research questions, the propositions, the unit of analysis, the logic of linking the data to the propositions, and the interpretation criteria. The questions and propositions point to the scope of the study and what it includes. In this study, it led to the definition of the *reverse distribution systems* as cases, rather than the waste management companies. It also resulted in us being able to define the *system* as the unit of analysis.

In line with Yin's (2003) basic types of designs for case studies, we have identified that a single embedded case study design is appropriate for our study. This limits the context to "collection of EE-waste", as opposed to studying different types of wastes (e.g. paper, plastics). In this respect our case is *a representative case*, where lessons learned are expected to be informative about other cases (reverse distribution systems for other wastes) (Yin 2003). In choosing a representative case, we are able to control for the context as a variable, i.e. if there is systematic variation depending on the type of waste collected. We have also included the longitudinal element, which to Yin (2003) is an argument for a single case design. The argument for including an embedded (as opposed to a holistic design) is the fact that the system unit of analysis includes a number of sub-units of analysis, in particular the different actors (companies) involved in the systems. We investigate the actors that constitute the system and make inferences about the system on the account of the actors. The challenge with this design is to ensure that we can conclude on the system level of analysis.

The system as a unit of analysis and the cases need elaboration, as they are not typical of the research tradition within which our framework is based. Therefore we continue by discussing the design elements - 'unit of analysis' and 'choice of cases' - in further detail.

5.1.1 Unit of analysis

The unit of analysis in our study is *system*. The choice of this unit of analysis is motivated by our interest in understanding distribution systems. In his work on distribution, Alderson (1954) argues that systems need to operate as *an integrated whole* in order to obtain effectiveness and efficiency. The task of a distribution system is to ensure that manufactured products are made available for consumption. The task involves a set of operations, which in the end constitutes a system.

To study systems is an identified need in the distribution channel literature (Gripsrud et. al. 2006, Achrol, Stern and Reve 1983, Reve and Stern 1979). However, the tradition has been to utilize the dyad as the unit of analysis (Rindfleisch and Heide 1997, Achrol, Stern and Reve 1983). One argument for this is the need to become more theoretical within channels research (Stern 1988). In the political economy research tradition, 'more theoretical' has been interpreted in terms of stringent measurement, which has been difficult to apply beyond the dyad. It is argued that it is necessary to understand "the basic transaction or acts of exchange between pairs of social actors by applying a dyadic interaction model" before studying the extended network (Achrol, Reve and Stern 1983). Most distribution channel studies have focused on dyads and continue to do so (Gripsrud 2004). However, moving to such stringent research on a dyadic level has lost some of the conceptual whole of the channel, and there is a gap between the research agenda and the actual research when it comes to unit of analysis. This gap has been recognized and development beyond the dyad as the unit of analysis in research on distribution systems has been promoted (e.g. Wathne 2001). The importance of having a systems scope in our study cannot be limited to lack of measurement techniques, and it is recognized that case studies offer a vehicle to develop the knowledge on distribution further (Gripsrud 2004).

How are systems studied? One of the key questions Aldrich and Whetten (1981) address is how to cope with the unmanageable complexity of social systems. They suggest the concepts of organization-sets, action-sets and networks with which to study social systems, and the complexity of social systems is studied using various network concepts (Aldrich and Whetten 1981). Aldrich and Whetten's (1981) perspective represents social exchange theory. However, the industrial network approach also represents a way in which networks can be studied (e.g. Håkansson and Johansson 1993). The basic unit of analysis is the relationship and networks are studied using the concepts of activities, actors and resources (Håkansson and Snehota 1995). Thus, the industrial network approach is not, in principal, interested in how the network is *structured* in itself, but more the *industrial* elements within them. Rather than focusing on nodes, links and structural holes, industrial networks focus on the actor bonds, activity links and resource ties. That is, the content of the relationship rather than the existence of the relationship itself.

In order to study systems, a viable route is to utilize the concepts promoted in the industrial network tradition. Anderson et. al. (1994) discuss in particular how industrial network concepts and dyadic business relationships are related. They propose that network concepts have an effect on cooperation in dyadic business relationships. They argue that the *relationship state* is the focus of a dyadic business relationship perspective, and that the *activities* are the focus of the network perspective (p. 7). In this sense, it is argued that the network properties underpin the relationship state, as it is the activities performed that confirms the relationship state.

The activities in one company are related to activities in other companies by a matter of degree and are represented through a concept of anticipated activity complementarities (Anderson et. al. 1994). In particular, it is argued that 'the value of the outcomes from activities undertaken in connected exchange relationships may be contingent on activities performed in the focal relationship' (p.8). This notion captures the logic of a "system". In this manner, the companies are interdependent and, according to Anderson et. al. (1994), the effect of linked activities has both positive and negative sides. The positive effects are expected to be constructive, while the negative ones are expected to be deleterious. In other words, by studying the activities between the actors that are involved in a system (i.e. distribution system), we are able to identify and describe our unit of analysis.

In summary, studies within distribution have largely been framed within the dyad as the unit of analysis. However, this is not sufficient to understand distribution systems. The system as a unit of analysis has been promoted in the distribution literature but has rarely been used. In order to develop knowledge about distribution systems, we utilize the system as a unit of analysis and do so by identifying and describing the activities that are performed between the actors involved.

5.1.2 Choice of cases

When choosing cases, Eisenhardt (1989b) argues that the concept of a population is crucial because an appropriate population controls extraneous variation. In choosing cases within the same waste industry (i.e. collection of electric and electronic products), we have been able to achieve this level of control. Eisenhardt (1989b) further argues that specification of the population clarifies the domain of the findings. As we have chosen to study reverse distribution systems within the waste sector, our findings have relevance primarily for other waste systems.

Choosing cases from a population is, according to Eisenhardt (1989b), unusual when building theory from case studies. The argument refers to the distinction between theoretical and statistical sampling. The goal in hypothesis-testing studies is to sample randomly from a population (i.e. statistical sampling). The goal in theory building, however, is theoretical sampling, i.e. to choose cases that replicate previous cases or extend theoretical categories and provide examples of polar types (Eisenhardt 1989b). The specific demands for the cases in our study are derived from the conceptual framework. Therefore, for our purposes, the following dimensions have to be reflected in the cases:

- "A whole system"
- Physical and commercial interests
- Variation in coordinated action

Three factors have been identified in order to distinguish "a whole system". The industry organizations are obligated to the authorities to provide "systems that secure collection and environmentally responsible reprocessing of EE-waste"[33]. The industry organizations have established waste management companies to take on the operative responsibility[34]. The waste management companies are, in other words, given a mandate to provide "a whole system". Thus, departure from the waste management companies is what defines a given system. The waste management companies are easily identified as they are registered with the Norwegian Pollution Control Authority (i.e. registered at SFT).

The EE-products also help us to identify "a whole system". The products to be collected are clearly defined and all electrical and electronic products in the market are structured by customs numbers and are sorted into 18 categories (Hjellnes Cowi 1996). Within the industry agreement, the waste management companies are given responsibility for their separate categories (i.e. consumer electronics, white goods and household appliances, general electric) – thus enabling the systems to be defined. There are also independent waste management companies (i.e. not part of the industry agreement), and these companies do not necessarily collect products within the above product categories. A third criterion that helps us to distinguish "a whole system" is the stipulated 80 % annual collection rate. All the waste management companies registered with the authorities have to report the collected volume twice a year. The volumes have to be reported in the defined categories, thus the performance of a system is reported. In this manner, the waste management companies and the collected volumes identify the "whole system".

The exchange we are studying is 'the collection of EE-products at end-of-life'. The physical flow is the physical collection and movement of EE-products at end-of-life. The commercial interest, however, is represented within the industry organizations and EE-companies. That is,

[33] The citation is taken from the industry agreement.

the responsibility for the products is given to the EE-companies (i.e. the producer responsibility). The industry organizations have signed the industry agreement *on behalf of* the EE-companies and the waste management companies have taken the operative responsibility *on behalf of* the industry organizations. However, the final choice of how to handle the producer responsibility is placed with the individual EE-company. That is, the EE-companies have the commercial rights to the products. This is reflected in the fact that the waste management companies have to recruit members to their systems. For a waste management company to be registered with the authorities it must have members. In this way, the waste management companies take on the commercial rights for their members.

Consequently, in order to include both the physical flow and the commercial interest of the "whole system", it is necessary to include the waste management company, the collection system and the stakeholders in the case. Thus, a typical case in our study includes the parts as illustrated in the figure below:

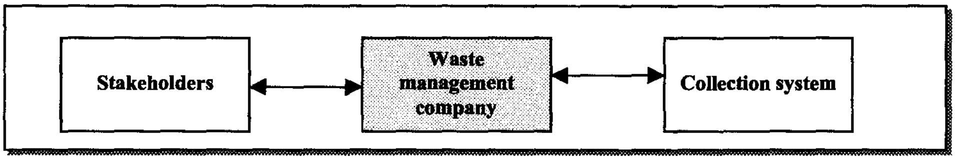

Figure 5.1: The content of 'a case' in our study

We need to distinguish between systems in order to achieve variation in coordinated action – i.e. achieving *comparison* in coordinated action. We have identified and included three possible cases that fill the demands of our study. The choice of the specific cases is based on a combination of the waste management companies, the product categories and the industry agreement. That is, each case has to include both physical and commercial interests. A physical flow involves a collection system, while the commercial interests include members. The waste management companies combine the two flows into one system. When using more than one case, the cases should be chosen either to (a) predict the same result, or (b) give the opposite results but for predictable reasons (Yin 1994). We have included three cases, which cover all 18 product categories in order to understand coordination beyond product specifics.

[34] Documented in the membership contracts issued from the waste management companies.

Also, the independent cases are included to control for the industry agreement. In summary, the cases are included to explain coordinated action in systems.

The first of our cases is "the El-retur system", which has come about through cooperation between two of the waste management companies, "Elektronikkretur AS" and "Hvitevareretur AS". This system is responsible for consumer electronics (Elektronikkretur), and white goods and household appliances (Hvitevareretur). The waste management companies have different owners and different members but cooperate on the logistics operations, i.e. organize one collection system.

The second of our cases is "the RENAS system". RENAS is the name of the waste management company and the system. The company is responsible for the category of general electric products. RENAS consists of one waste management company and organizes one collection system.

The third of our cases is referred to as "the independent systems". This case consists of the two waste management companies, RagnSells AS and Eurovironment AS. The companies cooperated on the collection when the systems were established, i.e. cooperated with respect to the physical flow. The cooperation was initiated because the Eurovironment system concentrated on reuse activities, and the RagnSells system concentrated on recycling activities. The Eurovironment system was dependent on access to recycling activities. Over the period of our study, the cooperation diminished because the Eurovironment system started performing recycling activities as well.[35] The waste management companies are identified because they are registered with the authorities, and they have their own separate groups of members.

These cases represent distinct reverse distribution systems. The figure gives an overview of the cases in our study.

[35] We will return to this in more detail in the case description in chapter 8.

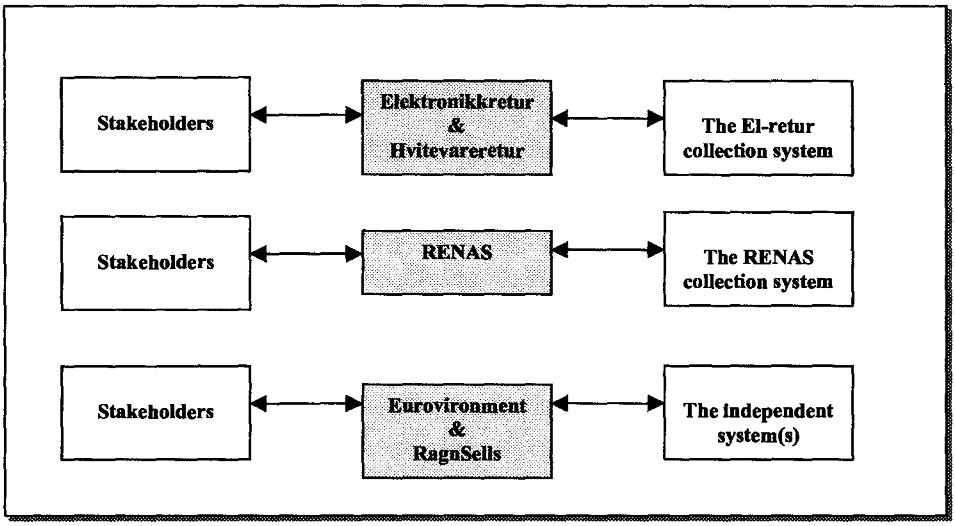

Figure 5.2: The cases (reverse distribution systems) in our study

Our study starts out from 1999 when the collection systems within the industry agreement were being established. Working with these particular systems over time has revealed a nice variance design. The waste management companies were responsible for setting up the reverse systems for the collection of EE-products at end-of-life. However, they did not invest in equipment and logistics solutions on their own. This task was contracted out to actors from the waste industry. A tender was issued in the fall of 1998, giving the actors contracts that would start June 1st 1999. The contracts were for a three-year period.

The contract period from 1999 to 2001 disclosed that the system had a number of weaknesses and, as the second tender period approached, the criteria were changed significantly. The second contract period was also for three years. The systems changed during the two periods, providing the study with variation on its key variables.

The independent systems did not operate with contracts and contract periods and this is described in the case later on. However, these systems also experienced changes over the time period. As the EE-regulations came into force July 1st 1999, all the cases had the same starting points and frames of reference. In order to make the cases as comparative as possible, we limit the study to the two first contract periods, as defined by the waste management companies within the industry agreement. The design is illustrated below:

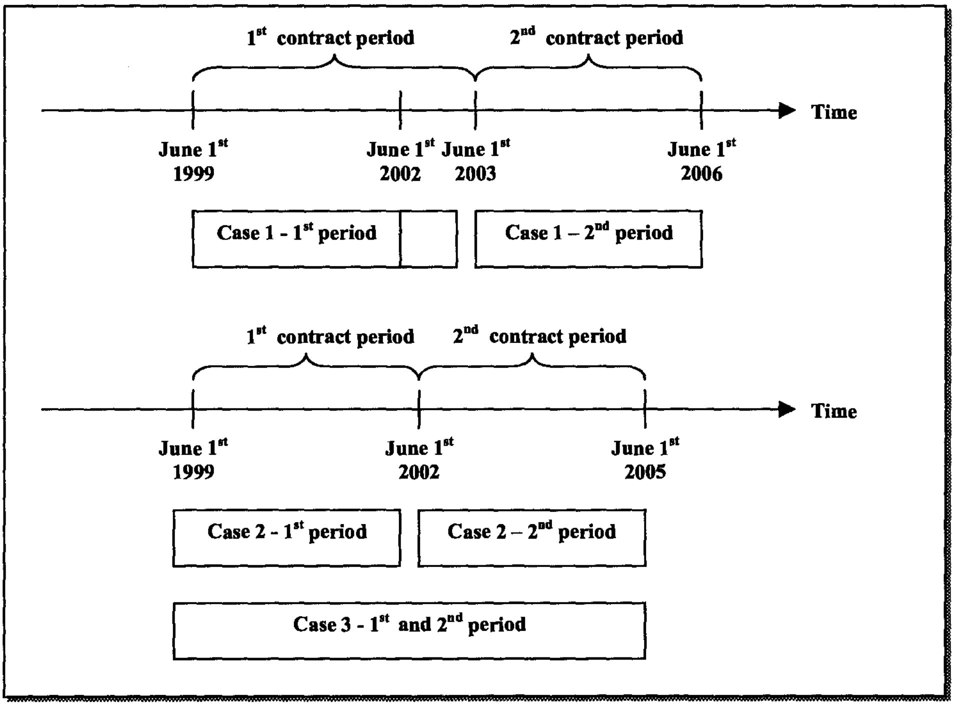

Figure 5.3: Illustration of the periods of comparison within the cases

In sum, we have identified cases that provide theoretical variation. We have selected a few cases that represent our variables and give variation to the variables. In this way, the cases have been chosen on the basis of theoretical sampling. Beyond our cases are a number of companies that are registered with the authorities as waste management companies (ref. chapter 2), plus there are EE-companies that have programs for the collection of EE-waste as a private initiative. However, when looking for cases for our study (i.e. variation and comparison), we found that these other companies and systems did not suit our purposes.

We explored the possibility of setting up a design, which could compare reverse distribution systems for recycling with reverse distribution systems for commercial return (Flygansvær 2001). Even though both types of systems address the return of products, it turned out that reverse distribution systems in general are not one context. Drawing on this experience, we found that collection systems for EE-products at end-of-life was the relevant context in which to address our research interest. In the same study, we also compared a reverse distribution system on the industry level with an internal company case (i.e. Xerox' program for returning copiers). We experimented with this design before developing the one used in this study. The systems did not compare well on the variables that we were interested in and, therefore, we chose not to continue with such a design.

5.2 Data collection

In case studies it is recommended to collect data by multiple data collection methods (Eisenhardt 1989b), or triangulation (Yin 2003), in order to provide stronger substantiation of constructs and hypotheses. Triangulation is, in this respect, both a way to collect data and to check the findings (Miles and Huberman 1994). Triangulation reduces the risk of the conclusions being biased or the limits of one specific method. It also makes it possible to increase the validity of the study (Yin 2003). A usual recommendation is to combine qualitative and quantitative data because the terms qualitative data and the case study are often used interchangeably (Eisenhardt 1989b). However, this distinction pinpoints the fact that triangulation is used primarily to check rather than complement the data. Dubois and Gadde (2002) argue that direction and redirection in case studies is a method to both check data and add understanding, and includes both different sources of data and different methods of data collection. Eisenhardt (1989b) points to the fact that frequent overlap of data analysis and data collection is a striking feature of case studies. In the process of doing field research, the making of field notes, along with 'whatever impressions occur' notes, the researcher is allowed to take advantage of the flexible data collection methods (Eisenhardt 1989b). The key feature is that researchers have the freedom to make adjustments during the data collection process (Eisenhardt 1989b). However, Eisenhardt (1989b) warns the case study researcher that this "flexibility is not a license to be unsystematic" (p. 539).

In our study we have utilized a flexible data collection process. We have performed field interviews following protocols (see appendix D), site visits, attended meetings and seminars, and investigated printed sources of information. We present this process in further detail in the next two sections on primary and secondary data. First, however it is necessary to reflect specifically about what constitutes a system and how this has influenced the data collection.

Our goal has been to understand "a whole system" and we have investigated the system in the context of collection of EE-products at end-of-life. We have identified that our system consists of three main types of actors – namely, the stakeholders, the waste management companies and the actors in the collection system. As a consequence, our data has been collected from all of these categories of actors.

In the context chapter, we identify the types of stakeholders and the waste management companies. In the case studies, we identify the types of actors that are involved in the collection systems. Thus, the latter aspect has been discovered during the data collection and in dialog with the waste management companies. The collection, transport, reprocessing and secondary market are included in a collection system. In summary, the "system" in our cases is made up of the components shown in the figure below:

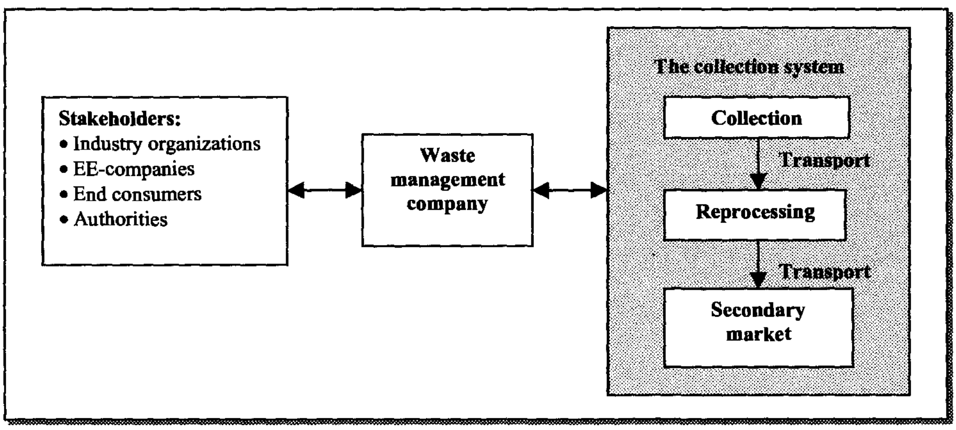

Figure 5.4: The components of the systems

While working with the case studies, we have focused on gaining a thorough 'understanding' of our three cases. We have not concentrated on interviewing the same number of actors in each case because the cases are not identical. The case studies reveal how their focal systems are structured. However, we have strived to get an interview with each *type of actor* in our data material, which represents each *type of function* in the system.

The functions include collection, transport and reprocessing. We do not consider the secondary market to be part of the system we study because it is not within the waste management companies' direct responsibility. However, the waste management companies do pay attention to the secondary market in order to secure preferable choices for the natural environment. Therefore, it is included briefly in the description.

Collection includes delivery from the end consumers to the collection sites, as well as operation of the collection sites. Reprocessing includes the dismantling, sorting and registration of products and materials. Transport includes the handling and transport from collection sites to reprocessing units. The secondary market includes the sale and disposal of products and materials. Transport from reprocessing to secondary markets is not within the waste management companies' responsibility range.

5.2.1 An overview of the collected primary data

Our primary data covers waste management companies, stakeholders and actors in the collection system. The data comprise interviews, site visits and seminars.

Interviews with the waste management companies were the starting point of the data collection, as we considered these companies to be the 'centres' of the systems. There were been several interactions with the waste management companies (1-4 interviews with each of the five companies). The waste management companies are administrative units and therefore the interviews took place at their offices. In addition to being interviewees, the waste management companies were an important reference to identify other actors to interview in the systems.

Data collection from the stakeholders included interviews with member companies and the authorities. Data on the other stakeholders were gathered from the secondary data (see next section). Contact with members was undertaken randomly from lists acquired from the waste management companies. The number of interviews was decided upon using the exhaustive principle, i.e. we stopped doing interviews when the information began to be repeated and we believed we had an understanding of their point of view. This resulted in six member interviews. The waste management companies have in many respects taken over what the members in the reverse distribution system used to do when they disposed of EE-waste. Therefore, these member interviews were not used explicitly in the study but provided useful background information in understanding the role of the waste management companies. One interview was undertaken with the Norwegian Pollution Control Authority (SFT) and the understanding was supported by extensive sources of secondary material (ref next section).

Data collection on the collection system involved interviews and site visits. Interviews were conducted with more than one person, often including the general manager and operations manager. The site visits were very useful in understanding the operation of the companies. We visited collection sites, the premises of transport operators and the sites of the reprocessing units. By doing so, we achieved a thorough understanding of, amongst other things, sorting, handling, cages, accumulation of volume, transport capacity, dismantling, and reporting.

The table below gives an overview of the actors that were interviewed and the sites that were visited (indicated with I and SV respectively). Some of the actors were involved in more than one of the systems. This means that the collection, transport or reprocessing companies had a contract with more than one waste management company. In these cases, the interviews and site visits were applicable to more than one case. This is indicated in the table with an X. RENAS also held seminars for each of the type of actors in the collection systems (indicated with an S). That is, they had collection seminars, reprocessing seminars and member seminars. We attended these seminars and were able to follow the presentations and discussions with the participants. A number indicates where interviews, visits or seminars were held or attended more than once. The data were collected over time in 2002 and 2003. A few interviews were conducted in 2004 in order to clarify some issues in the cases. The table gives an overview of the data, which needs to be viewed in light of the cases that are presented in the next three chapters:

Table 5.1: Overview of the data of the study

Name of company:	Actor*:	Data**:	El-retur	RENAS	RagnSells	Eurovironment
Hermod Teigen	C	I/ SV		X		
Roaf Bøler	C	I/ SV	X	X	X	
Follo Truck Utleie	C	I/ SV	X	X	X	
Seminar in Oslo 2003, 2004	C	S x 2		X		
Haukedal Transport	T	I/ SV	X			
Norsk Gjenvinning Skien	T	I/ SV	X			
Norsk Gjenvinning Oslo	T	I	X			
Elektronikkgjenvinning Vest	C/ RU	I/ SV		X		
Elektronikkgjenvinning	C/ RU	I/ SV	X	X	X	X

Stena Miljø	C/RU	I/ SV	X	X	X	X
Seminar at Hamar	RU	S		X		
RENAS	WMC	I x 3		X		
Hvitevareretur AS	WMC	I	X			
Elektronikkretur AS	WMC	I x 2	X			
RagnSells	WMC/ RU	I/ SV			X	
Eurovironment	WMC	I x 2				X
Miljøfabrikken	RU	SV x 2				X
Expert Norge	M	I	X	X		
Canon Norge	M	I	X	X		X
Ricoh Norge	M	I	X	X		X
Xerox	M	I	X	X		
Ericsson	M	I	X	X		
Telenor Mobil	M	I	X	X		
Seminar in Oslo 2002, 2003	M	S x 2		X		
The Norwegian Pollution Control Authority (SFT)	A	I	X	X	X	X

* Type of actor: C=Collection site/collector, T=Transporter, RU=Reprocessing unit, WMC=Waste Management Company, M=Member, A=Authority.
** Type of data: I=Interview, SV=Site Visit, S=Seminar

The interviews were documented with notes, tapes and pictures. The choice of technique was decided at the time of the interview, both in dialog with the person being interviewed (e.g. if they were willing to be taped or not) and what was possible at the site (e.g. at some of the site visits the noise made it impossible to use tape). We were not, in other words, consistent in the use of technique but as a means of compensating for this, we worked through our notes immediately after the interview while it was still fresh in the mind. The interviews and visits were conducted and written in Norwegian.

We utilized an interview protocol for each meeting but it had to be adapted to the type of actor (i.e. whether it was a collection site, transport operator, reprocessing unit, stakeholder or waste management company). The protocol is included in appendix D.

5.2.2 Use of secondary data

In addition to the interviews, visits and seminars, we also used secondary data in our study. An overview of the secondary data can be found in appendix F. The secondary data included legal documents, which related to the EE-Regulations, and the tenders that were issued for the contract periods. The data also included brochure material, volume reports and presentations used to inform the different stakeholders. Information was also gathered from related research projects (Flygansvær 2001, Jahre and Flygansvær 1996, Baklien and Flygansvær 1996).

The secondary data were studied in depth to gain background information and further understanding of the cases. It formed important reference literature for the interviews, plus it was used to understand the context of the reverse distribution systems.

5.3 Data analysis

A detailed description of how the data have been analysed makes it easier for others to see how the conclusions have been reached (Miles and Huberman 1994). The case, however, is an iterative process between collection and analysis (Eisenhardt 1989b). It is acknowledged that the process of analysis of case studies is intrinsically complex (Dubois and Gadde 2002, Miles and Huberman 1994, Eisenhardt 1989b). However, case analysis does have some key features and Eisenhardt (1989b) points to analysis of *within case* data, together with the search for *cross case* patterns. Dubois and Gadde (2002) argue that cases evolve and should be regarded as both a tool and a product.

In our data analysis, we have followed the general analytic *strategy* of relying on theoretical propositions (Yin 2003). We have been interested in understanding coordinated action in a system, in terms of how the physical flow and the commercial interests are organized and contribute to an integrated whole. We have therefore described the physical flow and the commercial interests of each case, and analyzed how the coordination of these flows contributes to coordinated action. In our study, coordinated action is measured against the collection rate level of 80 %. In other words, we are interested in discovering the extent to which the systems in our cases are able to collect 80 % of EE-products at end-of-life within their categories and responsibility. We also want to find out to what extent this is explained by the mechanisms that coordinate physical flows and commercial interests.

Our theoretical model has guided the data collection and we have also been open to what we have learned during the process. That is, we have been attentive towards how the physical flow and commercial interests have been coordinated, but we have also used an inductive process to understand how these flows have influenced each other.

Further, we have utilized time series analysis as an analytic *technique* (Yin 2003). Our cases span two time periods and we have compared the two sets, both within and across the cases. Yin (2003) argues that the ability to trace changes over time strengthens case studies. In our case descriptions, we have presented the systems at two points in time, i.e. in two contracts periods. The waste management companies issued contracts to the actors for two periods, and we have presented and evaluated the physical flows and the commercial interests for these two periods. Rather than tracing events over time, we have compared systems at time 1 and time 2, i.e. the first and the second contract period. Note that the period of our study is from 1999 until 2004 and therefore the second period is shorter than the first.

We have made a within case analysis for each of the three cases and we have searched for cross case patterns. In our work, the shaping of propositions has been a result of the within and cross case analysis. The propositions are formulated in chapter 10. Now we go on to explain in more detail how the cases have been written up and analyzed.

5.3.1 Writing the cases and within case analysis

Within case analysis involves, according to Eisenhardt (1989b), detailed case study write-ups and there is no standard format for such analysis. Each of our three cases represents one system, and we have identified the waste management company as the focal company in each system. In this respect, our case descriptions start with a presentation of the waste management company/ies and we have developed the case in accordance with the waste management responsibility range. Our interest has been to describe the physical flow and the commercial interests, and we have described these flows in two time periods. In describing the physical flows, we have followed the path of the products being collected, tracking the activities from collection and transport to reprocessing. In describing the commercial interests, we have followed the financial, title and negotiation flows. Each case describes coordinated action within the system in question. This includes the intermediary and dependent variables, as well as an overview of the collected volume as reported to the authorities by each of the waste management companies. The collection rates represent the degree to which the system goal is achieved.

The case descriptions have been developed alongside the data collection. Our cases have been developed from our primary data (the interviews) and the secondary data. The interviewees were asked to explain both how the system was supposed to work and how it was actually working. Our interviews were conducted with different types of actors, who represented different roles in the systems. This has helped us to gain an understanding of the reverse distribution system in question, as well as insight into the other systems in the study. We have not utilized a particular coding technique but the data have been manually systemized. The cases have been written in conjunction with working through the interviews. This has been an ongoing process during the study period. The process has been one of data reduction (Miles and Huberman 1994), where analysis helps to "sharpen, sort, focus, discard and organize data in order to draw and verify "final" conclusions"(p.11). The data have been documented and displayed (Miles and Huberman 1994) by using statements[36] from the interviews, together with various tables and figures both in the cases and in this methodology chapter. The result of the process is that the case write-ups are not just data reduction, documentation or data display; they actually form part of the analysis (Miles and Huberman 1994). Thus, even though the cases are divided between a descriptive part and an analytical part, the description constitutes a part of the analysis. The description is a utilization of the analytical framework (cf. chapter 4).

In the within case analysis part, we have analyzed the coordination mechanisms of the physical flows and commercial interests by utilizing the theoretical framework (cf. chapter 4). That is, the theoretical concepts have been used to evaluate the physical flows through collection, transport and reprocessing, and to evaluate the commercial interests through the negotiation, financing and transference of title. The analysis contributes to an understanding of coordinated action. The comparison between the two time periods gives insight into the dependencies between the physical flows and commercial interests. The change in each flow gives insight into the change in the other flow.

5.3.2 Cross case analysis

The cross case analysis enhances generalizability and deepens understanding and explanation (Miles and Huberman 1994). In our cross case analysis, we have compared the three cases (systems) with respect to physical flows and commercial interests and we have identified that there is variation between the cases. The comparison is more directly achieved between the systems within the industry agreement (the El-retur system and the RENAS system) but the independent systems contribute to understanding the nuances.

[36] The statements are not a word-by-word citation from the interview, but reflect the statements of the

In the cross case analysis it is important not to be mislead. Eisenhardt (1989b) points out that researchers are "notoriously poor processors of information" (p. 540). To mitigate this challenge, Eisenhardt suggests a number of tactics, including various analyzing patterns. The goal is to get investigators to go beyond their initial impressions and secure theory development that has as close a fit to the data as possible. The methodology of the evolving framework, which is promoted by systematic combining, is utilized in our study (Dubois and Gadde 2002). It is suggested that the theoretical framework is an important ingredient in the research process and that the point of departure needs to be "tight and evolving" (p. 558). The tightness is suggested in order to avoid a "multitude of meanings" but the evolvement is a component because the "empirical observations inspire changes of the view of theory and vice versa" (Dubois and Gadde 2002:558).

Working with the context of collection of EE-waste and setting out to understand the coordination of the systems, we have developed a framework that explains coordinated action. In the analysis we develop this theoretical framework further and analysis of the cases result in the shaping of propositions (Eisenhardt 1989b). The analysis is structured according to the framework, in the sense that we explore the coordination of physical flows and commercial interests separately, and then combine these aspects in order to understand how the processes in our cases contribute to coordinated action.

5.4 Research Quality

In evaluating the research quality of the study, we draw on the three concepts of validity, reliability and objectivity. There are many types of *validity*, which are separated into two main groups: internal and external validity (Ghauri and Grønhaug 2002). Internal validity is an evaluation of the extent to which the results of the study are 'true', while external validity is an evaluation of whether the results of the study may be generalized. *Reliability* is a second criterion used to evaluate research quality. The term refers to the stability of the concepts in the research (Ghauri and Grønhaug 2002). Validity refers to the extent to which the study has been able to measure what it was supposed to measure. Reliability deals with whether the results are trustworthy. The third dimension in evaluating research quality is the *objectivity* of

interviewee.

the researchers, as they are highly integrated in the research process. Our evaluation starts with this latter dimension.

5.4.1 Objectivity

An issue in qualitative research is whether the researcher is able to stay objective in the process. Maxwell (1996) identifies two main threats to be *researcher bias* and *reactivity* in qualitative research. Researcher bias is the extent to which the qualitative conclusions are a selection of the researcher's existing theories or preconceptions, and the selection of data that stand out to the researcher (Miles and Huberman 1994). However, since it is difficult to isolate the researcher from him or herself, it is necessary to explain the possible biases. Reactivity is the extent to which the setting or the individuals studied is influenced by the researcher. Again, it is impossible not to have any influence on the interviewee when doing interviews but it is important to avoid leading questions and to understand *how* the researcher influences (Maxwell 1996). Eisenhardt (1989b) notes that "the flexibility of the case study is controlled opportunism in which researchers take advantage of the uniqueness of a specific case and the emergence of new themes to improve resultant theory" (p. 539). In other words, at some point it is necessary to trust that the researcher actually has interpreted the data in the best possible way.

During the interviews we tried to encourage the interviewees to speak as freely as possible. The interview guide (see appendix D) was used as a checklist for the researcher and was presented to the interviewee. Also, even though the interviewees spoke in depth about what they were particularly occupied with (ref. political stakes in the case discussed in the validity section), they were not interrupted, as this was viewed as important insight into the case. The interviewees received the researchers in a welcoming manner for all the visits. As a result, we believe that they were not overly influenced by the research agenda.

A challenge is also the research process itself. We believe that our attention was more focused towards the end of the process because we were more aware of our framework and had an overall understanding of the cases. This can be attributed to the nature of systematic combining, where one moves back and forth between the case and theoretical framework, which gives increased understanding and a greater focus as the research progresses.

5.4.2 Validity

Validity denotes research quality and is represented in terms of several dimensions. Maxwell (1996) argues that there is no "gold standard" for valid research and, as such, the key concept is the validity threat: to uncover in which ways you might be wrong.

Quantitative and qualitative research deals with validity threats in different ways (Maxwell 1996). Quantitative researchers attempt to design controls in advance that can deal with anticipated and unanticipated threats to validity, e.g. control groups, statistical control and randomization. Qualitative researchers rarely have the luxury of a priori control. Instead they have to try "to rule out most of the threats after the research has begun" (Maxwell 1996:88). Validity in qualitative research is taken care of in terms of *description validity*, *interpretation validity* and *theoretical validity* (Maxwell 1996).

Description validity refers to (in)accuracy or (in)completeness of the data. In our case, this type of validity was taken care of by ensuring that all the interviews were worked through immediately after the meetings. Some of the interviews were taped and then written out word-for-word. The other interviews were based on notes. It was also easier to work with the data structuring after having viewed the operations (site visits) that the interviews covered. In addition, the data were strengthened with repeated discussion with the waste management companies, which were focal to the cases. Also, extensive use of secondary data helped towards this demand. Another issue is the extent to which the interviewees gave correct data. On this account, it should be mentioned that there was a political dimension to this topic. The interviewees viewed the researchers in some instances as "a way to influence". Their stakes and position therefore colored the input to the research. However, we tried to mitigate this by explaining the stakes for the parties in the cases.

The structure for the within case analysis was developed over time, growing as the case evolved. In parallel with this work, one of the cases (RENAS) was developed as a NETLOG[37] case (see appendix G). The write-up of this parallel case was helpful in facilitating the cases, especially with respect to understanding the significance of the two contract periods. This

[37] NETLOG was a four-year research project at the Institute for Strategy and Logistics at the Norwegian School of Management. The project set out to analyze resources in logistics based on the industrial network approach (Gadde et. al. 2002).

work was a part of the NETLOG research project, and the case was presented and discussed at several research meetings and contributed to the understanding of this study.

Interpretation validity refers to the extent to which the researcher imposes his or her own framework or meaning on a situation, rather than trying to understand the perspective of the people being studied. One way to circumvent this issue is to ask the interviewees to read and comment on the finished cases. A challenge in our study was the different roles the interviewed actors had within our cases (systems). Due to this situation, it was difficult to get the actors to comment on the cases as they had quite separate views. Gaining and incorporating the opinions of so many actors was not seen to be fruitful and time constraints placed such a solution out of reach. However, since we used a number of statements from the interviews, we asked the managers to permit usage of the statements. The position of the managers and companies are included in appendix E.

Theoretical validity refers to the extent one pays attention to discrepant data, or considers alternative explanations or understandings. Maxwell (1992) argues that theoretical validity involves the two concepts of *construct validity* and *internal validity*. Construct validity refers to the extent to which an operationalization represents the concept that it purports to measure (Ghauri and Grønhaug 2002). Construct validity is often difficult to achieve in case study research (Yin 1994). It may be difficult to develop adequate measures and that subjective opinions may be represented in the data. A way to strengthen the construct validity in case studies is to use several sources of data (i.e. triangulation). We used this technique in our study when we conducted interviews, undertook site visits and utilized secondary materials.

Internal validity refers to the relationship between constructs or the cause-effect relationship (Gharui and Grønhaug 2002). This relationship is a challenge in qualitative research because it is basically impossible for others to repeat the research (Sykes 1990). By documenting the research process, the data material and the data analysis in a thorough way, we mitigated the internal validity demand.

Beyond these validity types that refer to the quality of the study, it is appropriate to discuss external validity. Generalizability in qualitative research and case studies is a question of generalizing back to theory (Yin 2003): To what extent is our study valid in order to detail the understanding of our framework? We have developed propositions that expand the understanding of our theoretical framework and have therefore contributed to generalizability.

A second aspect is that the broad scope of our study within one context is valuable for this type of research. This generates an important outset for further research within the area. We believe that the study in itself has a value, as the systems we study are the first of their kind in the world.

5.4.3 Reliability

Reliability is about the stability of the research process (Miles and Huberman 1994). A challenge in our study with respect to reliability was the explorative approach to the data collection. In seeking to understand the systems, we carried out fairly open interviews, encouraging the interviewees to speak freely on our research interests (e.g. how does the physical flow work in the system, how are the commercial interests taken care of in the system). Based on the open questions, the interviews were guided with supplementary questions. At the same time, interviewing actors with different roles makes it difficult to claim that reliability is high. However, the strength of the study is that the approach promoted the nuances of the study, which were difficult to predict. Plus it is important to remember that these systems were the first of their kind in the world and our research interest was in looking for system effects. Therefore, it was necessary to take an open ended exploratory approach in the study.

We have documented the way we have done the study and explained how we have arrived at the results. The same researcher collected all the data, worked through the interviews, studied the secondary data and wrote the analyses. In this way, the researcher has been involved in the entire process, which gives added strength to the study. However, a potential weakness is that the results are limited by the researcher's cognitive capacity and understanding. On the other hand, the study and results have been discussed with supervisors, in seminars and with the case companies during the period of the study. Miles and Huberman (1994) point out that if several observers have the same understanding of a study, reliability is increased.

5.5 Summary

In this chapter we have tried to detail the methodology of the research process. Based on the characteristics of the study, we have arrived at an exploratory design, a case study research design and qualitative data. The design is suitable for theory development, which is central to this study.

A main strength of our study is that it has been an iterative process that has provided a thorough understanding of the cases. We believe we have a deep understanding of the empirical part of the study. In particular, the adjustments in the process have led to the understanding of the two contracts periods, which has been important for the study.

It is also of strength that the study has a limited context and that the cases almost cover the entire population within the context. This has strengthened the understanding of the work. In addition, having an overview of the systems advances this research area.

6. Case 1: The El - retur system

In this chapter we present and analyze the El-retur system. We describe the case in sections 6.1 to 6.4 in accordance with the analytical framework, and then the case is analyzed in section 6.5. In the last section of the chapter, the case is briefly summarized.

We compare the case in two periods (cf. chapter 5). The collection system started operating July 1st 1999, and has operated for two contract periods. The first contract period was extended for one year. That is, the collection system had a contract period from July 1st 1999 until July 1st 2002, with an extension year 2002 – 2003. The latest contract period runs from July 1st 2003 until July 1st 2006. The case is presented in accordance with the contract periods.

The El-retur system consists of two waste management companies and one collection system. The products that are returned in the El-retur system are reprocessed for materials recycling (the waste management option). We start with a presentation of the waste management companies, before we present the physical flow. Next, we present the commercial interests in the system and close the presentation of the case with the performance variables. The case is analyzed as to the extent to which the El-retur system is able to achieve coordinated action.

6.1 The waste management companies

The waste management companies Elektronikkretur AS and Hvitevareretur AS are similar organizations with separate administrations. In 1998, when the two waste management companies were established, it was recognized that there were synergies in coordination of activities and, therefore, the companies were structured and organized in the same manner[38]. The companies have different owners, different types of members and are responsible for different product categories[39]. Therefore, administrative activities need separate attention.

[38] The business statements are basically identical, except the definition of products and owners.

[39] See appendix A for an overview of the product categories.

The products that the two organizations have a responsibility for are considered to have highly integrated product flows: "the same chains, shops and municipalities to collect waste from". For example, Elektronikkretur is responsible for collecting TVs, while Hvitevareretur is responsible for refrigerators but these types of products are often sold at the same shops and chains. Common interests and activities led the waste management organizations to develop a common collection system under the name of "El-retur". El-retur is a concept rather than a legal business unit. El-retur is used as a concept to simplify information and communication. Elektronikkretur and Hvitevareretur jointly manage the collection system. Management of the collection system includes the definition of operation structure, identification of which logistics operators to include, negotiation and operation of contracts with the actors, and control of the operations. The waste management companies seek to work with professional partners in the collection system to find the best solutions for handling EE-products at end-of-life. The goal has been to reach the 80 % collection level within the first five years of operation, as agreed with the authorities.

The waste management companies also undertake different tasks. This results from the companies having different owners and member groups (cf. chapter 2). They are separately responsible for reporting their activities in terms of number of members, collected volume and shares of hazardous waste to the authorities.

The EE-companies that import and/or produce consumer electronics can become members of Elektronikkretur AS. As of June 2002, Elektronikkretur AS had 455 members. The share of members is assumed[40] to be a 70 % share of EE-companies in its product segments. Membership means that Elektronikkretur takes on the responsibility of collecting 80 % of EE-products at end-of-life on behalf of the EE-companies. The members compensate Elektronikkretur AS for the task by paying fees, which are based on the imported and/or produced volume of EE-products.

The content of the memberships is the same for Hvitevareretur. As of June 2002 Hvitevareretur AS had approximately 150 members. This is assumed to cover 90-100 % of the distributors and importers for white goods and household appliances. The members of Elektronikkretur and Hvitevareretur are represented by the industry organizations that own the

[40] The customs has an overview of all the potential companies (i.e. population), however it is not public information.

waste management companies. A direct dialog between the waste management companies and the member companies is limited, as illustrated:

"Our dialog towards the member goes through the industry organizations, our owners. Problems that occur are solved administratively. If there are political challenges we expect these to be solved on the industry level. These types of problems have, knock on wood, been next to nothing. We have had few practical problems as well." Elektronikkretur

"We inform the members through our websites. I have to admit that the interest for our work is very low with the EE-companies. The EE-companies are sales organizations, and their business is sales. As long as they are not bothered too much, the cost is kept as low as possible, and agreements become better over time – they are satisfied." Elektronikkretur

The collection system has been established as an industry wide initiative, i.e. a service to all the importers and producers of consumer electronics and white goods. The logic behind the system is "one for all and all for one". However, as the membership is voluntary, the waste management companies experience a challenge with free riding, as this statement illustrates:

"Companies that have not joined a collective system, or have their own system that fulfill the demands of the EE-Regulation and the government regulations, do not take their share of the cost. Rather, they leave it to other companies, their competitors. This give a competitive advantage[41] and they are capable of having a lower price on the products in an industry with low and pressed margins." Elektronikkretur

Elektronikkretur has a more heterogeneous product assortment to work with than Hvitevareretur (cf. appendix A), and therefore the range of EE-companies that falls under their responsibility is broader. Hvitevareretur reports less of challenge with free riders compared to Elektronikkretur. The EE-companies pay for the reverse distribution systems and therefore free riding creates a challenge. Members transfer funds to the waste management companies in order for them to administer returns. The membership is signed with the waste management companies separately. Thus, the funding process is also separate for the waste management companies. We describe the funding next.

6.1.1 Funding

In order to ease the work with the funding, Elektronikkretur's owners have established funding companies (i.e. three funding companies – one for each owner). The funding companies do not have employees but buy administration from Elektronikkretur AS.

Elektronikkretur AS charges the funding companies at the end of each month for the *actual* cost of the collection system for EE-waste. The invoice is based on kilos collected by Elektronikkretur AS. It is important for Elektronikkretur to cover the cost of the collection system, although the waste management company is not concerned with how members are charged with the fee, as this statement shows:

"We collect and transport scrapped EE-products in kilo, have contracts on transport and reprocessing in kilo separated in different product groups. We are indifferent how the industry companies and the members agree on their fee." Elektronikkretur

The cost is directed from the three funding companies to the appropriate industry organizations, or members of those. The funding process was changed on April 1st 2001. The change to Elektronikkretur's funding system was implemented based on a disagreement of how the transfer of money was being organized. Prior to this date, the members of the systems were charged directly by customs[42] (based on customs tariff numbers) on behalf of Elektronikkretur AS. The fee was a unit cost per imported or produced product and the fee was charged at the time of import (i.e. when the products were new), i.e. in advance of the operations in the collection system. After April 1st 2001, the funding companies were established as an intermediary funding unit, and Elektronikkretur AS now has three debtors as opposed to all the members (more than 400), which was a feature of the first funding model. The funding processes are illustrated below:

[41] The Norwegian word used was "konkurransevridning".
[42] The Norwegian Customs and Excise – Tollvesenet.

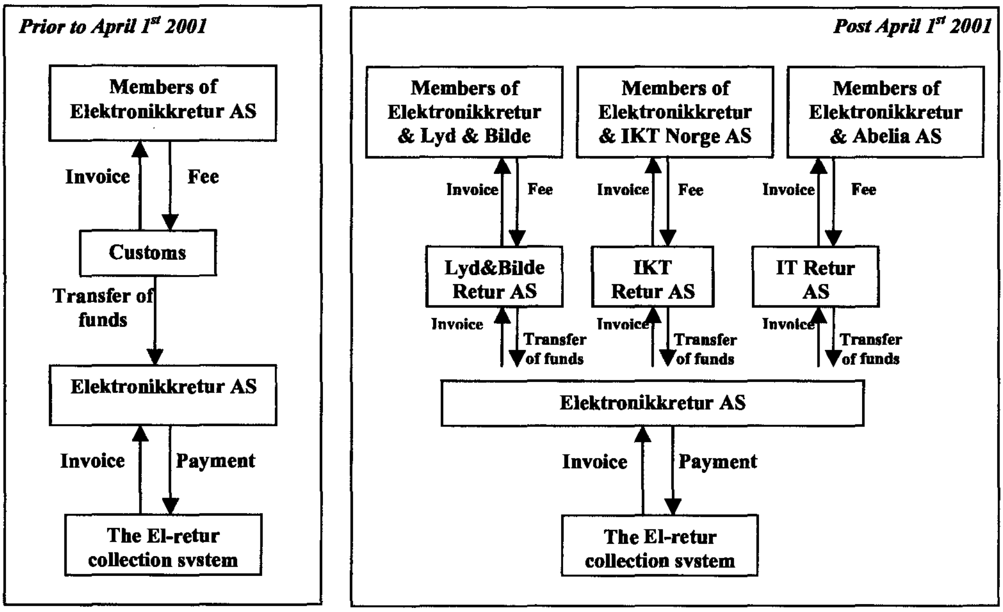

Figure 6.1: Funding process in Elektronikkretur – before and after April 1st 2001

There were two main reasons for the change. First, it was very difficult to agree on the fee format across the different industry organizations on three dimensions. The dimensions included how to fund each product (fee for copiers vs fee for cameras or computers etc), whether to charge the fee per unit or per kilo/tonne, and how to organize the funding process. The new model improved the situation:

"Every owner-constellation gets to decide how to collect the money for the products that they have responsibility for. In the new model, companies responsible for copiers do not have to relate to how TVs are funded, and vice versa. Now, each industry can decide individually how to fund the system." Elektronikkretur

The industry organizations decided on the fee in dialog with their members. Two changed their fee from unit- to kilo-based (IKT Norge AS, Abelia AS), whereas one continued using a unit-based fee (Lyd & Bilde). Two of the industry organizations decided to charge their members based on their market share from the previous year (IKT Norge AS, Abelia AS). The market share comes from the National Bureau of Statistics. The other company decided to charge its members based on units (Lyd & Bilde), and is dependent upon the members to report the numbers of units sold the previous month. The funding process has not been straightforward for the members. Elektronikkretur explains that the companies decide themselves on how to solve these issues:

"Small companies are in most cases members in one waste management company, while larger companies, e.g. like Phillips, are members of all the waste management companies. In this sense, it is easier for the small companies to relate to one system, than the large company that gets a different type of invoice from each of the waste management companies. It may be complicated if you ask a frustrated accountant, but it is their directors that have taken these decisions. It has been decided politically in the industry that this is how we want it, and then at some level there is a frustrated employee that has to coordinate a number of systems. One system had of course been a better solution, but then it had been a problem to agree which system. Then you would have problems in a different manner." Elektronikkretur

"With respect to competition rules, we are not allowed to instruct the EE-companies on how to fund our collection system. Each company has to decide this for themselves. Also, they have to decide for themselves on whether the fee is to be visible to the customer or a part of the product calculation. Each part in the distribution chain needs to decide this. It is illegal to cooperate across the distribution chain." Elektronikkretur

Second, it was agreed that a better solution would be to invoice costs according to the actual transport and reprocessing in arrears[43] of the waste management, rather than payment up front. In this manner, the collected products were registered in the different product categories and the invoice could be directed to the correct 'recipient'.

The funding process in Hvitevareretur AS is identical to Elektronikkretur's first model. The funding of the waste management companies is strongly influenced by the structure of the ownership. Elektronikkretur had to change its funding process so that it would fit better with the ownership structure. Hvitevareretur has had a straight forward funding process, as explained:

"The difference between our's and Elektronikkretur's funding processes is primarily tied to the presence of their three companies. Our owners have been happy with how the funding is organized, and as long as that is the case, we keep it as it is." Hvitevareretur

"The number of owners is a major difference. It has probably contributed to the situation in Hvitevareretur being more easy-going than in Elektronikkretur. The owners of Elektronikkretur have had divergent interests from time to time. We have not had such experiences." Hvitevareretur

[43] The word '*arrears*' means 'på etterskudd' in Norwegian.

Hvitevareretur AS is funded based on a fee per unit. Hvitevareretur charge their members with a fee in advance of waste management (i.e. when the product is new). The members are charged by customs through use of the customs clearance system, which is based on the customs tariff numbers. The fee is supposed to cover the actual cost of the collection system. It takes approximately two months before the funds are transferred to Hvitevareretur AS.

The funding process in the El-retur system is complex in many respects and represents an identification and integration challenge. The question is to identify how products have to be funded and at what time (at time of import or at end-of-life). That is, what is the cost of collecting and reprocessing a computer, a copier, a refrigerator and so on? Next, there is a challenge to identify how to share the cost between the EE-companies (i.e. the members of the waste management companies). The products are not sorted according to brands when collected and, therefore, a calculated factor has to split the cost between the members. The cost then has to be integrated between the collection system and the sales system of each EE-company. The waste management companies in El-retur have decided on different funding processes to handle the situation, and it has been demonstrated that the ownership structure is an influencing factor.

6.2 The physical flow in the El-retur system in two periods

In this section we present the physical flow in the El-retur system for the two contract periods. Starting with the period from 1999 to 2002/2003. The second period runs from 2003 to 2006.

A characteristic of the El-retur system is that the products are mainly returned from private end-consumers. As a consequence, there are a high number of heterogeneous deliveries that needs to be coordinated. A characteristic of private end-consumers is that they take back a low volume of products at a relatively high frequency. Accumulating private end-consumers therefore results in a heterogeneous physical flow of products.

6.2.1 The physical flow from 1999 - 2002/2003

The waste management companies (Elektronikkretur AS and Hvitevareretur AS) established their system with two types of actors: transport operators and reprocessing units. The collection sites are defined by the EE-Regulations and consist of retailers[44] and municipalities. El-retur has identified 4000 municipalities and retailers, i.e. collection sites, that handle El-retur's product categories. The transport operators are organized to pick up the products at the collection sites and deliver them to the reprocessing units. At the reprocessing units the products are dismantled and reprocessed into materials after the hazardous materials are sorted out. After the products have been handled at the reprocessing units, they are supplied to secondary markets for recycling or disposal.

The extension of the contract period from July 1st 2002 to June 30th 2003 was a direct continuation of the system as it was, but it allowed for increased integration of the waste stream between Elektronikkretur and Hvitevareretur. That is, the products did not have to be sorted within the El-retur categories at the collection site and by the transport operators. In addition, the CFC (chlorofluorocarbons)-white goods[45] were incorporated in the system.

The system has three functions: collection, transport and reprocessing. The collection activities are defined in the EE-regulations and the waste management companies define the transport and reprocessing activities. The El-retur system signed with three transport operators and four reprocessing units during the first contract period. The collection system is nationwide in Norway but the actors were given specific geographical areas to operate within. The structure is illustrated below:

[44] Defined as "distributors" in the EE-regulations.

[45] White goods with CFC were regulated in the CFC-Regulations a few years prior to the EE-Regulations. A collection system was established for these types of products. After the collection systems for EE-waste was established, it was possible to include the CFC-products into the collection systems for EE-waste.

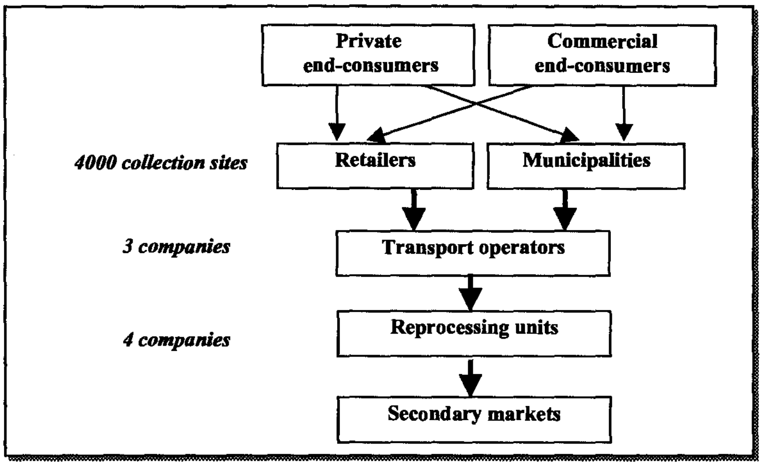

Figure 6.2: The El-retur's collection system from 1999 – 2002/2003

The retailers are sales outlets for the products, while the municipalities are public waste collection sites. Under the EE-regulations it is mandatory for retailers and municipalities to operate as collection sites for EE-products at end-of-life. In addition, the retailers and municipalities are obligated to inform their customers (i.e. the end-consumer) about the possibility of returning EE-products at end-of-life. The rationale for the retailers as collection sites is that as long as they sell EE-products, they also have to take on the responsibility for collection. For the municipalities, however, the rationale is based on the fact that they already provide a public service of collection sites for other types of waste. Thus, when the new waste category of EE-products was introduced, it could be coordinated through the same sites.

Products are delivered to the collection sites from both commercial and private end-consumers. The end-consumers may bring their products to a collection site or have them picked up at their premises (e.g. an old TV is picked up when a new one is delivered). Private consumers may deliver their waste to any of these collection sites free of charge. Retailers are obligated to take back the products they sell, irrespective of brand, e.g. if they sell fax machines they are obliged to take back all fax machines. Commercial end-consumers (companies) may return products to retailers only if they buy the equivalent volume of new products from the retailer. Alternatively they can send them to the municipalities for a cost.

End-consumers can get in contact with the El-retur system and have products picked up from their premises[46].

The transport activities include identification of frequencies towards the collection sites, possible accumulation of volume at a regional collection site, and transport to the reprocessing units. The reprocessing activities include registration of volume, dismantling, and reporting hazardous materials and reprocessed volumes to the waste management companies. The activities are summarized in the table:

Table 6.1: The process in the El-retur system

Process	Comments regarding activities
Delivery of EE-products at end-of-life from private and commercial end-consumers to retailers	• Transport (either by the end-consumer or the retailer). • Commercial end-consumers need to buy equivalent volume. • Private end-consumers can deliver products free of charge.
Delivery of EE-products at end-of-life from private and commercial end-consumers to municipalities	• Transport (by end-consumers) • Commercial end-consumer pays a fee for delivery. • Private end-consumers can deliver products free of charge.
Handling at collection sites - at retailers or municipalities	• Keep cages and containers to secure safe handling and transport. • Provide information to customers/end-consumers about the collection service. • Provide area for collection of returned products. • Collect and sort products according to certain categories and secure careful handling.
Transport to and handling at regional collection site	• Identify collection frequencies and transport capacity • Transport from 4000 locations to regional collection sites. • Register sorting, storing and handling of volumes. • Labeling of outbound volumes.
Transport to reprocessing unit	• Transport to reprocessing unit. • Report volumes to waste management companies.
Reprocessing	• Registration of arrived goods • Sorting and registration of volume into the categories (6 main and 24 sub-groups) • Dismantling products • Remove hazardous waste • Find secondary markets • Report volume and disposition of products to the waste management companies

Collection sites were not initially included as a part of the El-retur system. The system related to the EE-regulations where it was defined that all the retailers and municipalities were obligated to operate as collection sites for EE-products at end-of-life. The waste management companies in El-retur expected the end-consumers to either deliver the products to the

[46] Have to cover the transport costs but the service may be free of charge if the volume exceeds 500 kilos.

collection sites, or get in contact with their transport operators. The high number of collection sites was expected to secure availability and make it easy for the end consumers to return the products. This was strengthened because there was no charge for returning products to the sites for private end-consumers, only commercial end-consumers had to pay a fee. One municipality explains:

"Our collection activity consists of eight collection sites. We have high competence in handling small deliveries from households and small companies when they bring it to our sites. It is our opinion that commercial customers should deliver their products elsewhere than at a municipality collection site. We do not prefer commercial customers to deliver to our site. The price we have for them to leave their products with us, usually makes them find other solutions." ROAF Bøler

The collection function, however, is not straightforward. End-consumers are not attentive to information about the system and dispose of EE-waste at the 4000 collection sites and other actors (waste companies external to the El-retur system). The experiences of the waste companies are that it is difficult to get end-consumers to sort wastes correctly. In many cases, end-consumers do not want to relate to a number of channels for a number of waste categories (e.g. one for paper, one for EE) but prefer a one-stop delivery (one actor takes all). This creates product flows through other channels in addition to the El-retur system. The waste management companies in El-retur expected the actors either to deliver the products to the collection sites or get in contact with their transport operators. However, waste companies acquired cost elements in handling the products that were not compensated. The statement shows:

"Products (i.e. EE-waste) are returned through the 'wrong channels'. It is not possible to ensure that everything is sorted correctly at the collection sites. This generates a sorting process for the waste company, which is not paid for. Our company works without compensation for El-retur. The companies in our industry are very annoyed." Follo Truck Utleie

Sorting was also a challenge for the collection sites within the El-retur system, which reported that it was necessary for activities to be monitored closely. The activities also generated costs for the collection sites. The waste management companies in El-retur expected the collection sites to follow the EE-regulations, but the collection sites were not satisfied with the solution:

"For a large batch of waste, the customer calls us and plans for a delivery. The customer is met by one of our representatives, who secures a correct sorting. The customer is not allowed to leave our area before the products are sorted correctly. If they do not sort correctly, we have to do the sorting over again." ROAF Bøler

"We do not get compensation for taking back the products in the El-retur system. We prefer not to handle products from the El-retur system." ROAF Bøler

The physical flow in the El-retur system is separated in two: the volume that is generated through the 4000 collection sites, and the volume that is generated through other[47] waste actors/sites. The activities for the collection sites are defined in the regulations and are, in this sense, coordinated within the El-retur system. The flow generated through the other sites is not coordinated within the El-retur system. However, this volume can also be delivered to any of the 4000 collection sites, but the fact that the products end up at these other premises in the first place is a deviation from the system. It is not guaranteed that this product flow is integrated in the El-retur system. The figure illustrates:

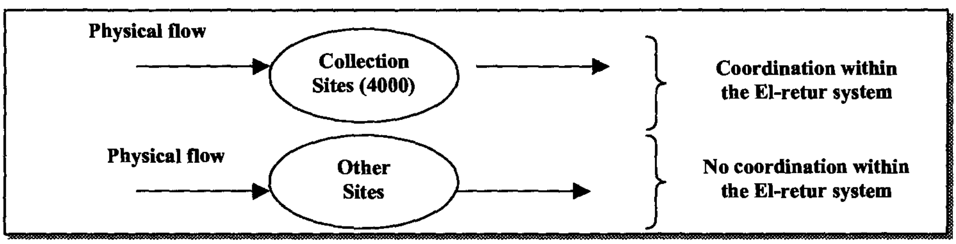

Figure 6.3: Coordination of the collection function in the El-retur system 1st period

The transport operators had a one-sided responsibility to coordinate towards the collection sites. It included investment in and organization of cages and containers, as well as discussing the schedule (frequency) with the collection sites within their geographical areas, and planning the capacity. The choice of how to organize the physical flow generated extra transport because the collection sites made a reduced effort:

"Cages from the transporter are used for the El-retur products. According to the contract with the El-retur system, the transporter is supposed to provide us with the cages for collection without extra costs. The transporter picks up the cages from all our eight sites when they are filled. Our collection activity consists of eight collection sites. The RENAS products are sent from the seven other collection sites to the main collection site. There is a payoff in sorting the RENAS products." ROAF Bøler

[47] I.e. not defined as a part of the El-retur system, and does not have a contract with the waste management companies.

The transport operator experienced a challenge with the cages, which generated extra costs to the system:

"Our task was to ensure that all the collection sites had cages for collection. The cages were without costs for the collection sites, assuming they were filled six times a year. Some of the actors filled 10-15 cages per day. However, a number of collection sites did not fill the cages six times a year, but it was difficult for us to charge them after the system was started. It was difficult to identify this up front." Norsk Gjenvinning Oslo

The transport operators need a few days to plan capacity. This creates a time lag towards the collection sites, and the cages and containers are often overfilled at time of pick-up. This presents a challenge to the transport operator because the cages are difficult to stack, and the planned capacity and collected volume do not match.

"It is a problem to us that the products are not sorted when they are returned. Also, the cages are filled up too much, which makes them difficult to stack on top of each other. The products do not necessarily fit the cages that are used for collection." Norsk Gjenvinning Skien

"We have implemented a planned route to collect products at the collection sites within our area. We guarantee collection within three days if there is an extraordinary need from the collection sites in our area. However, the collection sites call us when the cages are full, and by the time we get there to pick them up they are overloaded." Norsk Gjenvinning Skien

The transport operator gets paid per kilo from the waste management companies. It is as such a direct cost for them to handle cages that do not fit the capacity. The result is that the transport operator has to reschedule the transport and come back another day or utilize only parts of the capacity. Either way, the promised service to the collection site is not fulfilled and costs increase.

The transport function in the El-retur system faced challenges in this period. The transport operators had contracts with El-retur to handle a given number of the 4000 collection sites (according to geographical areas). Coordination with the sites was not straightforward:

"The collection sites were not clearly defined. It was a job to identify the collection sites, especially the retailers. The municipalities were relatively straightforward. In addition there was a number of what we called "third persons", where we also collected waste. However, we were able to charge the third persons for transport and rent of cages." Norsk Gjenvinning Oslo

The transport operators collected volume from the defined collection sites in the El-retur system, but the volume that was collected at the independent actors/sites was not necessarily integrated in the system:

"There are a number of actors that collect volume without being an approved operator. A lot of the volume is of course returned to the El-retur system, but there is no guarantee. As soon as they find a better disposition for the volume that is better paid, it will be used as long as it is legal. We had a challenge with volume that was being exported to Eastern Europe and South America. It was business. It was somewhat on the limit of what was legal, but we found no way to stop it, and the Regulations did not stop it." Norsk Gjenvinning Oslo

The volume that was generated outside of the El-retur system was not included in the transport operators' coordination. The figure below illustrates the flow in the transport function:

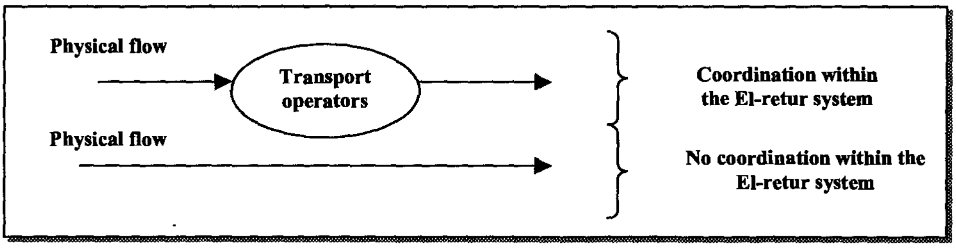

Figure 6.4: Coordination of the transport function in the El-retur system 1st period

The transport operators delivered the products to the reprocessing units and also faced integration challenges toward these actors:

"We had an issue with respect to cages for collection. The waste management company argued that we had too few cages in the system. However, we had a challenge with the reprocessing units storing products in the cages keeping them from circulation." Norsk Gjenvinning Oslo

"We also had smaller problems in adapting the transport. The reprocessing units were not flexible with respect to opening hours, lunch hours, unloading and loading. This created waiting time for us, and complexity when you have transport routes and time schedules to keep." Norsk Gjenvinning Oslo

The reprocessing units operated in defined geographical areas and were dependent on deliveries from the transport operators. The transport operators accumulated volume and delivered the volume to the reprocessing unit once the transport capacity was filled, and they were able to send full loads. The incoming volume from the transport operators in the El-retur system was not satisfactory for the reprocessing units. The volume was too low with low frequencies. A reprocessing unit explains:

"For the El-retur system, we are dependent upon the transporters. In El-retur we are given certain geographical areas to work with, and we are a reprocessing unit only." Elektronikkgjenvinning

"The transport collection route creates a low volume. The transport operator plans the routes according to the collection sites. There is a problem to get a hold of volume from the transport operator." Elektronikkgjenvinning

"The more volume we can get a hold of the better. It is kilo-kilo-kilo that counts. The more kilos that we trade through our reprocessing unit the more money we make." Elektronikkgjenvinning

Sufficient volume is a key factor to the reprocessing units. The reprocessing units also include products from actors outside the El-retur system. A reprocessing unit explains:

"20% of the products are returned from the El-retur transport operators, 80% are returned from our own contacts." Elektronikkgjenvinning

In this sense, the reprocessing units also coordinated the multifaceted product flows that were generated in the system. However, this was not defined by the systems, but rather on the initiative of the reprocessing units. The products may well have been traded directly in the secondary market (ref. transport operators statement about exporting products). The figure illustrates:

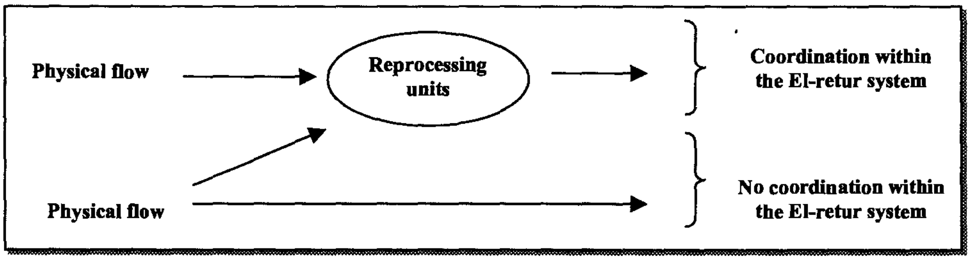

Figure 6.5: Coordination of the reprocessing function in the El-retur system 1st period

6.2.2 The physical flow from 2003 - 2006

The structure of the physical flow did not change to a large degree in El-retur from the first to the second period. The collection continues to be organized through retailers and municipalities (in accordance with the EE Regulations). The collection system consists of two types of actors: transport operators and reprocessing units. For the second contract period, the waste management companies decided on a structure with six transport operators, and five reprocessing units. The collection system in the second period is illustrated below.

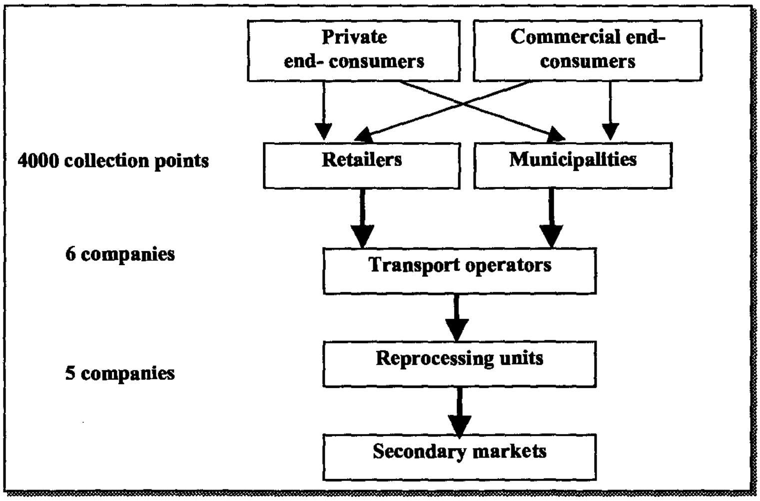

Figure 6.6: The El-retur's collection system from 2003 - 2006

The system is composed of the same type of actors and functions but some of the activities have been rearranged. The changes in the activity structure included primarily the fact that sorting of the products was moved from the collection sites and transport operators to the reprocessing units. In this manner, fewer of the actors had to know the sorting categories in detail. The changes in the sorting activity were needed in order to fill the cages faster and, in this way, increase the transport frequencies. The transport operators experienced improvements as a result of rearranging the sorting activities:

"It helps that the waste management companies have adjusted how we are allowed to sort the products. The consumers do not sort the products correctly in the cages and containers, which are returned with a mix of various products." Norsk Gjenvinning Skien

The coordination in the second period was also adapted with respect to transport planning. The transport operators were increased from three to six, and the transport operators were allowed to engage sub-suppliers. The increased number of transport operators included the replacement of one transport operator with four actors. The geographical areas were adjusted accordingly, which gave each of the actor's smaller areas to operate within. The optimization task for the actors was more practicable. The increased number of actors would provide the waste management companies with more comparative data between actors, and contributed as an incentive for the actors to improve collection (increased competition).

The restriction, in terms of smaller areas to operate within, has been compensated for with increased flexibility to engage sub-suppliers. The transport operators could engage other waste companies. The transport operators now have a formal agreement with the waste management companies. In this manner, the waste companies external to the system now get compensated for their services, and it is possible for the transport operator to increase the collection volume. However, the transport operators experience delays in the communication with the collection sites, which continue to be a challenge (mismatch between volume and capacity) also in the second period:

"We have a number of containers that do not fit well with the collection task. If the end consumer fills the large containers at the collection sites, it results in chaos of products. We have a number of vehicles, containers and cages that have to be adapted properly to the system. We are dependent on reloading at our regional collection site in order to fill transport capacity." Haukedal Transport

"The alternative is to take the products directly to the reprocessing units from the collection sites, but this is much too expensive. We have to deliver the collected products in Oslo, because we are a sub-supplier of the companies that have the reprocessing unit in Oslo." Haukedal Transport

"We sort the products at our premises, because we want to deliver sorted goods when we deliver them to the reprocessing units. The important thing is to exploit the transport capacity, because we have a long distance. If you have a short distance, it is possible to deliver unsorted goods in these containers directly to the reprocessing units." Haukedal Transport

In the second period, the transport operators are entitled to engage sub-suppliers in the collection of volume. This is done in order to integrate volume that is collected from actors outside the 4000 collection sites into the El-retur system. The figure below illustrates the coordination of the physical flow in the transport function for the second period:

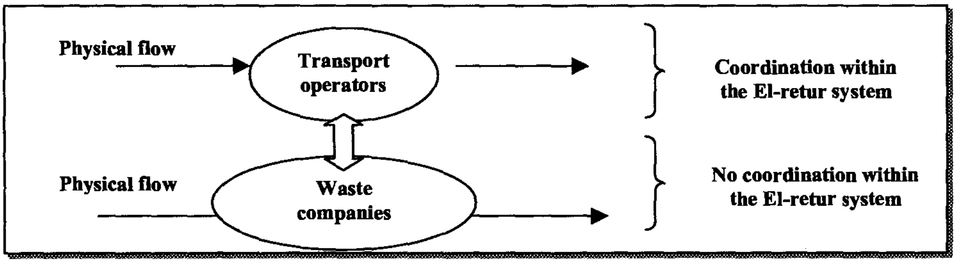

Figure 6.7: Coordination of the transport function in the El-retur system 2nd period

The reprocessing activities have not been changed to any extent in the second period. The geographical areas have been rearranged. The changes in the transport function have increased the possibility for higher volume to the reprocessing units.

6.3 The commercial interests in the El-retur system in two periods

In this section we present how the commercial interests in the El-retur system are organized during the two contract periods from 1999 to 2002/2003, and from 2003 to 2006.

6.3.1 The commercial interests from 1999 - 2002/2003

The waste management companies use the concept El-retur to coordinate negotiation and discussion with the operators in the system. At the time the system was established , the tender was also issued in cooperation with RENAS AS. As such, the waste management companies were able to negotiate with larger volume towards operators (i.e. total volume from both Elektronikkretur AS and Hvitevareretur AS, and RENAS AS).

Three types of operators were invited to tender: collection sites, transport operators and reprocessing units. The waste management companies in the El-retur system decided to engage in contracts with transport operators and reprocessing units.

Coordination of commercial interests in the collection system is achieved through the EE-Regulations and the contracts between the waste management companies, and the transport operators and reprocessing units. The EE-Regulations direct the activities of the end-consumers and the collection sites. The waste management companies define the directions for the collection system, where the regulations are incorporated. The figure below illustrates the coordination of the commercial interests in the El-retur system during the first period:

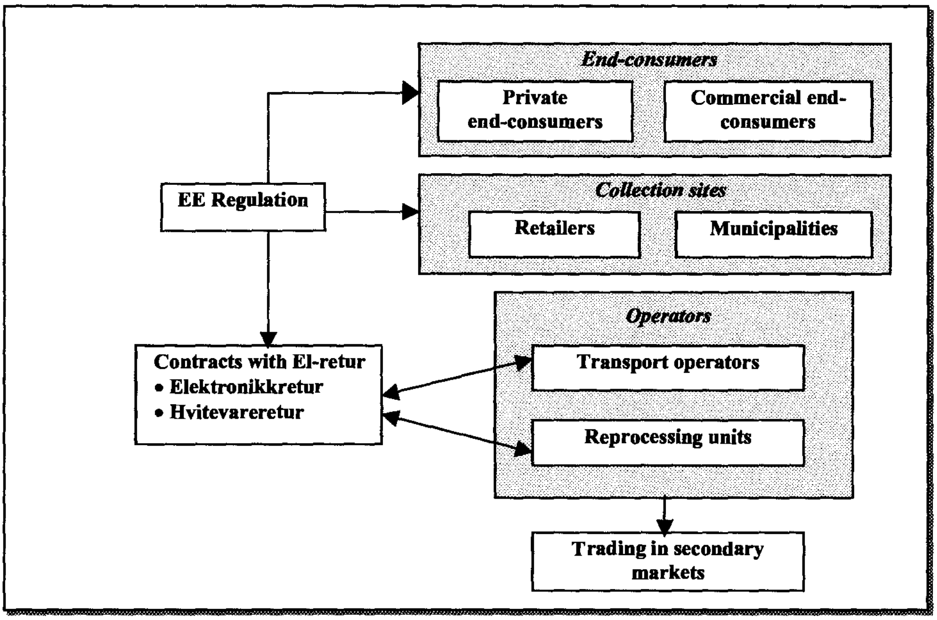

Figure 6.8: The coordination of the commercial interests in the El-retur system 1999-2002

The El-retur system based their collection on the municipalities and retailers according to the EE-Regulations. These 4000 locations did not have a specific contract or agreement with the waste management companies in the El-retur system. In accordance with the regulations, the collection sites had to receive products from end-consumers and inform them about the system. It was reported that this task was challenging:

"The EE-Regulations are a huge pedagogical challenge within waste collection. There are a lot of people involved, and it is difficult to teach everyone what to do. We have daily contact with companies and consumers explaining the system to them." ROAF Bøler

The collection sites explain that the lack of focus from the EE-companies contributed to the information challenges:

"The EE-companies do not see the differences between the various reverse systems for EE-products at end-of-life and the municipal waste system. The customers that arrive at our site argue that they have paid a fee to deliver their products. The EE-industry is not sufficiently informed about the differences." ROAF Bøler

The collection sites had an opinion that the waste management companies and the EE-companies needed to increase contribution with respect to communication and information:

"In our opinion there is a lack of interest and will from the EE-industry to really face the challenges with the waste from EE-products at end-of-life." ROAF Bøler

"In our opinion there should have been some criteria in the ISO certification of companies that are tied to whether they know how to handle waste." ROAF Bøler

The waste management companies were obligated to provide information about the El-retur system to the community as a whole, and undertook information campaigns directly towards the end-consumers in order to increase their awareness of the collection system. A low attention rate of the information campaigns in national media led the El-retur system to try an alternative means in order to gain the consumers' attention and initiate the return of products to the collection sites. A joint collection project with another type of waste (hazardous waste) was one such alternative means. However, information was evaluated to be a challenge:

"There was a challenge with information, and we felt that El-retur did not do enough. They sent information to the management of the companies. The information stopped in the corporations; it takes time for information to go from the directors to the front desk personnel." Norsk Gjenvinning Oslo

Due to the legally separated units, the waste management companies had individual contracts with the operators in the systems. The contracts were identical:

"Elektronikkretur have a contract with the transport operator, and Hvitevareretur have one. The contracts are identical. We pay a price per kilo, indifferent of type of product. We also share the cost 50/50, so the transport operators do not have to sort the products. The products are sorted at the reprocessing unit. The reprocessing cost varies strongly between products, and this cost is different for the waste management companies." Elektronikkretur

The contracts with *the four transport operators* included the following:

- An geographical area for operation
    - Specification of which actors to cooperate with (collection sites and reprocessing units)
- Compensation (a price per tonne transported volume)
- Operating standards
    - Investment in cages and containers is a condition in the contract.
    - The service level towards the collection sites, i.e. collection facilities (cages and containers) and frequencies.
    - Access to a regional collection site.
    - Sort the products into the defined categories.

The contracts with *the three reprocessing units* included the following:

- An geographical area for operation
    - Specification of which actors to cooperate with (transport operators)
- Compensation (a price per tonne per category of waste for dismantling)
- Operating standards
    - Sorting into product categories, handling, report volumes
    - Environmental demands
    - Report the disposition of products (both disposals and sales to the secondary markets)

The waste management companies were very concerned with documentation of the process, quality and the cost in the system:

"We have a very rigid reporting system, which the authorities are very satisfied with. Our system is the most rigid report system in Europe to be precise. Success is not only dependent on the economic dimension. We are a not-for-profit company and need to get the most of every Krone, but we are also an environmental company. We have to be able to trace everything we do. We have very strict criteria for this activity." Hvitevareretur

However, there is a trade-off between reporting and cost efficiency. The operators explained that the reporting has not been in accordance with the operations:

"The products that are collected are separated in certain product groups, weighed and registered. In El-retur there are 6 groups and 24 sub-groups. We need 2-3 employees just to weigh and register the materials. The more detailed the sorting the more it costs. It is not

possible for us to sort in more detail than at present. That will be too expensive." Elektronikkgjenvinning

"We disagreed with the change in reporting that was made. They made a system to report volume from each collection site and between types of products. We disagreed strongly with what El-retur did. The volume was to be registered when delivered at the reprocessing unit. Our opinion was that the registration had to be made at the collection site, in order to trace the volume." Norsk Gjenvinning Oslo

"We delivered the products to the reprocessing unit, and they registered the volume. Then we had to divide the volume between the collection sites where it was collected based on the transport manifesto we had. It became very inaccurate, an in my opinion completely senseless. It became a pro forma account, which in our opinion was completely wrong. In our opinion we had to register the volume at the collection site to get it right. In case of deviation it was necessary to know where to place the costs. Alternatively, you had to guess where to place the costs." Norsk Gjenvinning Oslo

The waste management companies were directly involved with the product flow, in the sense that any complaints from the operators (collection sites, transport operators or reprocessing units) about the other(s) were to be reported directly to them.

The waste management companies took advantage of an option in the contracts with the operators and continued the operations for one year. The reason for doing so was an expectation of coordinating with the Swedish market. Elektronikkretur and Hvitevareretur announced in the environmental report that they sought to cooperate with their Swedish counterparts[48] in the next contract period. The goal was to get positive synergies with respect to quality and prices for transport and reprocessing (larger volume). However, the Swedish actors wanted to wait until the EU's WEEE-directive was available before deciding on how to develop their systems. The waste management companies in the El-retur system saw Norway and Sweden as one market, and believed that such an opportunity could be realized in the future.

6.3.2 The commercial interests from 2003 - 2006

The coordination of the commercial interests in the collection system is basically the same as it was in the first period. The waste management companies argue the importance of acting as one unit:

[48] The companies have the same function, but there are no linkages with respect to ownership.

"In the negotiations we operate as two parties together. We enter the contracts in the same meetings. We have agreed to act together. We agreed on that in 1999 when we started, and we have done this for the following contract periods. It has a simple explanation. We have large volumes if we act together, and we get better prices and terms. With respect to both transport and reprocessing." Elektronikkretur

There has been a change of contract-partners to the system in the second contract period. The waste management companies decided to change from three transport operators to six, which included exchanging one large operator for four smaller companies in order to get better local control. When the operators were evaluated, one of the actors from the first period did not perform to the waste management companies' satisfaction. They found their operator to be somewhat difficult to cooperate with. In addition, new actors had a better offering on price and quality:

"We have had a very good relation to our partners, except one. This actor had 70% of the volume in the first contract period. We have had much back and forth with them. Now they are out. Their problem was both cultural and organizational. They have had a culture in running things their own way, be the market leader. The company is organized with a head office and operations in Oslo and local business units around the country. The problem has been that when the local business units have been instructed by the head-office how to do things, there has been a lack of ability to carry out the instructions. The structure has not been convenient for us in order to reach our goals. It concerns the effort we want to do locally. They have not had the power to see it through. It has been an everlasting discussion." Hvitevareretur

The waste management companies wanted to increase the number of actors in order to have a competitive situation (i.e. avoid a monopolistic one). The geographical areas were changed and adapted to. A larger number of transport operators were given a contract, but with smaller geographical areas to cover.

From the first to the second period, there has been an increased flexibility in the system, as the operators have been allowed to engage sub-suppliers. The sub-suppliers get paid for their services, and it has therefore been possible to compensate activities performed by waste companies external to the El-retur system:

"The companies that have been given a contract with El-retur have been encouraged to cooperate with the other companies in this business. In this case it is possible for us to become a sub-supplier to the system. This is positive." Follo Truck Utleie

The transport operator reports that the system creates misunderstandings and difficulties. The combination of the geographical areas and planning has created a loss of efficiency in the transport function. The transport operator would like to schedule the transport without consulting the collection site:

"The communication is directed between the collection site and our contract partner. However, this creates a delay in the operation. The collection sites are filled too much by the time we get the information and are physically at the collection site. The operations create a lot of misunderstandings. I would like to plan the collection operations directly." Haukedal Transport

The reprocessing units have been given the same type of contracts but have increased in number from four to five. The reprocessing units reports that the cooperation with the waste management companies is working very well:

"Our experience with El-retur is very good. But of course, it is because we have a large market share. If we lose our contract things would look different of course, but our cooperation with the waste management companies is working very well." Stena Miljø

However, the reprocessing units have a limited coordination obligation and have to wait for deliveries from the transport operators:

"In the El-retur model there is nothing we can do to influence the level of volume. We have to await deliveries from the transport operators. We knew that we had 50 % of the market." Stena Miljø

In summary, the El-retur system is coordinated in the same manner in the second period as in the first. The only difference is the increased number of transport operators, and the transport operators' ability to plan the transport in cooperation with waste companies external to the system.

6.4 Performance in the El-retur system

In this section we comment on the level of integrated activities and degree of aligned behavior within the El-retur system, and the system performance variables.

The *system goal* in the El-retur system is to collect 80 % of the consumer electronics, white goods and household appliances at end-of-life. The table on the next page gives an overview of the collected volume from 2001 to June 2004.

Table 6.2: Collected volume in the El-retur system from 2001 – June 2004

		Total volumes	2001			2002			*Total volumes*	2003			2004 (per June)		
Nr:	Category	*1999-2002*	Hvitevare retur	Elektronikk retur	%	Hvitevare retur	Elektronikk retur	%	*2003*	Hvitevare retur	Elektronikk retur	%	Hvitevare retur	Elektronikk retur	%
1	Vending machines	*470*	16,0		3 %	48,0		10 %	*470,0*	42,0	-	9 %	40,2	-	17 %
2	White goods	*28 493*	20 366,0		71 %	22 527,0		79 %	*29 413,0*	25 405,0	-	86 %	12 359,0	-	84 %
3	Brown goods	*11 000*		5 508,0	50 %		6 356,2	58 %	*11 000,0*	-	7 514,2	68 %	-	4 040,5	73 %
4	Cabling and wiring	*13 000*							*12 330,0*	-	-		-	-	0 %
5	ICT equipment	*7 800*		3 293,0	42 %		3 691,5	47 %	*7 800,0*	-	5 174,2	66 %	-	3 360,1	86 %
6	EE-toys	*1 700*		816,0	48 %		849,6	50 %	*1 700,0*	-	722,5	43 %	-	158,5	19 %
7	Heating, air-conditioning, Ventilation	*4 100*							*5 024,0*	606,0	-	12 %	324,9	-	13 %
8	Lighting	*6 700*							*4 340,0*	-	-		-	-	
9	Medical equipment	*2 700*		118,0	4 %		144,4	5 %	*2 700,0*	-	218,4	8 %	-	116,4	9 %
10	Equipment for measurement and control	*11 000*							*5 785,0*	-	-		-	-	
11	Office equipment	*3 400*		1 599,0	47 %		1 821,9	54 %	*3 400,0*	-	2 369,5	70 %	-	1 153,7	68 %
12	EE-tools	*12 000*							*14 925,0*	-	-		-	-	
13	Telecommunication	*2 400*		717,0	30 %		340,6	14 %	*2 400,0*	-	377,4	16 %	-	242,1	20 %
15	Clocks and watches	*300*	1,0			0,3			*300,0*	1,2	-	0 %	2,3	-	2 %
17	Security equipment, smoke detectors	*190*		12,0	6 %		6,9	4 %	*221,0*	-	-		-	-	
18	Electro equipment	*9 300*							*9 573,0*	-	-		-	-	
	Totalt 2001	***114 553***	20 383,0	12 063,0		22 575,3	13 211,1		***111 381,0***	26 054,2	16 376,3		12 726,4	9 071,3	
	Collection rate Hvitevareretur	**29 263**	20 383,0		**70 %**	22 575		**77 %**	**35 207**	26 054		**74 %**	12 726		**72 %**
	Collection rate Elektronikkretur	**29 190**		12 063,0	**41 %**		13 211,1	**45 %**	**29 000**		16 376	**56 %**		9 071	**63 %**

The El-retur system has an average collection rate of approximately 69 % (2003) but the variation within the product categories is great.

For Elektronikkretur, the collected volume amounts to 16 373 tonnes, and the cost of operation was reported at NOK 80.9 mill[49] (2003). The average cost per tonne is then NOK 4 940. For Hvitevareretur, the collected volume was 32 661 tonnes, and the cost of operation was NOK 108.9 mill (2003). The average cost was then NOK 3 334 per tonne.

However, the total collected volumes have not passed the 80 % level within the first five-years, but the waste management companies relate to it relatively:

"My reasoning is that if no-one complains, if products are not disposed of on the general waste compounds or products are not laying around along side some road, we have done our job. Then we have collected the volume there is." Elektronikkretur

Thus, the waste management company argues that the system is able to collect a satisfactory level of volume, even though the rate does not match the demand from the authorities. On the other hand, there are reports from the system that costs have not been addressed, which may contribute to this lack of compliance in the system.

6.4.1 Performance in the physical flow

Regarding the physical flow, we have seen that the collection sites have not been satisfied with how the El-retur system is organized. The collection sites explain that they perform a number of sorting activities for the El-retur system without compensation, which results in added operations costs. The expression from one collection site illustrates:

"We do not get compensation for taking back the products in the El-retur system. We do not prefer to take back the products from the El-retur system." ROAF Bøler

The collection sites were compensated with a free delivery pick up. This service was made available through the transport operators, who were supposed to provide the collection sites with a pick up service within a few days, and to provide cages and containers for collection.

[49] The costs for Elektronikkretur and Hvitevareretur are reported to the Brønnøysund Register Centre (www.brreg.no).

The transport operators, however, experienced challenges in adapting the capacity to the operations at the collection sites, and this increased their operations costs. The EE-waste were not necessarily sorted in accordance with the agreement and, by the time transport operators to pick up, the cages were overfilled and they did not fit with the transport capacity. The operations costs therefore increase as a consequence of sorting the EE-waste, and adjusting the transport capacity. At the same time, it has been difficult to fulfill the promised service level, and the transport operators have experienced complaints:

"If there were any trouble with our routes, the waste management companies complained. It was pretty difficult when we started." Norsk Gjenvinning Skien

In addition, the transport operators experienced a challenge when delivering volume to the site of the reprocessing units. The reprocessing units were not necessarily able to receive the volume when the transport operators arrived. Thus, operations costs increase as a consequence of waiting time. Secondly, the reprocessing units did not necessarily empty the cages and containers, which tied up collection facilities and increasing costs.

The reprocessing units on their side experienced a challenge in receiving sufficient volume, and needed to get access to volume from other sources in addition to that delivered by the transport operators.

In summary, these elements increased operations costs and reduced the customer service level in the physical flow of goods in the first period. The challenges were created because of low level of integrated activities between collection sites and transport operators, and between the transport operators and the reprocessing units.

The El-retur system was changed to some degree in the second period. The collection sites and transport operators did not have to sort the products, but were expected to fill the cages consecutively. In this manner, it was possible to reduce handling costs. However, the cages still had to be sorted into the correct product categories, which proved to be a challenge:

"The collection sites do not fulfill the directions from the system. Both with respect to the sorting and the assistance to us as a transport operator. In most cases we have to reload and sort the cages and containers." Haukedal Transport

"If the collection sites do not sort the cages according to the definition, we have decided to leave the cages behind and come back when they have sorted correctly." Haukedal Transport

Secondly, the transport operators were allowed to engage sub-suppliers and, therefore, were able to integrate more volume and increase utilization of capacity. This reduced the cost per unit. However, difficulties in adjusting the capacity to a correct level continued to be reported. The level of waste was reported to the transport operators, who followed a service level agreement which was to pick-up the waste within a few days. However, during those days the level of waste changed.

The El-retur system proved to have *challenges with integration of activities*, which resulted in a higher level of operations costs and lower level of customer service than was expected. Difficulties were reported regarding the administration of cages and containers, and the matching of capacity and frequencies.

6.4.2 Performance in the commercial interests

Performance related to commercial interests has experienced challenges in the El-retur system, and this has incurred transaction costs. The collection sites did not receive compensation for their collection effort and, as a consequence, they adapted their behavior by minimizing their effort in the system. This statement illustrates the point:

"Cages from the transporter is used for the El-retur products. According to the contract with the El-retur system, the transporter is supposed to provide us with the cages for collection without extra costs. The transporter picks up the cages from all our eight sites when they are filled. Our collection activity consists of eight collection sites. The RENAS products are sent from the seven other collection sites to the main collection site. There is a payoff in sorting the RENAS products." ROAF Bøler

The collection sites do not make an effort to accumulate volume for the El-retur system, and thus create added transaction costs. The transport operators also experienced additional transaction costs. The agreement did not work in accordance with expectations:

"Our task was to ensure that all the collection sites had cages for collection. The cages were without costs for the collection sites, assuming they were filled six times a year. Some of the actors filled 10-15 cages per day. However, a number of collection sites did not fill the cages six times a year, but it was difficult for us to charge them after the fact. It was difficult to identify this up front." Norsk Gjenvinning Oslo

The volume did not match the planned capacity. When the transport operators tried to adapt their operations, they were perceived as behaving divergently from the point of view of the waste management companies (cf. section 6.3.2). However, one transport operator had a different view, arguing that it was difficult to continue with the relationship:

"We used a high share of resources to get the system started. When El-retur realized that the system was working, they started to press the prices in the next contracts negotiations. This was some of the reason why we did not want to continue. They pressed the prices too low, and it was not interesting for us to continue with the contract. We realized that this was just a transport commission with low margins, and limited funds to develop the market. It was not interesting." Norsk Gjenvinning Oslo

The transport operator also argued that the contract specified behavior that was impossible to comply with. One such area was the registration of where volume was to be sent to and from:

"We had to register the volume anyway, which resulted in double workload we didn't get paid for. We were not interested in getting more work and less pay." Norsk Gjenvinning Oslo

The actors outside the system reported that they performed activities for the benefit of the El-retur system and that there were not compensated. The waste management companies argued that free return of EE-waste to the system was a form of compensation. In this manner, transaction costs were generated in the system. The actors received EE-waste as a part of their operations and were bound to perform the activities according to the EE-Regulations. However, as long as the system does not include these activities, the volume generated could go astray.

"In my opining there is a problem with the model for the El-retur system. I think it is wrong. It is a monopoly. There are a number of actors that collect volume without being an approved operator. A lot of the volume is of course returned to the El-retur system, but there is no guarantee. As soon as they find a better disposition for the volume that is better paid, it will be used as long as it is legal." Norsk Gjenvinning Oslo

The activities in the system created diverging behaviour and added transaction costs in the El-retur system, which resulted in the exchange of one of the partners in the second period. The transport operator argued that it was difficult to fulfill the agreement, while the waste management company argued that the transport operator did not comply with the agreement. The collection sites also adapted behaviour that was not beneficial for the system, which created added transaction costs.

In the second period, the system allowed for increased flexibility by including external actors as sub-suppliers in the system. Thus, the transaction costs were somewhat reduced. However, there was still a challenge for the transport operators who were trying to adapt to the collection sites.

6.5 Analyzing coordinated action in the El-retur system

So far in the case we have presented information about the El-retur system. In this section we continue with analysis of the case in accordance with the analytical framework.

The El-retur system has been in operation for two contract periods. The system continued in the same manner from the first to the second period, with marginal changes. In both periods, the physical flow was organized through collection sites, transport operators and reprocessing units. The commercial interests were coordinated through the EE-regulations for the collection sites, and the waste management companies entered into contracts with transport operators and reprocessing units in both periods.

This analysis seeks first to establish the type of coordination mechanisms that has been utilized for physical flows and commercial interests respectively, and secondly we evaluate to what extent the El-retur system has been able to achieve coordinated action.

6.5.1 Coordination of the physical flow

The El-retur system can be characterized as *standardized* with its defined collection site locations (4000) and the defined transport routes to dedicated reprocessing units. The operations have also been standardized within defined geographical areas.

The collection sites in El-retur system are standardized to locations that the end-consumers visit for other purposes. In this manner there is a scale effect in visiting the site for multiple purposes. If going to the municipality, it is possible to take back multiple types of wastes. If the customer is going to the retailer, it is to make a purchase of a similar type of product, and there is an effect in making one errand for two purposes. Based on the large number of sites, there is high availability for the end-consumer to return EE-products at end-of-life. The availability facilitates the return of products and also makes it easier to communicate the locations to the end-consumers. In this manner, standardization makes it convenient for the end-consumer. The returning of products is further facilitated by the fact that it is free of charge to deliver the products.

The El-retur system has, in this respect, exploited *pooled interdependencies* by adapting the transport operations to these sites. That is, several sites utilize the same transport service. The transport operators were given defined geographical areas to optimize frequencies, capacities and collection facilities (cages and containers). In the same manner, the reprocessing units were adapted to geographical areas in accordance with expected volume and reprocessing capacity. The reprocessing units were dependent on the effort from the transport operators. In this manner, the transport and reprocessing units have been standardized in the collection system.

The El-retur system is mainly *standardized* in the second period. The collection sites are defined with respect to location and activities to perform. The transport operators have adapted to collection sites in the geographical areas, and are expected to deliver to specific reprocessing units. The reprocessing units are dependent on deliveries from these transport operators.

The El-retur system adapted the system somewhat in the second period. The collection sites and transport operators did not expect to sort products, thus consolidating the volume to some degree. Second, the transport operators were allowed to integrate volume from other collection sites and actors in addition to that collected from the defined 4000. If the end-consumer had a relationship to other operators than that specified in the El-retur system, they did not necessarily adjust to the El-retur system. However, as the El-retur system was standardized towards the 4000 sites, it was difficult to incorporate the alternative product flows. In this manner, the system was able to also exploit serial interdependencies, in adapting the transport activity somewhat to where the volume was generated. Thus, adapting to the sub-suppliers involved some degree of *planning* in the system. The table gives an overview of the coordination mechanisms of the physical flow in the first and second period:

Table 6.3: The coordination mechanisms of El-retur's physical flow in two periods

	Coordination mechanisms	Characteristics
1st period	• Standardization	• Geographical areas • 4000 collection sites defined by the regulation • Focus on adapting the system to the collection sites • Specific transport routes and reprocessing units
2nd period	• Standardization • Planning	• Geographical areas • 4000 collection sites defined by the regulation • Focus on adapting the system to the collection sites • Flexible transport operations: specific transport operators with a possibility to work with operators external to the El-retur system • Specific reprocessing units

6.5.2 Coordination of the commercial interests

The waste management companies in the El-retur system have not included the collection sites directly into their system because they have relied on the demands in the EE-Regulations.

The waste management companies Elektronikkretur and Hvitevareretur have the decision control in 'the El-retur system'. The waste management companies have been given the mandate from the industry organizations. The decision control has been strengthened in the El-retur system as a consequence of the coordination between Elektronikkretur and Hvitevareretur. Even though El-retur is not a legal unit, the waste management companies use it as a coordination mechanism towards the operators in the system (common negotiations) and externally (information campaigns). Elektronikkretur and Hvitevareretur published separate environmental reports up until 2001. From 2002, El-retur published environmental reports as one entity. In addition, El-retur started publishing newsletters from 2003 onwards. Thus, the coordination between the waste management companies in El-retur has increased over the two periods. The El-retur system may therefore be characterized as being coordinated with the governance mechanism *centralization*.

The waste management companies of El-retur have centralized decision control for the operations in the collection system, but have a different role in the relationship towards the stakeholders. In this relationship, El-retur takes on the obligations on behalf of the members and reports back the collected volumes. However, the relationship is formalized in the membership contracts and any adjustments are addressed through the industry organizations (i.e. the owners of the waste management companies). The waste management companies operate as separate companies with respect to these relationships, which the funding models demonstrate. Thus, the relationships towards the stakeholders are to a large degree coordinated with the governance mechanism of *formalization*.

Summarized, the El-retur system is coordinated through the waste management companies with centralized decision control. Each of the transport operators and reprocessing units has a contractual relationship with the waste management companies, but not with each other. The communication and reporting is directed through the waste management companies and El-retur. The exception comes in the form of the collection sites within the collection system, as these are regulated through the EE-regulations:

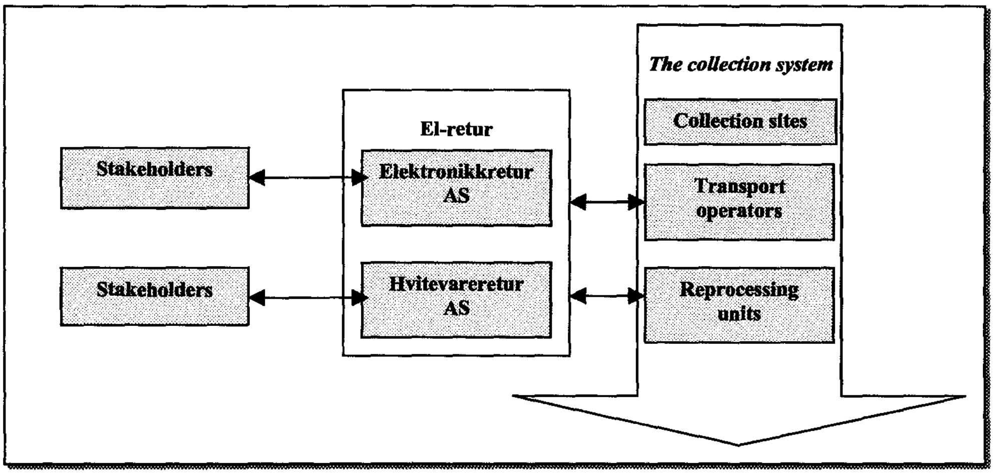

Figure 6.9: The role of the waste management companies in the El-retur system

The El-retur system has a strong focus on *control* in both contract periods. The contracts specify to a high degree how the operators are expected to behave, and deviation from behavior is reported to El-retur rather than adjusted between the actors. In addition to having a centralized decision control in the system, there is a high degree of *formalization* towards the operators. There are both specified standard operating procedures in the contracts and expectations of qualification programs (ISO 9001 and ISO 14000) to join the system.

The waste management companies experienced a challenge in achieving control with one of the transport operators in the first period. The operator did not fulfill the operating standards according to the definition of the waste management companies in El-retur, and the waste management companies found it difficult to intervene and adjust the level. The actor did not, according to El-retur, align the behavior to their expectations and were, therefore, exchanged during the second period. El-retur divided the geographical areas into smaller regions for the second period and increased the number of operators. It was reported that this facilitated the possibility to pay closer attention to the performance of the operators in the system. The actors were given the same type of formalized agreements as in the first period. It can therefore be argued that the level of decision control towards the operators in the collection system increased during the second period and centralization was, therefore, strengthened.

By these means, the waste management companies in El-retur are closely monitoring the behavior of the operators. The motivation for the operators in the system is regulated through the compensation (i.e. price per collected tonne). In this sense, the compensation is a rewarding outcome (i.e. the collected volume). In this manner, the governance mechanism of *incentives* is also utilized to coordinate the commercial interests in the El-retur system.

The governance mechanism of *norms,* on the other hand, is only present to a limited extent as a means of coordinating commercial interests in the El-retur system. The experiences in the system strengthen the notion of control, as the waste management companies have shown the will to replace partners that diverge from expected behavior. In this manner, there is a limited notion of flexibility, and it may not be argued that the parties place high value on the relationship.

There is one exception, however, as there is some level of information exchange in the system primarily towards the collection sites and the end-consumers. The waste management companies are expected to provide information to the end-consumers and the collection sites in order to increase awareness of the system (i.e. an effort to influence the level of volume). Thus, it may be argued that the collection function is coordinated with the governance mechanism of norms. In fact, there is no direct formal relationship between the collection sites and end-consumers and the El-retur system. The collection sites are regulated by the EE-Regulations, which the waste management companies in the El-retur system rely on for coordinating the commercial interests.

The information obligation is a general demand of the EE-Regulations. However, attention rate has proven to be low and it has been difficult to fulfill the information obligation. The El-retur system has reported that it is a challenge to provide information to the end-consumer because of a low attention rate. In this respect, they have stopped with general PR-communication and moved to projects[50] in cooperation with some of the collection sites. The information exchange seems to contribute to a limited degree to the alignment of behavior between the waste management companies and the end-consumers and the collection sites. The collection sites have reported that it is necessary to provide clear guidance for the consumers in the sorting at municipalities and retailers. The coordination mechanisms for commercial interests in the El-retur system are summarized in the table:

Table 6.4: The coordination mechanisms of El-retur's commercial interests in two periods

	Coordination mechanisms	Characteristics
1st period	• Centralization • Formalization • Incentives	• Communication in the system is directed through El-retur • Activities specified in detail in contracts • Collection sites are expected to follow the regulations • Focus on price per kilo collected volume • Limited information
2nd period	• Centralization • Formalization • Incentives	• Communication in the system is directed through El-retur • Activities specified in detail in contracts • Collection sites are expected to follow the regulations • Focus on price per kilo collected volume • Limited information • Possibility for cooperation in the transport function

6.5.3 Coordinated action

Next we analyze the combination of coordination mechanisms in the El-retur system, and the ability of these mechanisms to coordinate the system as a whole and achieve coordinated action.

The El-retur system has been in operation for two contract periods. The system has been continued in the same manner from the first to the second period, with marginal changes. In both periods, the physical flow has been organized through collection sites, transport operators and reprocessing units. The physical flow is coordinated primarily with standardization and, to some extent, by planning in the second period. The commercial

50 The small-sized electronics project

interests have been coordinated through EE-Regulations for the collection sites, and through contracts with transport operators and reprocessing units. The governance mechanisms utilized have been primarily centralization, formalization and incentives. The table summarizes the coordination mechanisms that have been implemented in the El-retur system during the two periods.

Table 6.5: An overview of the coordination mechanisms in the El-retur system

	1st period	2nd period
Coordination of the physical flow	• Standardization	• Standardization • Planning
Coordination of commercial interests	• Centralization • Formalization • Incentives	• Centralization • Formalization • Incentives

The coordinated action of the El-retur system faces some challenges in both periods. Actors have been reported to behave divergently (end-consumers, collection sites and transport operators), and there have been integration challenges between activities (transport operators have found it challenging to coordinate at the collection sites and reprocessing units). Correspondingly, it has been challenging to achieve the system goal of the system (80 % collection rate level). There are a few possible explanations for this when we look at the system as whole.

The collection function proves to be heterogeneous and multifaceted. Products are returned through a large number of sites (4000) and through alternative sites (waste companies external to the systems). There is to some degree a flow of goods outside the El-retur system. The collection function is the start of the process in the El-retur system. The waste management companies expect the actors to follow the EE-Regulations and have not implemented additional governance mechanisms for the collection function. Rather, they expect the authorities to ensure control of this part of the system. However, the end-consumers are not sanctioned to deliver the products to the 4000 sites. The authorities have, however, in some cases issued demands to the collection sites to improve their collection facilities and communication with the end-consumer (SFT March 18th 04). The El-retur system does, however, try to provide information to the collection function, although this only seems to have had a limited effect.

Even though the decision control of the collection sites has been placed with the authorities, the El-retur system has standardized the collection function based on the 4000 sites. The El-retur system utilizes the governance mechanism of information exchange in parallel with standardization. The transport operators have to integrate the activities of the collection functions with the rest of the system through their operations. This has generated both transaction and operations costs for the transport operators. The transport operators face sanctions from the waste management for not fulfilling the contract, and incur higher operations costs because the cages and containers at the collection sites and reprocessing units are not filled and emptied in accordance with the standardizations. The reprocessing units also face increased costs, as they do not get the expected deliveries from transport operators and have to find volume from other sources in order to utilize the capacity.

It may be speculated, therefore, that the lack of decision control towards the standardized operations at the collection sites is a cause of diverging behavior. The governance mechanisms only regulate a part of the El-retur system. The transport operators face formalized agreements, but these agreements do not regulate the behavior of the collection sites. The coordination between the transport operators and the collection sites are not explicitly addressed.

Increasing control from the first to the second period is, therefore, speculated to have limited effect, as the control is directed towards other aspects than those in need of control: The control of the transport operations have been increased, while it is the collection sites that need to receive increased control. The collection function, on the other hand, is coordinated through the use of information, which is only reported to have limited effect. The figure below illustrates this:

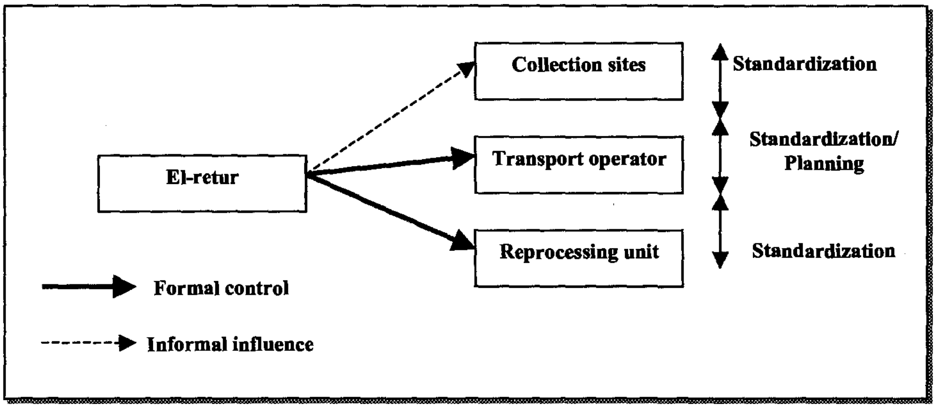

Figure 6.10: Illustration of the coordination in the El-retur system

The El-retur system has experienced a challenge in achieving both aligned behavior and integrated activities. We have also seen that the system performance has reported higher costs and lower service compared to expectations. Our argument is that the *interaction effect* between the two sets of coordination mechanisms influences the system performance negatively. We argue that the governance mechanism of norms is too weak a towards the collection sites because the operations incur system specific costs that are not specifically addressed.

However, explanations for the choice of coordination are visible. The waste management companies have communicated *a cost control perspective.* They have coordinated their interest in one system in order to get a better bargaining situation, and they have been seeking to integrate alternative volume (from Sweden) in order to improve the bargaining position. The focus has been to minimize costs in the system, which is understandable given that the reverse distribution system and the waste management companies are cost centers and non-profit based.

The waste management companies have chosen to draw on the regulations to control the collection sites. In this manner, they do not have to compensate the effort in the collection function. The waste management companies are in this way minimizing their costs. A challenge with this strategy, however, is that the collection function is in fact generating cost and, for as long as it is not compensated, there is no motivation for the actors involved to make any extra effort. It is natural for the actors to try and minimize *their* costs and, as such, put as little effort as possible into the collection activities. The collection function in the El-retur system is a source of *conflict of interests* between the actors in the reverse distribution system.

The waste management companies are engaged by the EE-industry to fulfill the obligations in the industry agreement. The EE-companies (that have joined as members) have two main concerns towards the system. One is to keep the cost as low as possible and the other is to ensure a high collection rate. The cost focus of the waste management companies in El-retur may be explained in relation to the stakeholders. Elektronikkretur has experienced a challenge in organizing the funding of the system, as the interests of the owners have been somewhat contradictory. As a result, time has been spent identifying a model that splits the costs in a mutually acceptable way. The cost issue has had a high profile in the organization of the system. For Hvitevareretur, the organizing of the funding has not been subject to such contradictions because the ownership relationship is less complex.

The waste management companies represent, in many respects, the EE-industry as the commercial partner towards the collection system and the actors in the waste industry. It is therefore natural for the waste management companies to reflect the interests of the EE-industry. In the case of the El-retur system, there has been a challenge in sharing costs between the participating organizations of Elektronikkretur, and this may explain why the cost control focus is primarily directed towards the collection system and the actors that perform the operations.

6.6 *Case summary*

In this chapter we have presented and analyzed the El-retur system, a reverse distribution system that has been established to collect and reprocess EE-products at end-of-life within the categories of consumer electronics and household appliances. We have presented the case in accordance with two contract periods, showing how the physical flows and commercial interests of the system have been coordinated.

The physical flow in the El-retur system is coordinated mainly through standardization, based on a large number of collection sites, and a selection of transport operators and reprocessing units that are assigned to operate in specific geographical areas. The commercial interest is coordinated with governance mechanisms that give a high level of control, namely, centralization, formalization and incentives.

The choice of governance mechanisms and coordination mechanisms for the physical flow can to a large extent be explained by the waste management companies in El-retur close focus on costs. The effect of their cost focus is to some extent leading to sub-optimization and higher (transaction and operations) costs for the system as a whole.

The cost focus is generated from the fact that the waste management companies are cost centers and non-profit companies, and from the relationship to the stakeholders. This is visible through the challenges the waste management company Elektronikkretur has faced in identifying a justified funding model between the collection system and the members.

The result of the interaction effect between the two sets of coordination mechanisms has influenced the system performance negatively, and the El-retur system has had a challenge in achieving the system goal of an 80 % collection rate.

7. Case 2: The RENAS system

In this chapter we present and analyze the RENAS system. We describe the case in sections 7.1 to 7.4 in accordance with the analytical framework, and then the case is analyzed in section 7.5. A brief summary of the case is given in the last section 7.6.

We compare the cases in two periods (cf. chapter 5). The system started operations July 1st 1999, and has operated for two contracts periods. Each of the contract periods has had a three-year timeframe – from July 1st 1999 to July 1st 2002, and from July 1st 2002 to July 1st 2005. The case is presented in accordance with the two three year periods.

The RENAS system consists of one waste management company and one collection system. EE-waste within the category of general electric is collected in the RENAS system and this represents the largest share of the EE-products collected at end-of-life (cf. chapter 2). Products that are returned in the RENAS system are reprocessed for materials recycling (waste management option). The case starts with a presentation of the waste management company and then we present the collection system according to the two contract periods. The presentation is divided between the physical flow and the commercial interests in the system. Next, we evaluate the performance of the system, before analyzing the level of coordinated action.

7.1 The waste management company

RENAS AS was established August 7th 1997. RENAS is a non-profit company owned by two industry organizations (cf. chapter 2). RENAS does not get directly involved in the operations of the collection system but cooperates with professional partners in order for the waste handling to be effective and environmental friendly. RENAS' goal is to achieve the 80 % collection rate of waste from general electric products annually:

"We take the obligation to collect 80% very seriously. We expect sanctions from the authorities if we do not meet their demands. The member companies are also very serious about the task, as this system is costing them a great deal of money." RENAS

The producers and importers of general electric EE-products are RENAS' members. RENAS has calculated the potential number of members to be approximately 7,300 companies. Approximately 1300 of these companies have become members of RENAS (as of June 2002). It is assumed that the member companies of the system represent 75-80% of the total volume of general electric products. The largest companies in the (general electric) industry have joined the system. Approximately 5900 companies represent the remaining 20-25% of the volume. It is assumed that it is difficult to identify possible members both for RENAS and the company itself:

"In some cases companies do not identify themselves with our industry, and do not know that they have general electrical in their products. It is in some cases more lack of knowledge than conscious free riding that explain why companies have not joined our systems." RENAS

RENAS has initiated a reference group to facilitate communication with the members. The group consists of a selection of member companies[51]. Establishment of the reference group gives a forum for discussing the RENAS system. The reference group meets once every three months. RENAS presents information from the collection system and uses the arena to get feedback from the members. In order to establish a dialog with the other members as well, RENAS arranges a member seminar once a year. At the seminar, members receive information about the system and motivation to continue as a member to RENAS. The invitation to the member seminar in March 2003 stated:

"Membership in RENAS is a competitive advantage. It shows that your company takes the environment seriously. We invite you to a free member seminar about environmental responsibility and marketing. We have prepared tools that member companies may use in their marketing and sales. We want to present this together with competence and entertainment."

Members are important to RENAS, as the system is funded from the membership fees. The fee is divided between an initial (one-time) fee, which is payable on joining the system, and a fee that is tied to the products. The initial fee is set based on the turnover of the member – the larger the turnover, the greater the fee. The product fee is charged per unit of general electric product that members import to, or produce in, the Norwegian market. There are three fee levels: 0,1%, 1% and 5%. The levels are based on the fact that different products generate different costs in the collection system.

[51] Approximately 11 companies are represented in the reference group.

Customs[52] charges the fee on behalf of RENAS at the time of import, based on customs tariff numbers. The funds are then transferred to RENAS. Additionally, the members report the volume they import/produce to RENAS. The information from customs and the members are compared and if they do not correspond RENAS makes the necessary correction. Products may have been wrongly identified in customs[53]. The figure below illustrates the process:

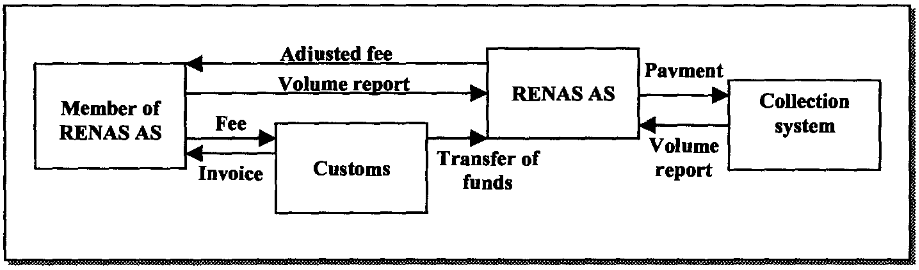

Figure 7.1: The funding process in the RENAS system

7.2 The physical flow in the RENAS system in two periods

In this section we present the physical flow in the RENAS system during the two contract periods, starting with the period from 1999 to 2002. The second period ran from 2002 until 2005.

Two characteristics describe the EE-waste from general electric that are collected in the RENAS system. First, commercial actors (the business-to-business market) represent the major group of end-consumers. That is, the largest share of the volume being returned is generated by commercial end-consumers. Second, some categories of general electric products have a high share of valuable content, e.g. steel, copper and aluminum. These products have a positive net value. Products with a positive net value contain materials that are attractive to a secondary market, as opposed to products with negative value. Products with negative value represent a liability in terms of hazardous waste content.

[52] The Norwegian Customs and Excise – Tollvesenet

[53] This has turned out to become a major activity for RENAS, who in 2001 billed the members for NOK 20 mill. extra after having compared information from members with that of the customs.

7.2.1 The physical flow from 1999 - 2002

The collection system was structured through three types of actors: collection sites, transport operators and reprocessing units. RENAS included collection sites as a part of the collection system and did not base the system on the collection sites specified in the EE-Regulations. The collection sites where chosen from municipalities and waste companies. RENAS expected other actors (e.g. municipalities and retailers) to deliver the EE-waste of general electric to their system. Anyone, including private households, companies and commercial enterprises, can deliver EE-waste free of charge to the system. The terms are regulated in the EE-Regulations. The main reason for establishing system specific collection sites was the lack of capacity for the sites identified in the EE-Regulations to handle volume returned from the commercial end-consumer:

"The best option is to deliver the products to our regional collection sites, which we have organized on behalf of importers and producers. From these sites we have established a transport system." RENAS

In summary, the structure in the first contract period from July 1999 until July 2002 included 72 collection sites, four transport companies and four reprocessing units. The system was established on a national basis and the actors were assigned to geographical specific areas. The figure below illustrates the structure of the collection system:

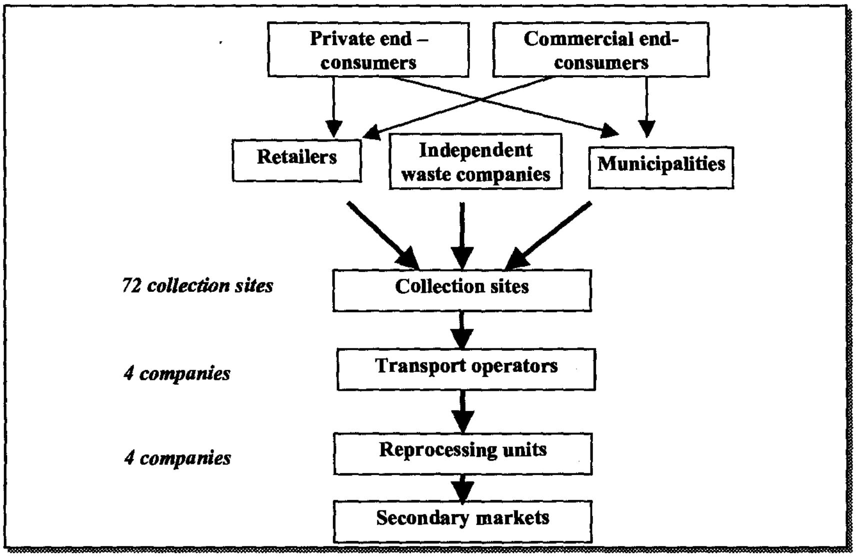

Figure 7.2: The collection system from 1999 until 2002

The process in the system was divided into the three functions of collection, transport and reprocessing. Each of the functions had a set of activities. The following table gives an overview of the process and the activities:

Table 7.1: The process in the RENAS system from 1999 -2002

Process:	Comments regarding activities:
Handling at collection sites	• Collection of general electric products at end-of-life (provide cages and containers). • Secure sorting into seven categories. • Secure proper internal routines. • Initiate transport from the collection site to the reprocessing unit. • Report volumes to RENAS.
Transport operations	• Transport from collection site to the reprocessing unit within a defined geographical area. • Identify proper schedules (frequencies).
Reprocessing	• Control that the delivered material are sorted into the seven product categories. • Register and report the volumes to RENAS. • Dismantling of products, and the extraction of hazardous material. Sort out groups of homogenized materials. • Register the dismantled materials in 40 categories. • Finding secondary markets for the materials. • Dispose of hazardous materials.

In the first period, the collection sites were primarily delivery points [54], and were supposed to sort products into the defined categories and initiate transport when the collection capacity was filled. The rationale in the first model was that the products could be returned to the system *free of charge* and the actors were paid by RENAS for the cost of the activities they performed.

The system did not operate according to expectations because of two main factors. First, the products' characteristic concerning positive and negative value resulted in two waste streams. The end consumers found the system attractive for 'negative valued products' because it was free of charge. The positive valued products had a tendency to be sold directly to the secondary market because the end-consumer was able to recapture a rest value for the products. These products were sold outside the RENAS system because their value was not compensated for within the system:

[54] End-consumers could negotiate for pick-ups, but this was an ad hoc operation. The end-consumer had to cover the cost of pick up.

"In the first period it was possible to deliver the goods free of charge, which sounds attractive. However, if you have a product that is worth NOK 1000 per tonne the end-consumer felt he was loosing money. As a consequence, the actors tried to recapture the value of the products and traded it outside our system." RENAS

A second dimension was how the actors were compensated for their services. The compensation for the services was a gross amount and RENAS calculated on income from the sales of the products. However, the income was to be deducted from the cost *after* the logistics operations had been performed in the collection system and provide the actors with a fixed margin. Combined with the defined geographical areas, the actors behaved passively in the system (i.e. they did not actively pursue volume). The defined geographical areas were supposed to provide the actors with a certain level of volume. There was, therefore, a lack of supply push in the system.

RENAS' coordination of the collection function did not grasp, in other words, all the characteristics of the physical flow. We have illustrated this in the figure below:

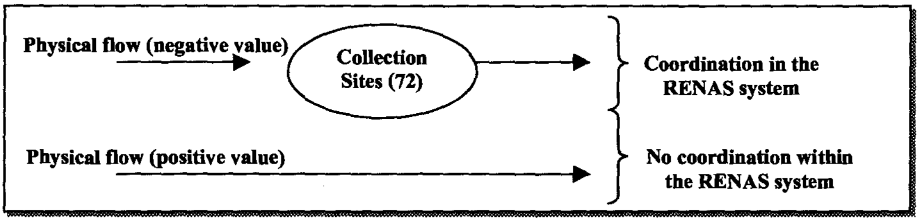

Figure 7.3: Coordination of the collection function in the RENAS system 1st period

The transporters worked within defined geographical areas, and collected products from defined sites and partners. However, as the physical flows did not follow the expected paths, the transport functions had difficulties gaining access to volume:

"We collected products for RENAS, but the system did not work well. RENAS' products were interesting for the scrap dealers, and it was no use in delivering products to RENAS when you got paid for it elsewhere." Norsk Gjenvinning Oslo

The end-consumer organized the flow of the positive valued products themselves and the collection sites did not seek volume actively. In this sense, the transport operators were left in a situation with low volume and did not have the possibility to influence the situation. This next figure illustrates the coordination of the transport:

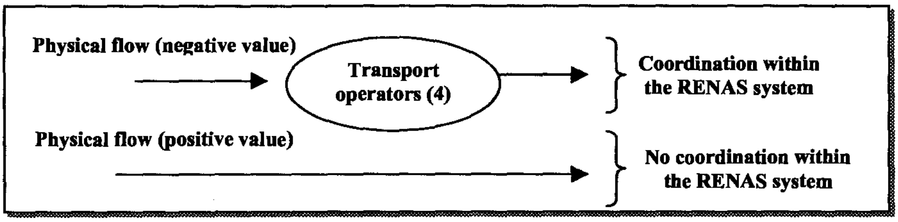

Figure 7.4: Coordination of the transport function in the RENAS system 1st period

Deliveries to the reprocessing units were handled by the transport operators. After the products had been dismantled and sorted, the products were sold to secondary markets. The geographically defined areas and the compensation model created challenges with respect to the reprocessing as well. The reprocessing units were not able to influence the volume and flows of goods because the geographical areas were given, and the volume was to arrive from specific collection sites via the transport operators. They were as such provided with a defined level of volume. Second, the reprocessing units were compensated in full for their services, and if there were any profits made from sales to the secondary market RENAS expected a refund. However, this left the reprocessing units with little incentive to look for a secondary market.

The dedicated geographical areas and the fixed transport contributed to a passive behavior from the reprocessing units. The reprocessing units were not able to influence the situation:

"RENAS' products have an 85 % share of metals. It was difficult to get a hold of the RENAS products. The products went directly to a scrap dealer." Elektronikkgjenvinning

The positive valued products were as such not integrated in the reprocessing units' operations either, as this figure illustrates:

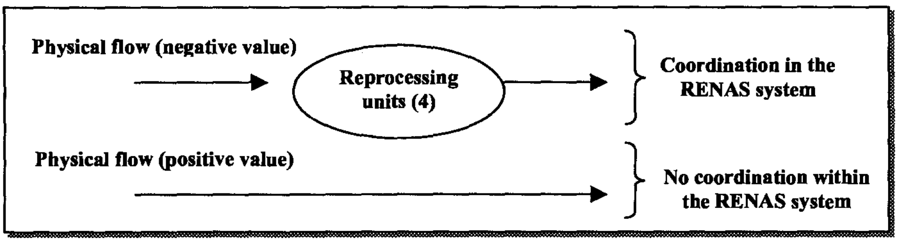

Figure 7.5: Coordination of the reprocessing function in the RENAS system 1st period

RENAS had difficulties in obtaining the expected collection rates and in geting a return of revenue from the operators in the collection system. The company ended up covering a higher cost of the collection system than expected. As a consequence, the coordination of the system was changed for the second contract period:

"A close dialog with the waste industry made us realize that we had to change the system. It was not working to the best interest for the waste industry nor us." RENAS

7.2.2 The physical flow from 2002 - 2005

The system changed in the second period. The transport operators were integrated with the collection site to become *collectors*. The number of collectors established was 140. The number of reprocessing units increased to 17. The collection system is illustrated below:

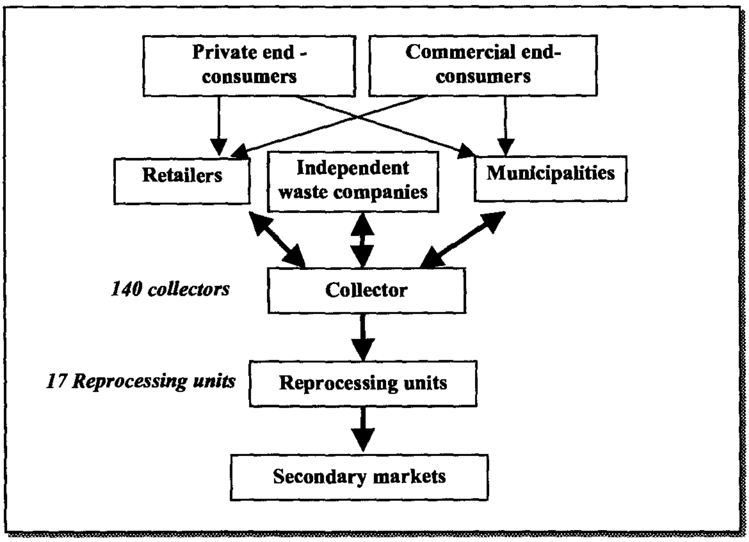

Figure 7.6: The RENAS collection system from 2002 to 2005

The transport function was integrated into both the collection and reprocessing function for the second period. The collectors performed collection and transport functions. The reprocessing units were also allowed to operate as collectors, and perform collection, transport and reprocessing functions. The activities changed somewhat. One specific change in the system was that the collectors were expected to look actively for volume (i.e. actively work with end-consumers). The table below summarizes the process and a description is also provided:

Table 7.2: The activities in the RENAS system in the second period

Process:	Comments regarding the activities:
Collecting	• Identify collection sites/users of general electric products. • Collection of general electric products at end-of-life (provide cages and containers). • Facilitate direct delivery if preferred. • Secure sorting into seven categories. • Secure proper internal routines. • Transport from the site of collection to the reprocessing unit. • Agree on routines in the process of delivery at the reprocessing unit. • Report volumes to RENAS.
Reprocessing	• Negotiate agreements with collectors and possibly with end-consumers of general electric. • Control that the delivered material are sorted into the seven product categories. • Register and report the volumes to RENAS. • Dismantling of products and the extraction of hazardous material. • Register the dismantled materials in 40 categories. • Sort out groups of homogenized materials. • Finding secondary markets for the materials. • Dispose of hazardous materials.

In the second period, a number of changes influenced the coordination of the system. The number of actors was increased in order to increase the competition between the actors, and the intensity of the collection, i.e. the availability of collection sites. Both these elements were expected to stimulate the actors to seek volume actively. However, the number was carefully evaluated in order for the actors to gain sufficient volume to be able to run a viable business.

"It is important to have a sufficient number of actors in order to cover the market, but also a small enough number of companies in order for the market to be interesting. We need the companies to work in order to achieve our goals." RENAS

The new compensation model stimulated the actors into taking an active role in the system. The model changed from compensating a gross amount, where both cost and revenue were expected to be reported back before the final compensation was settled. In the second period, the actors were compensated for a net amount, with no adjustments in arrears. An increased effort to find innovative ways to collect and handle the products from the actors' side would result in increased profits to themselves. In this situation, the actors were given the opportunity to search out for volume themselves, i.e. get in contact with the end-consumers of general electric products. The competition between the actors (as a consequence of not having geographically limited areas) stimulated the actors into finding volume in order to increase their profits:

"The system is gradually getting established. We are able to take an active role. At the outset I took an overview of the industry and thought, "who would be relevant partners for us"? The actors have an interest in delivering volume to us, because RENAS pays a fair compensation." Elektronikkgjenvinning VEST

"Our collection activity consists of eight collection sites. The RENAS products are sent from the seven other collection sites to the main collection site. There is a payoff in sorting the RENAS products. We have taught our employees to sort out the RENAS products." ROAF Bøler

The actors were allowed to, and expected to, trade and negotiate with each other. The changes resulted in a more flexible system. This was important with respect to the products with both types of character (positive and negative value). The products with positive value were being traded in the market. Without flexibility the actors were not able to integrate these waste streams into the system. The ability to negotiate with end-customers gave the collectors the ability to offer a pick-up service and a rest value for the collected material. As the collectors were also able to run the transport service, they were able to move the products directly from the site of the end-consumer to the site of the reprocessing units. That is, they identified the best possible transport solution for each collection task. In this manner, they avoided handling activities and were able to lower the cost, as this statement illustrates:

"It is an advantage to be both a collector and a reprocessing unit, because you then do not have the cost of transport between the two processes. Our company is a collector and in this sense we have a disadvantage." Hermod Teigen, Lierstranda

The transport operators were eliminated from the system. The collection sites did not receive the products as expected and RENAS realized that the transport function was not a straightforward activity of moving products between fixed points. A major factor was that the end-customers were mainly in the business-to-business market and they returned batches of products, rather than continuous volumes. Providing the transport function with greater flexibility was necessary.

"We did not observe an extra value created from the transport operators, and as such it was decided to integrate the two roles of collection and transportation." RENAS

The defined geographical areas had created artificial borders. In some cases, it was more natural to plan the transport in other ways than within the geographical areas. End-consumers also searched for return possibilities across geographical areas and it would have been difficult to reject them for such a reason. The collectors could also have individual different possibilities to serve a certain area, for example in synergies with other customers or operations.

The RENAS system's interest was to collect products in order to extract the hazardous parts from the products and to register the collection rate. In allowing for the flexibility in the system, there was an increased possibility to reach these goals. The physical flow of goods could take several paths through the system, but the products had to be taken care of in an environmentally sound manner, and reported to the waste management company (RENAS). The figure gives an overview:

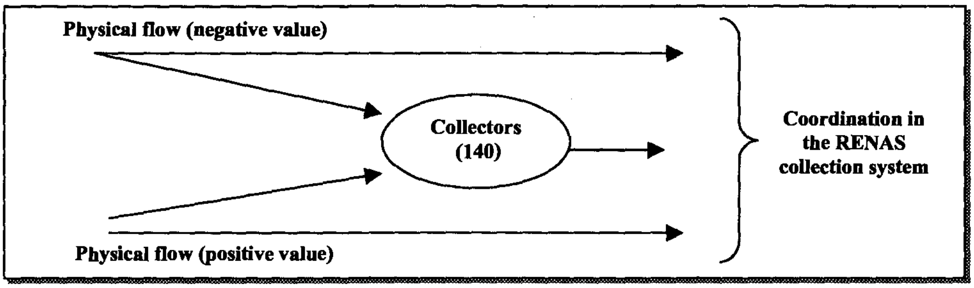

Figure 7.7: Coordination of the collection function in the RENAS system 2nd period

The reprocessing units were also allowed to operate as collectors. The main reason for this change was to integrate volume into the system that was delivered from actors outside the system. External actors did not necessarily understand the difference between the actors (collection sites/transport operators/reprocessing units) and could get in contact with either one in order to trade products with positive values. Being allowed to operate as collectors meant that the reprocessing units were able to secure that the volume was included in the RENAS system.

"A number of collectors phoned us regarding delivery from an independent actor. The products were traded in the open market. The product however, contains a high share of asbestos, and need to be handled and reprocessed carefully. However, the products also

contain a lot of copper. I expect that actors that are dependent on the value of materials would have traded it directly in the market without proper treatment of the hazardous materials. In this case we traded directly with the independent actor, and were able to secure proper treatment of the products. That is what I told all the collectors in the system when a number of collectors reacted negatively to our disposition. We had to get a hold of those products. It is the worst kind, and cannot go astray. I know there is some leakage in the system. It is in principle illegal for the independent actor to trade the product in the market. However, this is systems and rules that most people do not know of." Elektronikkgjenvinning VEST

The fact that reprocessing units were allowed to run a collection function may create conflict of interests towards the collectors. However, RENAS set as a criterion that all products had to pass through collectors. RENAS established the criterion because there was a need to divide the business between the actors to some extent. However, in order to secure that volume was collected and the actors were stimulated into finding volume, there was flexibility in adapting to the most efficient flow of goods. A second effect after the change of the system was that products could be delivered directly to the reprocessing units without being handled by the collectors. This was to ensure that the positive valued products that used to be traded in the open market were included in the system. One of the collectors explains:

"We also work as a broker for other companies that deliver products directly to the reprocessing unit, and use our name. That is, we do the paperwork." Hermod Teigen, Lierstranda

The reprocessing units have then had the opportunity to negotiate directly with the end-consumers and to negotiate with the collectors. In this manner, it was possible to integrate products that were traded in the market, and adjust the activities according to the specific collection task at hand. The result has been a set of different physical flows to the reprocessing units. The figure below illustrates this:

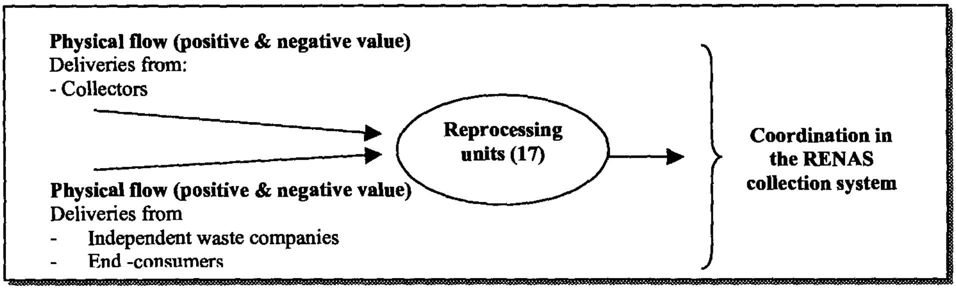

Figure 7.8: Coordination of the reprocessing function in the RENAS system 2nd period

There is of course no guarantee that the products can be integrated into the system if the end-consumer decides to trade the products with other actors than those within the RENAS system. In these cases, the hazardous share of the products cannot be extracted from the products. And, in this case, it would reduce the collection cost for the products. However, the new flexibility of the system has increased the possibility to prevent these situations.

The actors are pleased with the changes. The collectors and reprocessing units are able to run their operations according to their requirements. The changes have been able to include the physical flow of positive valued products in the collection function. It is a challenge in the system that the collectors and the reprocessing units both have the collection function as a part of their operations. The consequence is that both actors compete for the same volume but on different terms:

"One problem for us is that customers may skip us and deliver products directly to the reprocessing unit. In this sense, the customer gets a higher price for the products, and the reprocessing unit gets a larger margin. The direct delivery may be conducted after we have been in contact with the parties. In this sense we feel left out." Hermod Teigen, Lierstranda

The collectors necessarily have an extra handling operation compared to the reprocessing units, except in the cases of facilitating direct delivery.

7.3 The commercial interests in the RENAS system in two periods

In this section we present how the commercial interests in the RENAS system have been organized in the two contract periods from 1999 to 2002, and from 2002 to 2005.

7.3.1 The commercial interests from 1999 - 2002

The first contract period for RENAS was initiated in cooperation with Elektronikkretur and Hvitevareretur (one tender). The contracts were signed individually with the actors in the systems. RENAS issued contracts to each of the 72 collection sites, four transport operators and four reprocessing units. The actors had standardized contracts. That is, all collection sites had identical contracts, the transport operators had identical contracts and the reprocessing units had identical contracts. The contracts specified that the actors had to report directly to RENAS, who had to facilitate communication between the actors. The following figure illustrates the structure of the contract relationships in the RENAS system:

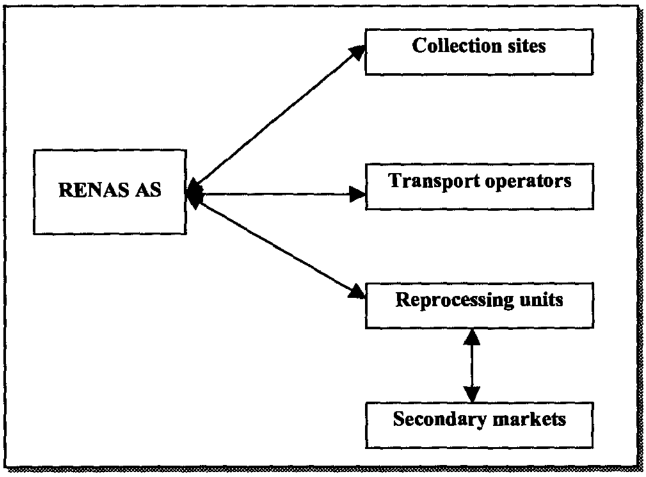

Figure 7.9: The coordination of commercial interests in the RENAS system 1999-2002

The main content of the contracts included[55]:

- The actors were given geographical dedicated areas to work with.
- Specifications of who the actors were expected to interact with.
- Operating activities and standards (packaging, availability, opening hours, etc).

Operating activities and standards are somewhat different for the different types of actors.

- Collection sites: Faced specific demands with respect to *provide information* to the local community.
- Transport operators: Faced specific demands with respect to *frequencies.*
- Reprocessing units: Faced specific *environmental demands* with respect to dismantling.

RENAS' responsibility in the collection system included:

- National information (e.g. Internet and brochure material and newspapers)
- Administration of the system (registration of data, compensate the actors)

The collected products are sorted into categories in the collection process. The products are registered in seven categories at arrival at the reprocessing unit, and the materials are sorted into 40 product groups when dismantled. The authorities have defined the 102 categories, and the other categories are defined by RENAS. The process can be illustrated as follows:

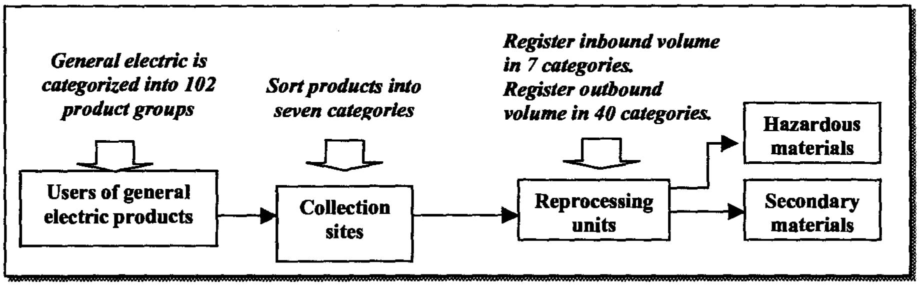

Figure 7.10: The sorting of products in the collection system

RENAS compensated the actors based on these data. The compensation was a *gross amount* in this period. General electric products have a large share of valuable materials, and RENAS calculated a certain income from the sales of these products. The income was to be deducted from the cost after the logistics operations had been performed in the collection system, and after the materials had been sold in the secondary market. The net income was, as such, expected to be returned to RENAS. Based on the logic from this compensation system, RENAS was supposed to cover the exact costs of reprocessing the materials.

7.3.2 The commercial interests from 2002 - 2005

The governing of the collection system changed in the second period. RENAS changed types of actors and, consequently, the content of the contracts. RENAS and El-retur did not coordinate a common tender in this second period.

RENAS entered into contracts with 140 collectors and 17 reprocessing units. The collectors were given identical contracts but the reprocessing units had individually negotiated contracts. The contracts included the activities the actors were expected to perform, and the actors had to be ISO certified. Beyond these aspects the actors were left with a higher degree of decision making for the second period. One main feature was that the actors were allowed, and

[55] RENAS provided a copy of the contracts and tenders.

expected to negotiate directly with each other. That is, identify for themselves with whom to cooperate both within the system (the actors that have contracts with RENAS) and with other relevant actors (actors that do not have contracts with RENAS). The actors were free to decide between themselves how to best organize their activities, as long as they kept the quality standards that RENAS had set.

"I am very satisfied with how the system has changed. Now we are able to govern all that happens around us. In the first model we were very dependent on everything else. Now we are in the center of things." Elektronikkgjenvinning VEST

In the second period, the actors have contracts with both RENAS and their operating partners. The contract relations in the system can be illustrated as shown below:

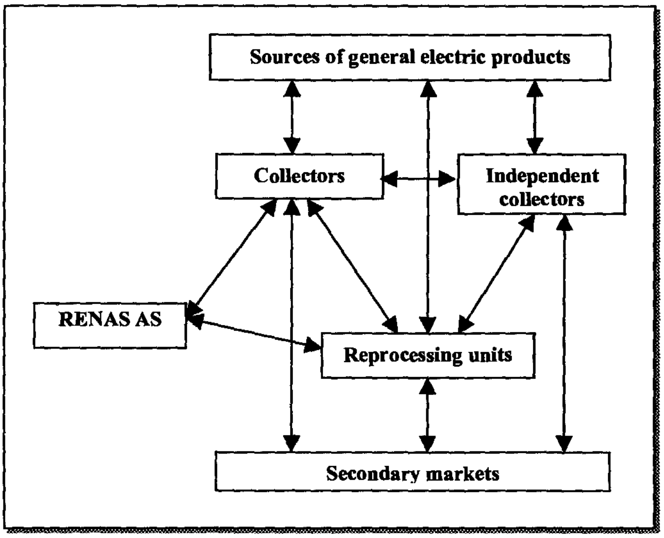

Figure 7.11: The coordination of the commercial interests in the RENAS system 2^nd^ period

RENAS made two changes to support the new activity structure. The actors were not limited to *geographical areas* and a new *compensation model* was established.

The compensation model changed from a gross to a *net amount*. RENAS paid the actors a fixed price for their services, without expecting returns. In this model the actors were able to keep the margins gained from increased efficiency. In the first model, RENAS set a fixed margin and any surplus from increased efficiency had to be returned. The actors were in the

2^{nd} period directly tied to their own performance. The more their efficient operations, the more money they make:

"We are very satisfied with the RENAS system. It works very well. We are compensated for the work we do." Follo Truck Utleie

"RENAS has a very nice model. In the RENAS model we receive a certain amount of money and are able to buy materials from the market." Elektronikkgjenvinning

Collected or delivered products still needed to be sorted in accordance with the seven defined categories. If end-consumers wanted to have products collected or to deliver unsorted materials, it was up to the specific collector whether the end-consumers paid for the services. The collector had to provide the proper facilities (packaging) for collection of the general electric products, and ensure that the correct products were delivered to their sites:

"In the RENAS system, the collectors have to deliver the products to one of the 17 reprocessing units. The products are supposed to be sorted into the 7 categories, which they are paid according to. It is then up to us to control the products and secure the quality. If the quality is not to standards, we have to do the sorting over again. In this sense all the parties watch over each other, and provide stability to the system. It works quite nice in this sense." Elektronikkgjenvinning VEST

The actors are no longer limited to geographical areas. This increased the competition between the actors. The actors were expected to spend time actively looking for volume, both within and outside the system. The collectors were expected to find end-consumers, rather than waiting for the end-consumers to find them. With an increased possibility to gain higher earnings, the incentive increased the search for waste:

"We engaged a consultant that traveled around for one semester to all the EE-companies in our area and promoted the return possibility at our collection site. All the customers were given a folder of printed material." ROAF Bøler

"With respect to the commercial dimensions, i.e. being creative towards the waste owners, the collectors are free to do whatever they like. We want there to be competition between the collectors. It will stimulate them into finding volume actively, and give an edge to the operation. We strive for competition in our system." RENAS

They were also expected to identify which reprocessing unit(s) to work with and negotiate agreements with them:

"It is possible for us to choose the cooperating reprocessing unit. We issued a tender and decided on the reprocessing unit." ROAF Bøler

The same applies to the reprocessing units. The increased competition between the reprocessing units increased the incentive to promote offers to collectors, and as such look actively for partners:

"In the RENAS model we are expected to address the market. It is an interesting model with a higher degree of a free marketplace. In the RENAS model we have to actively seek the volume, or someone else will." Stena Miljø

"We are a collector and a reprocessing unit in the RENAS model. We focus on reprocessing, but try to get a relationship to collectors. I work a great deal with getting these types of relationships. We think about hiring a sales representative to get in contact with collectors and generate volume for us." Stena Miljø

The earnings were in other words, dependent on their direct effort. This goes for the dismantling function as well – the better the solutions for the handling and dismantling of products, the higher earnings.

RENAS also started the second period with the decision to hold annual seminars for the actors in the collection system. The collectors are invited to a yearly 'collectors seminar', and the reprocessing units are invited to a yearly 'reprocessing seminar'. The seminars include training on how to identify general electric products (in order not to collect wrong categories of EE-products), and information about the performance of the system. The seminars facilitate communication in the system, and RENAS wants the actors to share experiences and give feedback about the system:

"Deviance from the contract may be based on misunderstandings. An important task for RENAS is to organize seminars for the actors of the system. It is a new industry, and focus is to develop knowledge on how to handle the returned products." RENAS

7.4 Performance in the RENAS system

In this section we comment on the level of integrated activities and degree of aligned behavior within the RENAS system, and the system performance variables. The *system goal* in the RENAS system is to collect 80 % of general electric products at end-of-life. The table on the next page gives an overview of the collected volume from 2001 to June 2004.

Table 7.3: Collected volume in the RENAS system from 2001 – June 2004

Nr:	Category	Total volumes 1999-2002	2001	%	2002	%	Total volumes 2003	2003	%	2004 (per June)	%
1	Vending machines	470					470,0	-		-	
2	White goods	28 493					29 413,0	-		-	
3	Brown goods	11 000					11 000,0	-		-	
4	Cabling and wiring	13 000	8 498,0	65 %	11 067,0	85 %	12 330,0	10 412,2	84 %	5 010,9	81 %
5	ICT equipment	7 800					7 800,0	-		-	
6	EE-toys	1 700					1 700,0	-		-	
7	Heating, air-conditioning, ventilation	4 100	1 679,0	41 %	2 235,0	55 %	5 024,0	2 610,1	52 %	1 380,7	55 %
8	Lighting	6 700	2 171,0	32 %	2 460,0	37 %	4 340,0	3 594,1	83 %	2 391,8	110 %
9	Medical equipment	2 700					2 700,0	-		-	
10	Equipment for measurement and control	11 000	2 999,0	27 %	3 023,0	27 %	5 785,0	3 776,7	65 %	1 959,6	68 %
11	Office equipment	3 400					3 400,0	-		-	
12	EE-tools	12 000	6 365,0	53 %	9 458,0	79 %	14 925,0	15 521,1	104 %	7 691,7	103 %
13	Telecommunication	2 400					2 400,0	-		-	
15	Clocks and watches	300					300,0	-		-	
17	Security equipment, smoke detectors	190			8,0	4 %	221,0	15,5	7 %	17,0	15 %
18	Electro equipment	9 300	6 482,0	70 %	7 661,0	82 %	9 573,0	9 814,3	103 %	3 934,4	82 %
	Total	**114 553**	**28 194,0**		**35 912,0**		**111 381,0**	**45 744,0**		**22 386,1**	
	Collection rate:	**56 100**	**28 194**	**50 %**	**35 904**	**64 %**[56]	**51 977**	**45 729**	**88 %**	**22 369**	**98 %**

[56] The collection rate at the end of the first contract period in June 2002 was reported to be 59 %.

The RENAS system had an average collection rate of approximately 59 % at end of the first period. In this sense, the collection rate was much lower than the system goal, and the costs were reported to be too high.

In the second period, however, the collection rates were satisfactory (more than 90%) and the costs were reduced. In fact, the collected volume increased by approximately 50% from the first to the second period, and the costs were reduced by approximately 50%.

The RENAS system fulfilled the government's demands in 2004 when the collection rate passed 80 %. Thus, the system goal was fulfilled in the second period. The collected volume was 45 958 tonnes, and the cost of operation was NOK 111 mill (2003). The average cost was then NOK 2 415 per tonne.

It is argued that the change in coordination mechanisms in the second period has had a large impact on the improvement in performance between the two periods. As one reprocessing units states:

"In the first model you were either inside of the system or outside. Many of the actors in the waste industry took offence at the others that gained these golden contracts, while they were not able to participate. In the new system we have been able to level out this difference in the sense that all can get a piece of the pie." Elektronikkgjenvinning VEST

7.4.1 Performance in the physical flow

The challenge in the RENAS system in the first period was first and foremost that the physical flow was divided between the positive and negative valued products. The collection sites were organized to receive products at specific locations, accumulate the volume and call for transport operators to pick it up when the capacity was filled. The transport operators then had to deliver the products to the reprocessing units within defined geographical areas.

The end-consumers did not deliver the products to collection sites. Rather, it was expected for the products to be picked up at the end-consumers' premises. The products had in many cases a positive value and, therefore, the end-consumer was able to negotiate free pick up and a rest value for the products. The transport need was not between fixed points; rather the transport need was from the end-consumer sites and therefore changed from collection task to collection task. The activities were not well integrated between the end-consumer and the collection sites, and it was difficult to fulfill the service levels in the collection system.

As a consequence, the operations costs of the collection sites and transport operators were higher compared to expectations, as the volume prognosis was not fulfilled. The collection sites could offer the end-consumers pick up from their premises, but this cost had to be charged. RENAS did not cover such costs. The result was that the positive valued products were traded outside the RENAS system. The reprocessing unit, as a consequence, did not receive the expected volume for dismantling.

In the second period, however, the collection sites and transport operators were integrated into one function – the collector. As a result, there was a closer coordination between the collection activities and transport activities. The waste management company states:

"We did not observe an extra value created from the transport operators, and as such it was decided to integrate the two roles of collection and transportation. " RENAS

The collectors were also allowed to offer a rest value to the end-consumers. The operators in the collection system had in this manner a possibility to integrate both negative and positive valued products in the system. Thus, activities were integrated to a high level in the second period, and the operations costs were reduced. The ability to adapt the activities to the end-consumers also increased the customer service level in the system for the second period.

7.4.2 Performance in the commercial interests

The performance in the commercial interests created a higher level of transaction costs than was expected in the first period. The fact was that products with positive value at end-of-life were traded with other actors and in other systems, and not the RENAS system. The contracts were not properly adapted to align behavior in the system, and reflected opportunity costs in the system. That is, costs of volumes not collected, income not earned, capacity not used and hazardous materials gone astray.

The end-consumers were primarily seeking their self-interests when trading positive valued products, and the interests were not in accordance with the common interests of the RENAS system. A second challenge was the fact that RENAS operated a gross compensation model in the first period. The operators' efforts were not rewarded as the earnings were supposed to be reported and transferred to RENAS. The non-profit profile led RENAS to set a fixed margin, and expected upsides to be returned to them[57]. The actors did not actively seek volume because 'there was nothing in it for them'. The earnings for the actors were fixed at the outset and the motivation of the actors was lacking in the system. The collection sites did not have an incentive to look for volume. The reprocessing units were not eager to seek profitable secondary markets for the recyclable materials. The model promoted diverging behavior of the actors, which was a source of transaction costs. The lack of effort represented costs to the systems.

RENAS had the possibility to compare efforts between actors during the first period. However, as the actors were assigned to different geographical areas, it was not straightforward to compare the operations between the actors. That is, each actor operated under different contingencies (in different areas).

In the second period, however, RENAS was able to align the behavior of the actors in the system. The contracts were restructured, which gave room for competition between the actors and included a net compensation model. RENAS was able to reduce transaction costs through the comparison of the actors. RENAS obtained a realistic comparison between the actors as the actors operated under similar contingencies (in the same areas). The performance criteria included collection rate and reported volume of hazardous material (i.e. separated from the products in the dismantling process).

The hazardous material represents a challenge. Withdrawing hazardous materials was a cost driver and the rationale was the inverse of an ordinary production. The more effort they put into dismantling, the more it cost, but their performance towards RENAS increased. However, if this risk had been left to the actors, there would have been *an incentive to cheat.* They could not know how the other actors (i.e. their competitors) would act. The reprocessing units received unique contracts with RENAS in the second period. RENAS was able to compare the performance of the actors against each other, and gained in this manner a certain level of

[57] The waste management companies are cost centers for the members, and as such the companies aims to balance earnings and costs.

control. In addition, RENAS covered the costs for the disposal of the hazardous materials. Again, if this cost had been left to the actors individually, there would have been an incentive to cheat. However, as long as the cost was covered centrally there was a reduced incentive to cheat.

"There are a number of actors in the waste industry that do not comprehend what we do. However, they do not know the system. Most of the actors that I talk to think that it cannot be profitable. Most of the scrap dealers live of the value of the materials. We do not. We do not need to relate to the value. We do what is environmentally correct, because RENAS cover the cost. That is impossible to understand for those who see the value of the materials." Elektronikkgjenvinning VEST

In the second period, there was a conflict of interest between the collectors and reprocessing units with respect to the collection function. This generated some transaction costs to the system, in the sense that the collectors may have lost some opportunities to the reprocessing units. However, it was not to the disadvantage of the system as a whole and RENAS, whose goal was to get products collected and hazardous waste extracted. The statement illustrates:

"We take the obligation to collect 80% very seriously. We expect sanctions from the government if we do not meet their demands. The member companies are also very serious about the task, as this system is costing them a great deal of money." RENAS

The actors have also been able to fulfill self-interests in the second period, without this being in conflict with the common interests. The actors were in the second period given control over their earnings, and were able to influence their profits in two ways. First, they were able to increase the collected volume and get a higher income, and second they were able to improve their operating efficiency and get higher profits. However, there was one source of added transaction costs, which resulted from the conflict between collectors and reprocessing units.

7.5 Analyzing coordinated action in the RENAS system

We have presented information about the RENAS system, including system performance, so far in this chapter,. In this section we analyze the case in accordance with our analytical framework.

The RENAS system has been in operation for two contract periods. The system has changed from the first to the second period. In the first period, the physical flow and commercial interests were organized through collection sites, transport operators and reprocessing units. In the second period, however, the system was organized through collectors and reprocessing units. The collection sites and transport operators were organized as one actor. In the second period, the functions were integrated and duplicated in the system. That is, the collector was expected to perform collection and transport function, and the reprocessing units were also entitled to perform collection and transport functions, in addition to reprocessing.

First, the analysis seeks to establish the type of coordination mechanisms that are utilized for physical flows and commercial interests respectively, and secondly we analyze to what extent the RENAS system has been able to achieve coordinated action.

7.5.1 Coordination of the physical flow

The RENAS system can be characterized as *standardized* in the first period with its defined collection sites, and defined transport routes to dedicated reprocessing units. The operations were standardized within defined geographical areas.

The RENAS system established separate collection sites as opposed to those defined in the EE-Regulations. The reasoning was that the volumes to be returned were mainly generated in the business-to-business markets, and larger returns were expected from each end-consumer, which demanded larger capacities than those that would have been available at retailers and municipalities. The regional collection sites were better suited to handle such types of returns. A second effect was that the flow of goods to be returned from business-to-business end-consumers would naturally be larger and less frequent than those from private end-consumers. Thus, the collection sites were expected to exploit pooled interdependencies, in the sense that the end-consumers were dependent on each other to utilize resources necessary to handle the type and size of volumes they supplied.

Departing from the same logic, the transport operators were assigned to geographical areas in order to serve a set of collection sites, and had to adapt capacities and frequencies to match the collected volume. The reprocessing units were also assigned to geographical areas, and adapted to the transport operators and collection sites within their areas.

However, the standardization proved to generate a divided flow of goods between the positive and negative valued products. The negative valued products were returned in the RENAS system, while the positive valued products found other paths towards secondary markets. The operators in the system had, as a consequence, problems obtaining volume, utilizing capacity and securing collection frequencies.

The system changed the coordination mechanisms of the physical flow to *planning* for the second period. The actors were able to exploit serial interdependencies. The collection sites were terminated as fixed locations, and the collector as an intermediary replaced the collection sites and transport operators. The collectors were expected to work with the end consumers and collect volume where it was generated and deliver it to a reprocessing unit of their choice. In this sense, the frequencies and capacities were adapted to the needs of the end-consumers, rather than existing as a part of standardized transport routes. The collectors had a choice between accumulating volumes at their premises, or delivering the products directly to the reprocessing units. The choice was a part of planning the (optimal) flow, rather than fulfilling a standard operation procedure. The reprocessing units were able to integrate volume from any of the collectors depending on the planning of operations, rather than being dependent on transport routes.

The reprocessing units were also given collector status so that they could plan collection directly with the end-consumers. This dimension created a collection system with a duplicated activity structure towards the end-consumers, but was a response to mitigate the searching that end-consumers were practicing when returning general electric products at end-of-life. In this manner, the RENAS system was adapted to exploit the serial interdependencies within the returning of general electric products. The result being that the RENAS system was able to integrate the product flows within their system. The table below gives an overview of the coordination mechanisms used in the first and the second period:

Table 7.4: The coordination mechanisms of RENAS' physical flows in two periods

	Coordination mechanisms	Characteristics
1st period	• Standardization	• Geographical areas • Specific collection sites, transport routes and reprocessing units • Focus on utilizing capacities
2nd period	• Planning	• No geographical areas • The actors decided individually how to plan the physical flow • Focus on adapting to the activities

7.5.2 Coordination of the commercial interests

The waste management company RENAS AS has the decision control in 'the RENAS system'. The waste management company has a mandate from the industry organizations to administer the system, which concerns the stakeholders on one side and the collection system on the other side. The interests of the stakeholder groups (and specifically the members) are to achieve a high collection rate at the lowest possible costs.

The members have *formalized* contracts with RENAS. The contracts specify the obligations that RENAS undertakes on behalf of the members, and the fee that the members have to pay in return. The membership contract has not been changed over the two periods, and RENAS underlines the importance of treating the members equally with respect to fees and obligations. In order to facilitate the memberships, RENAS started arranging membership seminars in the second period, in order to give members information about the activities in the RENAS system. A seminar is held once a year. The first year it was held (2002), it held in Oslo but over the years the seminar has been held at a number of different locations (the larger cities in Norway). Thus, the seminars enable RENAS to establish *norms* towards the members, and the coordination mechanism has been strengthened during the second period.

RENAS have been given the responsibility and mandate to organize the collection system. In this respect, RENAS is the negotiating partner for the operators in the collection system. RENAS' role has not changed over the two periods. The RENAS system may, therefore, be characterized as being coordinated with *centralization*. The figure illustrates:

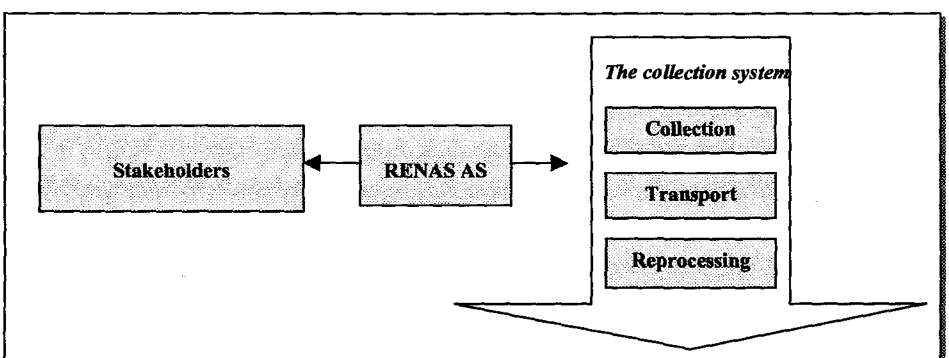

Figure 7.12: RENAS as a centralized authority of the RENAS system

In the first period, in addition to RENAS having centralized decision control, the operators were also coordinated with the governance mechanism of *formalization*. The operators were given formalized agreements, with defined operating standards, reporting system and compensation model. The compensation model was structured in a manner where RENAS expected the costs and income for the system to be reported to them for each operation, and that the total cost of the system was to be added up. The communication between the operators was also to be directed through RENAS, in order for the company to be in control of the system. The governance of the system resembled, in this way, a control level similar to that of a hierarchy.

In the second period, however, the coordination of the commercial interests of the system had changed. The operators were still coordinated with formalization because the agreements with RENAS that detail the operating standards, reporting system and compensation model were highly formalized. The operations, however, were not directly controlled. In order to secure the quality of these activities, RENAS expected their partners to have ISO 9001 and 14000 certifications. The actors themselves identified with whom to cooperate and where to operate. The volumes had to be reported to RENAS every month and based on these reports the actors were compensated. The compensation model was changed from a gross amount to compensating the operators based on a net amount, where RENAS did not expect any refunds from the actors. The actors were compensated based on registered collected volume. The fact that the actors competed (no geographical areas) provided RENAS with comparative data. Based on these data, RENAS was able to evaluate the actors' performance. The governance changed from monitoring behavior to rewarding outcome. In this way, *incentives* were also used to coordinate commercial interests in the RENAS system.

In the second period, the operators had to identify with whom and how to cooperate. In this manner, RENAS gave the operators the opportunity to develop *norms* in the relationships. The operators were given a defined compensation for collected volumes from RENAS, and in the second period the operators started trading and negotiating with each other. The operators were able to speculate on the level of volume that they were able to collect, and use this volume when bargaining with the other operators. As a consequence, the collectors were stimulated in actively finding volume in the market and the reprocessing units were able to bid for volume. The operators' performances were to a larger degree dependent on their own effort in the second period than in the first.

RENAS started to arrange seminars for the collectors and for the reprocessing units. In these seminars, RENAS communicated the performance of the system as a whole, and use the arena as to discuss challenges and clarify expectations. The operators were also given the opportunity to exchange experiences with each other. The seminars are arranged once a year. The seminar contributes, in this sense, to the creation of a common understanding of the systems, and facilitates the creation of *norms* in the system.

The commercial interests in the RENAS system had in other words changed from being coordinated with a high degree of control in the first period, to being coordinated with a balance between control, incentives and norms in the second period. Rather than resembling a hierarchy, the RENAS system in the second period is better characterized as a network of actors, where RENAS' decision control has also been decentralized to the operators. The table below summarizes this:

Table 7.5: The coordination mechanisms of RENAS' commercial interests in two periods

	Coordination mechanisms	**Characteristics**
1st period	• Centralization • Formalization	• Communication directed through RENAS • Gross compensation model • Activities specified in detail in contracts
2nd period	• Centralization • Formalization • Incentives • Norms	• Communication directly with each other • Communication at seminars • Net compensation model • Focus on certification rather than detailing activities

7.5.3 Coordinated action

In the following we analyze the combination of coordination mechanisms in the RENAS system, and the ability of these mechanisms to coordinate the system as a whole and achieve coordinated action.

The RENAS system changed over the two contract periods in our study. The coordination of the physical flow changed from being based on standardization to being based on planning. The governance of the commercial interest changed from being mainly based on hierarchical mechanisms to being mainly based on a combination of hierarchical mechanisms, incentives and norms. The table below summarizes the coordination mechanisms in the RENAS system for both periods.

Table 7.6: An overview of the coordination mechanisms in the RENAS system

	1st period	2nd period
Coordination of physical flow	• Standardization	• Planning
Coordination of commercial interests	• Centralization • Formalization	• Centralization • Formalization • Incentives • Norms

The coordinated action in the system improved from the first to the second period. After changing the system, RENAS reported an increase in collected volume by 50 % and a decrease in cost of 50 %. RENAS had been able to fulfill the demands of the authorities within the first five years of operations, as the collection rate passed the 80 % level. The system had in other words achieved the system goal. The explanation of the effect can be found in the coordination of the system.

It was demonstrated in the RENAS system that *standardization* was not a suitable coordination mechanism for the physical flow. The products were not returned to the collection sites as expected, because of the rest value of the general electric products at end-of-life. The end-consumers demonstrated that they wanted to recap the rest value of the products. The fact that the main group of end-consumers in the RENAS system was from the business-to-business market strengthened this behavior. This characteristic meant that larger volumes could not be returned from fixed locations, but from different sites (i.e. companies) and the system had to adapt to these sites. The collection pattern was variable both in volume and location on each collection task. The interdependencies between the activities were different from what the RENAS system had assumed. It was not a question of utilizing some common resource (like a collection site) but one of finding a solution of how to handle each delivery (adapting collection facilities, transport and separate deliveries to a reprocessing unit).

RENAS was, however, a cost center and a non-profit based company, and their mandate was to get the highest possible collection rate at the lowest possible costs. As a consequence, it was important for the company to have a close control of the costs. In this manner, the interaction effect between standardization and centralization and formalization provided the company with control. However, they developed a system that achieved control rather than the collection rates they desired and the system, therefore, did not achieve coordinated action.

In the second period, the actors were allowed to adapt to the inherent logic of the physical flow. The operations were based on *planning*, as the volume was generated from a changing pattern of locations. Consequently, it was difficult for RENAS to formalize standard operations of conduct for the operators because the operations changed for each collection task. On account of this, it was necessary to adapt the system with an outcome-based contract, which strengthened the incentives in the system.

The system experienced some degree of overlapping activities, as the reprocessing units were also given status as collectors. In some cases, the reprocessing units may by-pass the collectors. In such cases, the reprocessing units outbidd the collectors because the cost of direct delivery is lower (i.e. one handling step is skipped). The reason for permitting this overlap lay with the end-consumers. The fact that they did not distinguish between the different operator roles and that they were the ones who initiated the bidding between the actors pointed to the need to let the reprocessing units double as collectors. Additionally, the initiative for returning products lay with the end-consumers. Therefore, it was considered better for the system as a whole that the volume was returned to one of the actors, rather than it being traded outside the system. The waste management company took, in this respect, the perspective of the whole system and allowed this internal competition. The common interest was prioritized, which was to the advantage of some individual actors. However, this was to some extent counteracted, as the actors were allowed to, and expected to, take the initiative to find volumes.

The operations in the system were facilitated by the development of norms. The fact that the actors were able to negotiate directly with each other provided them with the possibility to build norms based on comparing expectations and experiences. As an example, there was a certain understanding between collectors and reprocessing units on the type of activities in which they engaged. The seminars initiated by RENAS also facilitated such development.

We argue that there was an interaction effect between the coordination mechanisms that contribute to coordinated action in the RENAS system. The planning was facilitated by a balance in the governance mechanisms that were implemented to coordinate the commercial interests between the actors in the RENAS system. That is, it was expected that planning would be difficult under the high level of control that RENAS exercised in the first period. The ability for the actors to negotiate directly with each other made it possible to plan the physical flows to a greater extent. Thus, the interaction effect contributed to the RENAS system achieving the system goal and coordinated action in the second period.

7.6 Case summary

In this chapter we have presented and analyzed the RENAS system, a reverse distribution system that has been established to collect and reprocess EE-products at end-of-life within the categories of general electric. We have presented the case in accordance with two contract periods, showing how the physical flows and commercial interests of the system have been coordinated.

The physical flow in the RENAS system was coordinated mainly through standardization in the first period, with the utilization of collection sites, transport operators and reprocessing units assigned to defined geographical areas. The commercial interests were coordinated through a high level of control, where the governance mechanisms of centralization and formalization were utilized. In many respects, the choice of governance mechanisms resembled a hierarchy.

The RENAS system changed its coordination in the second period. The physical flows were coordinated with planning, and the activity structure was to some extent duplicated and organized through collectors and reprocessing units. The commercial interests were coordinated with the governance mechanisms of hierarchical mechanisms but balanced with incentives and norms.

In comparison to the first period, the RENAS system experienced an increase of 50 % in collection rates and a decrease of 50 % in costs during the second period. During the second period, the RENAS system was able to collect more than 80% of the EE-waste from general electric products. It is our reasoning, therefore, that the interaction effect between the coordination mechanisms of physical flow and commercial interests made it possible to reach the system goal for the RENAS system.

8. Case 3: The independent systems

In this case we discuss the independent systems. The case consists of two waste management companies that have been established outside the industry agreement. The waste management companies are Eurovironment AS and RagnSells AS. The companies operate their separate collection systems but they also cooperate. We therefore present these systems in one case description.

The waste management companies have not operated with contract periods in the same way as the El-retur and RENAS systems. However, the independent systems have been in place during the same timeframe as the systems within the industry agreements. The independent systems have also changed over the period 1999 to 2004. Therefore, we present the cases and address the changes in a similar fashion to the previous two cases.

Eurovironment AS was established based on an initiative from a branch of ICT equipment importers. The companies were initially members of Elektronikkretur but found that the collection system in El-retur did not fit their needs. Eurovironment AS was established in order to organize a collection system for products that were the responsibility of these companies (i.e. producer responsibility for ICT equipment).

RagnSells Elektronikkgjenvinning AS[58] was a waste company prior to the EE-regulation and industry agreement, and had a portfolio of customers from whom it collected EE-products at end-of-life. RagnSells continued with its operations within the new business setting. That is, RagnSells was registered as a waste management company with the authorities, and the customers were registered as members.

The independent waste management companies performed several types of waste management. Eurovironment's operation was within *reuse* and *recycling* of EE-products, while RagnSells performed *recycling* of EE-waste at end-of-life. The cooperation between the companies concerned exchange of fractions, which means that Eurovironment sends some fractions to RagnSells for recycling. RagnSells has facilities to perform some recycling activities that Eurovironment does not. The change in the relationship concerned the spectrum

[58] We use the name RagnSells for short.

of activities. That is, over the period, Eurovironment extended its activities within recycling, and the cooperation with RagnSells included fewer recycling activities towards the end of the period.

We refer to the collection systems as 'the Eurovironment system' and 'the RagnSells system'. We present the systems separately, but analyze them as one case. The presentation follows a similar structure to that of the physical flows and commercial interests discussions of the first two cases.

8.1 The Eurovironment system

The Eurovironment system consists mainly of two privately owned companies, Eurovironment AS and Miljøfabrikken AS. The companies were established in the spring of 1999. Eurovironment AS is the waste management company, and Miljøfabrikken AS is a reprocessing unit. Miljøfabrikken is a fully owned subsidiary of Eurovironment AS. The actors in the Eurovironment system believed that it was necessary to have an incentive of making profits in order to find the most efficient solutions. In this sense, the Eurovironment system is a profit-based system[59].

Profits are generated both from the reprocessing facility and the waste management company. Means are retained in the system for expansion purposes. In addition to Norway, the system has also been established in Sweden, and there are plans to expand into Finland. The goal is to expand into more European countries when the EU's WEEE-directive is launched.

Eurovironment AS has four employees. In addition to the general manager, there are two who are engaged in sales work, and one who is responsible for logistics. The Eurovironment system also operates a membership program and the members are primarily ICT companies. A few of the largest member are represented in Eurovironment's board of directors.

Some of Eurovironment's employees and initiators own the company. At time of establishment there was a discussion as to whether the members should own the company. However, this turned out to be a difficult solution. The ICT industry is characterized with

[59] As compared to the non-profit based waste management companies.

frequent changes of companies, and it was decided that the waste management company should not have to relate to these frequent changes in the owner structure. Also, it was argued that collection of EE-products at end-of-life was not a core function for the ICT companies as they are focused on the marketing and selling of products. Each company also had to be able to choose freely between the systems and ownership would prevent this to some degree.

The goal of Eurovironment was to set up a low cost system and become a preferred waste management company for ICT companies. The system competes with the El-retur system in general, and Elektronikkretur AS in particular. The products collected within Eurovironment's operations are also covered by the El-retur system. Therefore, the companies that join Eurovironment as members are also potential members for Elektronikkretur. Eurovironment made the following arguments for the establishment of the waste management company and the collection system[60].

- *Flow of ICT goods are different from that of other consumer electronics*

The handling of ICT need different and additional activities compared to other consumer electronics. One major difference is the need to delete data in computers before dismantling.

- *The highest share of ICT products are primarily returned from commercial rather than private end consumers*

The highest share of ICT equipment is used by and is returned from commercial end-consumers. It was assumed that retailers/shops and municipalities were not relevant collection sites for commercial end-consumers. Rather, other solutions were needed.

- *Disagreement with the reporting procedures within the industry agreement*

The industry organizations decided to use customs in order to register the volume that was imported into Norway. The ICT companies (within Eurovironment) found the registers of the customs dissatisfactory. The numbers, weights, and volumes were not necessarily correct. The ICT companies (within Eurovironment) wanted to report this information directly to the waste management company.

- *Disagreement concerning the fee in the systems*

The ICT companies believed they could do a more efficient job with the money (the fees) that they had to pay to the El-retur system.

[60] Taken from the interview with Eurovironment.

Eurovironment concentrates on collection of ICT equipment. This includes PC's, monitors, printers, mobile phones etc. Borderline product categories are also included (e.g. electronic cameras) if the flows make it convenient.

Eurovironment AS faces stakeholders in the same manner as the other waste management companies. Eurovironment has to report to the authorities in the same manner as the other waste management companies (collection rates and members). Eurovironment also has an interest in demonstrating to their members (and potential members) that they are able to fulfill these demands. As of June 2002, Eurovironment had approximately 20 members.

The 'Green Team' is a council that consists of one representative from each of the members. The team meets once or twice a year. In this forum, general information and issues concerning the system are presented and discussed, e.g. general strategies, joint marketing and research. In some cases, Eurovironment also has meetings with the members individually. Members may want to do individual campaigns and may want to include Eurovironment. However, in order not to differentiate between members, Eurovironment does not initiate these kinds of initiatives.

Eurovironment works with its members in order for them to inform their customers. As an independent system, it is important for Eurovironment to inform the end-consumers about the system's existence. Information may be included in brochures, on Internet sites, on the labeling of products and in a separate line on some customer invoices. Eurovironment also organizes separate marketing campaigns concerning the collection system.

Eurovironment charges its members for the activities of the collection system. The prices are decided in a dialog with the Green Team. Once a year they agree on the price per unit (product). The price is based on the weight of each product and is standardized across products and brands. The members report their market share to Eurovironment and, based on this figure, Eurovironment calculates the cost for each member. The weight is registered at the time of arrival at the reprocessing unit (Miljøfabrikken). Eurovironment then sends invoices to the members for the cost of the system.

8.1.1 The physical flow

The Eurovironment system has to provide a nationwide system in the same manner as the systems within the industry agreement[61]. However, in the Eurovironment system the products are collected at the site of the end-consumer. They do not have fixed collection sites. Primarily, they work with commercial end-consumers (business-to-business) and have identified the collection sites as "where people work":

"Our belief is that the place where people work is the most relevant collection site, and also we believe this is where the largest volume is generated. The private end-consumer are not clever in getting rid of products, it is rather stored at home. In addition, we focus on reuse of products. Collection at companies we are able to get a higher volume of products that is reusable. It is important to get a hold of products for reuse as early as possible." Eurovironment

If private end-consumers want to deliver their products to the Eurovironment system, they have to provide the initial transport to a specified site. At some sites, Eurovironment has placed cages for collection. These sites are terminals of preferred transport operators:

"We want the customers to get in contact with us, and then we can decide in cooperation where it is better for them to deliver the products. It may be at a transport operator, using the postal services, a retailer etc. Because the customers are spread out we have to identify the solution that fit each end-consumer best." Eurovironment

"We pick up volume at retailers, however the volume is limited. We work with mobile phone retailers in particular. We have established a number of 'environmental-stations' at our regular customers (larger companies and public administration). We encourage the employees to bring their private products to the collection sites we have established at their workplace. In this manner, both the company and the individual may be certain that the data in computers are sufficiently erased." Eurovironment

The system has not established an infrastructure of collection sites, but plan for each delivery of waste independently. In other words, Eurovironment is engaged in activities in the collection system that concern planning of return from end-consumers, information, transport broking and sale of products for reuse. The collection system is organized through the reprocessing unit (Miljøfabrikken AS). The reprocessing units organize the transport in the local market and the waste management company buys national transport on the spot market:

"We have our own transport brokers to buy transport for the volume throughout the country. Oslo is a high-density area, where we utilize our own vehicles." Eurovironment

Initially, when it was first established, the Eurovironment system reprocessed products for reuse and sent all the products for recycling to RagnSells for reprocessing at. However, over time the Eurovironment system has also begun to reprocess products for recycling and has thus reduced the shipments to RagnSells:

"If the products are dismissed for reuse, they are sent for recycling. In the beginning we cooperated with RagnSells, but now we do the recycling internally. We only ship the monitors to RagnSells, because we do not have the facilities to dismantle monitors." Eurovironment

The waste management company sells the products for reuse to brokers, while the materials for recycling are sold to the secondary materials market. The collection system can be illustrated as follows:

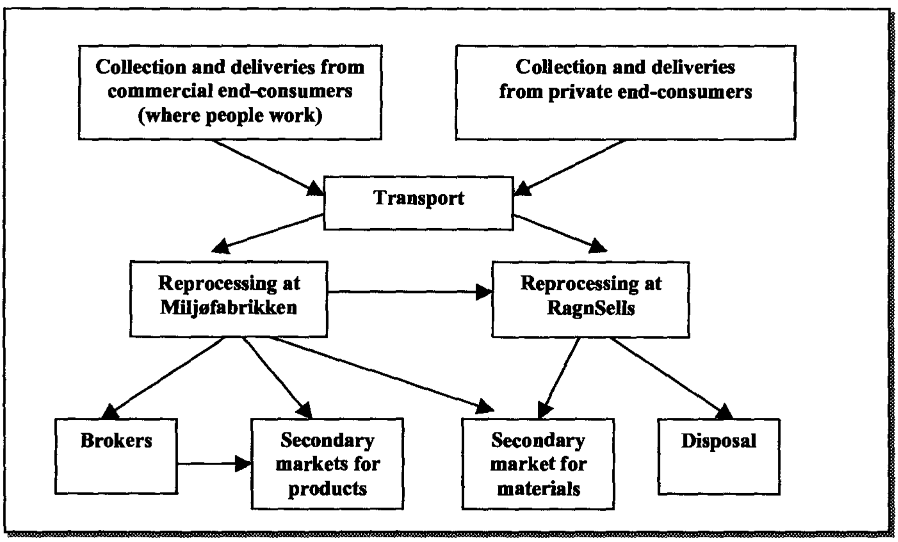

Figure 8.1: The reverse distribution systems for the Eurovironment system

The system has maintained the same overall structure over the whole period, but has added activities in order to reprocess products for recycling. As a part of the reprocessing, data cleaning is a large part of the business. The company is certified to reprocess computers with

~~[61] This is a demand in the EE-regulations.~~

classified information (e.g. from defene and public offices). As such, quality transport is important. If the products are "thrown into containers", they are impossible to reuse. It is also difficult to delete data and recycle these products. The goods are transported in cages, which protect them to some extent. There is a low degree of damage created by the transport itself. Close communication with the end-consumers prevents damage. Collecting at the site of use (where people work) is an advantage. Direct transport raises the quality of the returned products. The activities in the system are shown in the table below, and the added activities are illustrated in italics.

Table 8.1: The activities in the Eurovironment collection system

Process:	Comments regarding activities:
Collection	• End-consumer(s) and Eurovironment plans the delivery of products • Products may also be picked up at agreed collection sites
Transport	• Eurovironment plans the time of transport with the end consumer • Provides cages for transport • Eurovironment organizes the transport and plans for delivery at the reprocessing unit
Reprocessing	• Receive and sort (i.e. separating cables, batteries, toner cassettes, hard disks, packaging) products • Categorize and register products (evaluating the reuse possibilities) • Data cleaning (degassing or software cleaning) • Repair, testing of equipment • Installation of new software • Rebuild for reuse • *Dismantle the products categorized for recycling** • *Sort into fractions of materials**
Sales to the secondary market	• Find brokers and/or secondary markets for reuse • *Accumulate materials to 'a shipment load'** • *Find markets for secondary materials**

* New activities towards the end of the period

8.1.2 The commercial interests

The Eurovironment system is fully owned by one company – Eurovironment AS. The waste management company has therefore full control over the operations. The company has a mandate from a selection of EE-companies to handle their responsibilities according to the EE-Regulations. The system has been established as an independent initiative.

The Eurovironment system tries to establish relationships with customers (specifically commercial end-consumers), through information, marketing campaigns and in coordination with the members. Planning of return also includes coordination with members. When members prepare tenders for the customers, Eurovironment may include an offer to collect the product being replaced: If members compete, the offers of return are identical, as Eurovironment may be included in a number of tenders. A challenge is to get the attention of the sales personnel (who prepare the tenders) about Eurovironment's services:

"We get the largest volume through our members. When they sell new volume, they include an offer to take back the old volume, and ship this to our reprocessing unit. Not all our members are familiar with our company, and we need time for all the sellers to get to know this possibility." Eurovironment

The system is open for deliveries from end-consumers, as they can deliver the products free of charge to the collection system. Eurovironment covers the cost of the collection from commercial end-consumers but expects private end-consumers to deliver their products to a collection site. Eurovironment can pick up the products at the end-consumers premises but, if it does so, then a transport cost is charged. The cost is standardized across the country, as the authorities demand a nationwide collection system:

"We may have costly transport assignments, because its not supposed to cost more or less depending on where you live. In this manner we subsidize some of the transport. However, that is how it is. We are satisfied with our system." Eurovironment

The Eurovironment system runs an internal transport service in the areas with high population density (close to Oslo). The transport for the rest of the country is bought on the spot market. An internal transport service makes it is easier to trace products, which is important when it concerns data security. It is difficult to achieve such controlled (or 'closed') transport over the longer distances.

Eurovironment cooperates with other waste companies. If these companies collect any ICT equipment, they may return it to Eurovironment free of charge, as long as they cover the transport cost. This generates approximately 14% of the volume each year.

Shopping for spot market transport capacity keeps the transport cost down. Eurovironment is able to achieve a 50% discount, and even more on return freight. Eurovironment tracks down available transport from a number of suppliers from a pool of potential operators. An inquiry is sent to several actors for each task. Based on the feedback, the most 'optimal' solution is selected. The goods are either transported directly to reprocessing or via terminals in order to gather larger volumes. For small volumes, Eurovironment uses the postal services. Depending on the needs, a timeframe of between two to three weeks is used to schedule the transport operation. If end-consumers need an urgent removal of the goods, low cost transport may be difficult to find. In most cases, however, time is not important[62].

The Eurovironment system is based on an internal reprocessing unit, although, at the outset, the system was dependent on RagnSells' dismantling activities for recycling. As the scope of the reprocessing activities at Miljøfabrikken has increased to include dismantling for recycling, so the cooperation with RagnSells has decreased.

Eurovironment has different outlets for its products. The Eurovironment system focuses on reprocessing activities rather than sales. Brokers are used for some purposes, primarily for larger volumes. Products are sold to selected customers, such as schools and voluntary organizations. The markets are selected in close cooperation with the Green Team and the member companies. Eurovironment keeps clear of markets that could generate conflict of interests with their members.

The Eurovironment system is, in this respect, a system where the waste management company is directly involved in the collection system.

8.2 The RagnSells system

The RagnSells system consists primarily of one company – RagnSells Elektronikkgjenvinning AS. RagnSells is a privately owned waste company. The company is part of a larger group of companies that operate within the broader spectrum of the waste industry[63]. The group has joint functions like sales, marketing and accounting.

RagnSells is both a waste management company and a reprocessing unit. RagnSells operated as a waste company prior to the industry agreement and the EE-Regulations. RagnSells has no specific branch of EE-companies as members. The RagnSells also had a customer base when

[62] Time is dependent on the situation. If a company is moving, it may be that they have to remove old products within a limited timeframe and, as such, need immediate services. Products that are returned on a continuous basis need less capacity and may be more flexible regarding time.

[63] All the companies are named RagnSells, but the unit discussed in this case has specialized within waste from electrical and electronic products. However, for simplicity's sake, we refer to the company as RagnSells, and the others as companies in the RagnSells Group.

the EE-Regulations and industry agreement were established. RagnSells decided to continue its collection system based on the existing customer relations:

"We were in the business of recycling EE-products prior to the EE-regulations, and our customers wanted to continue their relationship with us. The customers are satisfied with the job we do for them, and they want to keep things as they are." RagnSells

RagnSells has five employees, one of whom is administrative (the manager), while the others are operative (i.e. work on the reprocessing of products)[64]. RagnSells takes back consumer electronics primarily, and focuses on ICT equipment. The company has approximately 5-8 % market share. The collected volume was approximately 2000 tonnes of EE-products at end-of-life in 2002. As with the other systems, RagnSells has to report its members, volume and the system's fulfillment of the demands in the EE-Regulations to the authorities.

The RagnSells system is based on making profits[65] and makes earnings on collection, handling, transport and dismantling of the returned products. Large reusable volumes may be collected free of charge (the income from the sale in the secondary markets covers the costs). The income from materials is also a part of the funding of the system. The waste management company, therefore, pays close attention to the prices in the secondary markets, accumulates volume, and tries to sell materials when prices are at a peak.

8.2.1 The physical flow

RagnSells has specialized in collecting EE-products at end-of-life from the site of the end-consumer. The idea is to provide each of their customers with an individually designed collection service. The customers are primarily commercial end-consumers.

RagnSells argues that their competence is in knowing how to handle the products at the site where the products are used. In this sense, it is possible to provide a high degree of flexibility and to get the highest possible value from the collected products. The products are often taken directly from their place of use to the secondary markets. RagnSells argues that intermediaries are costly and increase the probability of damaging the products:

[64] As of 2002.

[65] As compared to the non-profit based systems within the industry agreement.

"We are a flexible actor. We adapt to the customer. Products are dismantled at the site of the customer in order to make it most convenient for them and most profitable for us. We deliver the goods directly to the secondary markets rather than taking the products to a collection site. An intermediary is costly. Transport and handling is what costs money in the collection system. We solve this elegantly when collection the products at the site of the end-consumer and delivering the products directly to the secondary market operators. In addition, its possible for us to take back other types of waste for the end consumer." RagnSells

In addition, the RagnSells system utilizes the collection sites within the RagnSells Group. There is a transport operation within the RagnSells group, which is utilized for the collection of EE-products. Beyond this extended network of RagnSells companies, services are bought in the market. This especially concerns transport from sites that the RagnSells network does not cover.

Volume is also generated from the Eurovironment system (physically from Miljøfabrikken). When the EE-Regulations first came into force (July 1st 1999), RagnSells took on all the recycling activities for the Eurovironment system. However, over the period, the number of activities has reduced. RagnSells has not changed the scope of its activities over the period. The collection system can be illustrated as shown below:

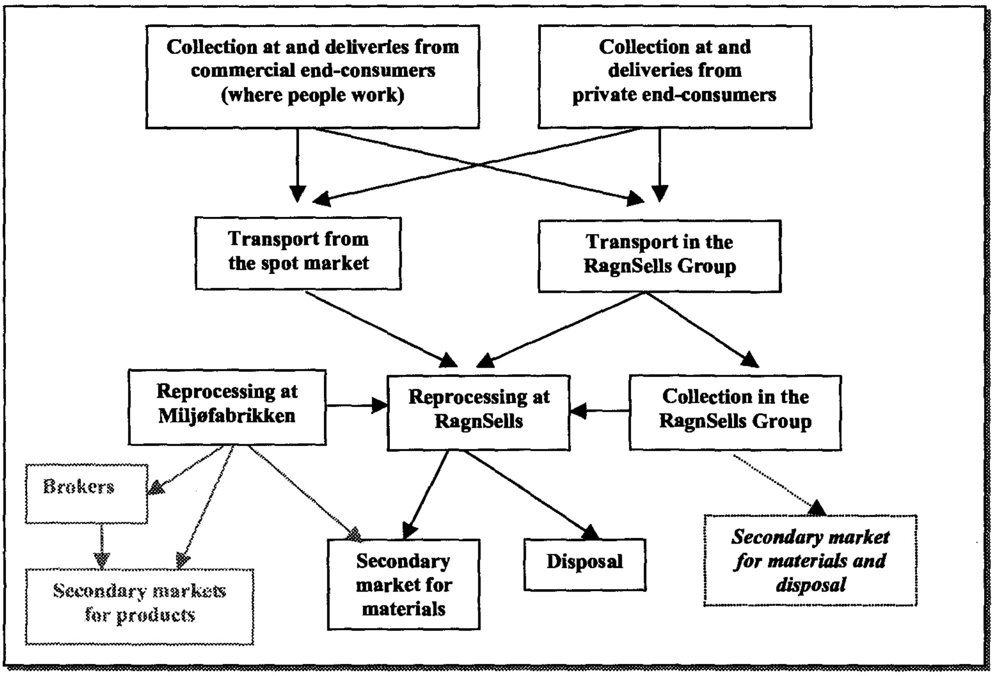

Figure 8.2: The RagnSells reverse distribution system

The activities that are performed in the RagnSells system are summarized in the table below:

Table 8.2: The activities in the RagnSells collection system

Process:	Comments regarding activities:
Collection	• Pick-up and dismantle the products at the site of the end-consumer(s) • Customers with a regular volume of waste may rent cages for collection of EE-products • End-consumers may also deliver products to the collection sites provided in the larger RagnSells system
Transport	• Utilize transport from the larger RagnSells system (RagnSells transport) • Buy transport in the spot market (from one preferred transport provider)
Reprocessing	• Dismantle products into different fractions of materials • Sort the materials into approximately 40 fractions
Sales to the secondary market	• Accumulate fractions into shipment loads • Trade fractions in the secondary markets when the price is right

8.2.2 The commercial interests

The RagnSells system existed prior to the EE-Regulations and industry agreement, and was registered with the authorities when the regulations came into force. RagnSells continued its operations, and have not changed to any extent over the five-year period. The RagnSells system consists of one company. The system is as such in full control of the operation:

"We are both a waste management company and a reprocessing unit. We have two functions. To some of our customers we operate as a waste management company, and to some we are a reprocessing unit." RagnSells

RagnSells tries to establish relationships to commercial end-consumers. The RagnSells system has not established collection sites but endeavors to pick up volume from the site of the end-consumer. However, it is not easy to get information through to the end-consumers:

"I have found out that it is better that I provide the brochures and information that the companies selling consumer electronics can supply to their customers. It is difficult for us to get information through to the customer. Information is a problem. Especially, to get accurate information through to the customer." RagnSells

RagnSells decides how to organize the collection from situation to situation. Transport is provided either internally or bought from the market. As part of the RagnSells network, there is an internal transport operation but collection from locations, which are not covered by the RagnSells network, is bought from transport service providers.

The company cooperated more extensively with Eurovironment at the beginning of the period than at the end (cf. presentation of Eurovironment). The RagnSells system took a fee for the collection and reprocessing of products that belonged to Eurovironment's members.

RagnSells have been in dialog with the authorities regarding the fulfillment of the EE-regulation. The authorities have pointed out that RagnSells does not fulfill the demands of the EE-Regulations (Aftenposten August 6th 2004, SFT March 29th 2001)[66]. The deviations are tied to three aspects. First, the authorities argue that the general public does not know about the system; second, the system is not sufficiently developed to cover the entire country; and, third, the collection rate is too low.

8.3 Coordination in the independent systems over the five-year period

The independent systems have been in operation during the five-year period after the EE-Regulations were launched. The systems are more or less run by the waste management companies. The Eurovironment system has established a separate reprocessing unit and it is fully owned by the waste management company. In the following, we discus the coordination in the systems.

The collection functions in the independent systems are not based on a defined structure of collection sites. They have based their systems on a direct relationship with primarily commercial end-consumers (companies), i.e. "where people work". The products are preferably picked up from the site of the end-consumer. The reason for this is twofold: first, it is where the large volumes are generated and, second, it is possible to prevent unnecessary damage. The waste management companies have identified that it is important to gain control of the products as soon as possible after it has been decided that the products are at end-of-life. This is in order to recover the highest share of value and minimize the operations costs:

[66] References in appendix C

"The idea is to get a hold of products as soon as possible, because then it is a highest chance to get the highest value from each product. If the products are mixed with other types of waste like banana peel, or left in the rain, it is not possible to reuse any of it." Eurovironment

"We often prefer to get the products from the site of the end-consumer, because then we can reduce costs in handling and transport. The end-consumer does not know how to handle the products." RagnSells

Data security is an issue when it comes to ICT. Eurovironment argues that when it is able to collect the products from the site of the company, it is also able to provide better security for the companies. In this respect, the coordination aim is to adapt to each customer and collect products from the site where the products are used:

"Our main concept is to pick up products "where people work". However, we have an offer to all the municipalities and the retailers of ICT equipment to collect products at their premises for free. It is a standing offer." Eurovironment

"Our advantage is that we collect the products at the site of the end-consumer. We do not have collection sites. We collect EE-waste where it is generated." RagnSells

However, if end-consumers want to deliver products to the systems, the waste management companies have made systems for such collection. These collection sites are to some extent ad hoc:

"We want the customers to get in contact with us, and then we can decide in cooperation where it is better for them to deliver the products. It may be at a transport operator, using the postal services, a retailer etc. Because the customers are spread out we have to identify the solution that fit each end-consumer best." Eurovironment

In this respect, the products flows are coordinated within the independent systems, both in direct delivery and through ad hoc collection sites. The systems, therefore, are flexible, but also demanding. They are demanding in the sense that each collection site (customer) is given an individual focus. The next illustration provides an overview of this:

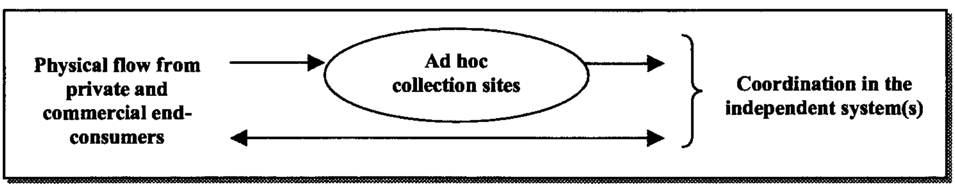

Figure 8.3: Coordination of the collection function in the independent systems

The independent systems use both internal and external transport services for collecting products. In the Eurovironment system, an internal transport service is used in the high-density area because it is possible to utilize the capacity. Throughout the rest of the country, the transport operations are bought on a spot basis from transport operators. RagnSells utilizes the internal transport service within the larger RagnSells Group and buy spot market transport. We can as such summarize that the flows are coordinated.

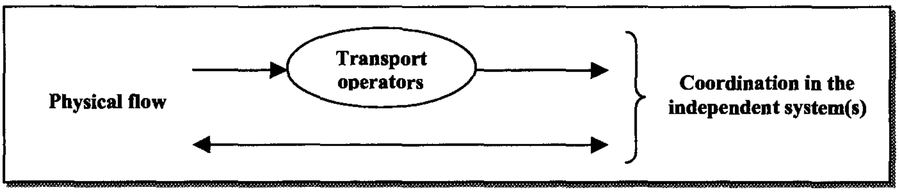

Figure 8.4: Coordination of the transport function in the independent systems

The reprocessing units are fully owned in the independent systems. The waste management companies are directly involved in the operations. The reprocessing units within the Eurovironment system and the RagnSells system were complementary at the beginning of the period (from 1999):

"We do not compete with Eurovironment, rather we collect and reprocess products for them. We are a complement to their business. They do not want to receive all the products, because not all of it is going to be reused. We take care of the products that are destined for materials recycling." RagnSells

Toward the end of the period (c. 2004), however, the activities begin to overlap. The Eurovironment system extended its scope of reprocessing activities from reuse to include both reuse and recycling. The change was an efficiency argument. It was more efficient (lower costs) for Eurovironment to perform reprocessing for recycling in house than sending the products to RagnSells:

"There is a margin for us to do these activities in-house." Eurovironment

The Eurovironment system takes all the products through the reprocessing unit. The products are sorted into reuse or recycling and reprocessed accordingly. The products are subsequently sold to the secondary market via brokers for products destined for reuse, and to the secondary market for materials for the fractions.

The reprocessing within the RagnSells system can be performed at the site of the customers or at the reprocessing unit. The materials flow, in this sense, via the reprocessing units and directly to the secondary market.

For Eurovironment, all the products and materials are taken through the reprocessing unit, while RagnSells handles both direct delivery and takes the products via the reprocessing units:

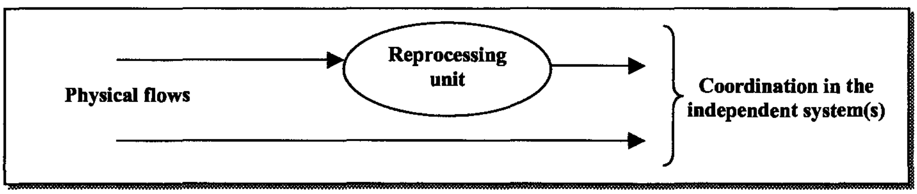

Figure 8.5: Coordination of the reprocessing function in the independent systems

8.4 Performance in the independent systems

In this section we comment on the level of integrated activities and the degree of aligned behavior in the independent systems and the system performance variables.

The waste management companies are responsible for collecting 80 % of their share of the EE-waste. The *system goal* is the same as for the reverse distribution systems within the industry agreements. The Eurovironment system has already achieved the 80 % collection rate goal (as reported by Eurovironment), while the RagnSells system has not. An overview of the volumes is provided in the tables on the next two pages.

Table 8.3: Collected volume in the Eurovironment system from 2001 – June 2004

Nr:	Category:	Total volumes 1999-2002	2001	2002	Total volumes 2003	2003	2004 (per June)
1	Vending machines	470			470,0	-	-
2	White goods	28 493			29 413,0	-	-
3	Brown goods	11 000			11 000,0	11,0	5,5
4	Cabling and wiring	13 000			12 330,0	9,0	4,5
5	ICT equipment	7 800	1 522,0	2 016,0	7 800,0	2 196,0	1 098,0
6	EE-toys	1 700			1 700,0	-	-
7	Heating, air-conditioning, and ventilation	4 100			5 024,0	-	-
8	Lighting	6 700			4 340,0	-	-
9	Medical equipment	2 700			2 700,0	-	-
10	Equipment for measurement and control	11 000			5 785,0	5,0	2,5
11	Office equipment	3 400			3 400,0	-	-
12	EE-tools	12 000			14 925,0	-	-
13	Telecommunication	2 400			2 400,0	9,0	4,5
15	Clocks and watches	300			300,0	-	-
17	Security equipment, smoke detectors	190			221,0	-	-
18	Electro equipment	9 300			9 573,0	-	-
	Total	**114 553**	**1 522,0**	**2 016,0**	**111 381,0**	**2 230,0**	**1 115,0**
		-					
	Collection rate:		**20 %**	**26 %**		**28 %**	**14 %**

Table 8.4: Collected volumes and rates in the RagnSells system from 2001 – June 2004

Nr:	Category:	Total volumes 1999-2002	2001	%	2002	%	Total volumes 2003	2003	%	2004 (per June)	%
1	Vending machines	470	63,0	13 %	49,0	10 %	470,0	32,0	7 %	15,024	6 %
2	White goods	28 493	152,0	1 %	297,0	1 %	29 413,0	611,0	2 %	465,918	3 %
3	Brown goods	11 000		0 %	18,0	0 %	11 000,0	25,0	0 %	68,280	1 %
4	Cabling and Wiring	13 000	28,0	0 %	46,0	0 %	12 330,0	16,0	0 %	8,291	0 %
5	ICT equipment	7 800		0 %	32,0	0 %	7 800,0	26,0	0 %	18,879	0 %
6	EE-toys	1 700		0 %	4,0	0 %	1 700,0	20,0	1 %	18,217	2 %
7	Heating, air-conditioning, and ventilation	4 100	13,0	0 %	20,0	0 %	5 024,0	45,0	1 %	41,081	2 %
8	Lighting	6 700	21,5	0 %	25,0	0 %	4 340,0	212,0	5 %	179,123	8 %
9	Medical equipment	2 700	8,0	0 %	1,0	0 %	2 700,0	3,0	0 %	1,947	0 %
10	Equipment for measurement and control	11 000	4,5	0 %	6,0	0 %	5 785,0	11,0	0 %	18,141	1 %
11	Office equipment	3 400	4,5	0 %	3,0	0 %	3 400,0	11,0	0 %	14,896	1 %
12	EE-tools	12 000	31,0	0 %	91,0	1 %	14 925,0	93,0	1 %	315,439	4 %
13	Telecommunication	2 400	48,0	2 %	82,0	3 %	2 400,0	102,0	4 %	61,317	5 %
15	Clocks and Watches	300		0 %	-	0 %	300,0	3,0	1 %	3,183	2 %
17	Security equipment, smoke detectors	190	41,0	22 %	41,0	22 %	221,0	38,0	17 %	14,968	14 %
18	Electro equipment	9 300	46,0	0 %	42,0	0 %	9 573,0	60,0	1 %	48,240	1 %
	Totals: [67]	**114 553**	**460,5**	**0,40 %**	**757,0**	**0,66%**	**111 381,0**	**1 308,0**	**1,17%**	**1 292,9**	**2,32 %**

[67] The collection rates are calculated based on 100 % of the total volume, but RagnSells' responsibility is not that big. However, the exact responsibility share is not available.

The systems are small-scale operations when the collection rate and volumes are looked at. Eurovironment has collected between 1500 to 2500 tonnes per year, while RagnSells has collected between 500 to 1300 tonnes per year. Eurovironment collects approximately 30 % of the ICT category and whether this is an 80 % collection rate depends on the members' sales volumes[68]. RagnSells, however, collects volumes within all categories and this amounts to 1.17 % of the total generated volume of EE-waste (2003). Again, it depends on the members' sales volumes as to whether this is an 80 % collection rate. However, it is difficult for RagnSells to show how they fulfill the goal collection with this broad scope of volumes.

8.4.1 Performance in the physical flows

Neither of the systems has established a collection and transport infrastructure. Instead each collection task is organized on a one-to-one basis. The activities are adapted to each collection task individually and the operations costs are kept to a minimum level.

"We deliver goods directly to the secondary markets rather than taking the products to a collection site. An intermediary is costly and handling is more expensive than the recycling. Transport and handling is what costs money in the collection system." RagnSells

"We shop transport capacity in the market, and achieve in some cases a discount of 50 % or more. Knowing that there is 80 % non-utilized transport capacity going back to Oslo, it is possible to achieve a low transport cost." Eurovironment.

The independent systems have in this manner minimized the operations cost, as most of the collection and transport activities are acquired when needed. The collection systems have not established infrastructures in the sense that there are sets of collection sites and transport functions available as a part of the systems.

Customer service level has been argued to be an important part of the independent reverse distribution systems. Both Eurovironment and RagnSells argue that they have the opportunity to adapt their collection systems to the specific needs of the end-consumer, with respect to location, capacity, timing and waste management options. They argue that there is a need for such adaptations in order to ensure collection of all the volumes of waste, and to retain most of the value in the collected products.

[68] An aspect with the reuse recovery option is that the products may end up at end-of-life a second time.

8.4.2 Performance in the commercial interests

The overview of the volumes shows that the Eurovironment system has collected products within one category, while RagnSells reports volume from all categories. RagnSells has chosen a strategy where it collects whatever waste there is from its customers. In this respect, it operates both as a "waste company" and a "waste management company". Both systems have established the activity structure for the collection of EE-products at end-of-life when the need is reported from the end-consumers. In this way, transaction costs in the system arise from the need to establish and adapt a specific collection system for each collection task.

Since the waste management companies are in direct control of the systems, the alignment of behavior is not a direct challenge for the independent systems. Rather, the challenge is in the interface towards the systems within the industry agreements and the authorities. It has been argued that the independent systems do not fulfill their obligations in accordance with the EE-regulations:

"Competition is healthy. However as Elektronikkretur says; 'it has to be free competition on equal terms'. That means, when RagnSells wants to be a waste management company, they have to do what the authorities expect of them. We believe they do not fulfill the demands from the authorities." Hvitevareretur

The independent systems have a different view of this aspect, arguing that they contribute to the overall collection rate of EE-products at end-of-life:

"It is strange that they do not welcome a company like ours. We are no threat. On the contrary, we could contribute to increase the collection rate. Our system is flexible, while theirs is not. They have a system that the customer has to conform to, while our system conforms to the customer. We adjust to the customers needs, and we take care of the value in the products in the best way in this manner. We think that the products are deteriorated in the other systems. In my view they buy trash. It is not possible to retrieve valuable materials from the processes they have designed." RagnSells

"We do not want to cooperate with respect to the collection system. We think that the companies need to be able to choose between systems. That is good. However, Elektronikkretur want us to concentrate on reuse and related services, and that they collect the volume for recycling. However, this is not right for us, nor for our members. The members need to have a choice with respect to which system they want to join." Eurovironment

The independent systems are of a different kind from the systems within the industry agreement, and the disagreement concerns how they operate. The independent systems do not have collection infrastructures and, as a result, they cost less to run. In addition, Eurovironment has a reuse waste management option, which is complementary to the El-retur system. At the beginning of the period, RagnSells took on Eurovironment's recycling activities, but towards the end of the period, Eurovironment could do its own recycling. The systems within the industry agreement question whether the independent systems take on their responsibilities fully. In this manner, the reverse distribution systems within the industry agreement argue that they collect products and take on costs for the independent systems. Thus, this is a source of transaction costs, although it is generated at the interfaces between the systems.

A challenge is to get information through to the end-consumers. The end-consumers have low attention towards these types of activities in general and do not differentiate between the systems. As a result, there is a high probability that the end-consumers deliver EE-products at end-of-life to collection sites structured in the systems within the industry agreement. It is therefore argued that the independent systems free ride on the systems within the industry agreement. We return to this discussion in the cross case analysis.

8.5 Analyzing coordinated action in the independent systems

So far we have presented the case of the independent systems, including their performance. Now we go on to analyze the case in accordance with our analytical framework.

The independent systems in the case consist of two collection systems that have been in operation over the period since the EE-Regulations came into force (1999-2004). In fact, one of the systems (RagnSells) was in operation prior to the regulations. The independent systems are small-scale operations and consist mainly of one company that organizes the collection system. The independent systems have experienced growth during the period from 1999 to 2004, plus the cooperation between the systems, which was present at the beginning of the period, has decreased towards the end.

Firstly, the analysis seeks to establish the types of coordination mechanisms that are utilized for physical flows and commercial interests respectively and, secondly, we analyze to what extent the independent systems have been able to achieve coordinated action.

8.5.1 Coordination of the physical flow

The physical flow in the independent systems may be characterized as being coordinated mainly with *mutual adjustment* in the period we have studied. The independent systems do not address the end-consumers through an infrastructure (i.e. collection sites). Rather, the independent systems work with end-consumers on a one-to-one basis, adapting the activity structure to each collection task. That is, depending on the needs of the end-consumers, the independent systems arrange an appropriate combination of collection, transport and reprocessing activities.

In the Eurovironment system, the end-consumers or customers are found either through marketing campaigns or through EE-companies that have joined as members. Collection, transport and reprocessing capacities are adapted to each customer, and in cooperation with the customer, Eurovironment is able to exploit reciprocal interdependencies. The system is adapted to the needs of the customer and the capacities of the Eurovironment. The customer may return either larger or smaller batches of volumes on a continuous basis. When smaller volumes are returned from different customer locations, the Eurovironment system cooperates with a specific transport operator throughout the country in order to accumulate volume. This activity is reported to be relatively marginal but can be characterized to be coordinated with *planning*: The Eurovironment system provides the transport operators with cages and containers for collection depending on the volume, and administers transport when the collection facilities are filled. In this manner, Eurovironment exploits serial interdependencies by adapting to a selection of collection sites for small volume deliveries.

In the Eurovironment system, the transport function is managed from assignment to assignment. In this perspective, is it difficult to standardize the transport function and therefore it is necessary to maintain flexible operations. The volume is returned to one reprocessing unit, where all products are evaluated for the reuse or recycling waste management option. The reprocessing unit adapts to the capacity to some extent at the reprocessing unit but peak volumes are stored in order to level out capacity.

The RagnSells system is organized in a similar manner as the Eurovironment system. They work directly with the end-consumer, and adapt the need for collection, transport and reprocessing activities in accordance with the needs of the customers. RagnSells operates a reprocessing facility, but has reported that sometimes the reprocessing activities are also performed at the site of the end-consumer. That is, RagnSells may dismantle products at the site of the customer. The transport activities are adjusted in accordance with the specific needs of the end-consumer, but in some cases the volumes are also accumulated in the network of the RagnSellsGroup. The system is exploiting reciprocal interdependencies in the sense that the system is adapted to each customer, and coordination is achieved through mutual adjustment.

In the independent systems the waste management companies trade the products in the secondary markets. Both Eurovironment and RagnSells trade the products in the open market when they have accumulated a sufficient volume of products, and at a time when the prices are acceptable for the companies. I.e. the activities are to some extent also coordinated with *planning*, as the systems exploit serial interdependencies. The following table gives an overview of the coordination mechanisms in the physical flows of the independent system[69].

Table 8.5: The coordination mechanisms of the independent systems' physical flows

	Coordination mechanisms	Characteristics
RagnSells	• Mutual adjustment • Planning	• Collection service adapted to each customers needs in accordance with the capacities of the system • Collection sites in cooperation with the larger RagnSells system if needed • Adapting transport to each collection task • Reprocessing at the site of the customer or at the reprocessing unit
Eurovironment	• Mutual adjustment • Planning	• Collection service adapted to each customers needs in accordance with the capacities of the system • Collection sites in cooperation with transport service providers if needed • Adapting transport to each collection task • Reprocessing at the reprocessing unit

8.5.2 Coordination of the commercial interests

The waste management companies Eurovironment and RagnSells have the decision control in the independent systems. In fact, the waste management companies own and run the reprocessing units and, therefore, this operation is organized as a *hierarchy*. However, the collection and transport activities are often bought in the open market, with price coordinating

[69] The independent systems have not operated in distinct periods. Therefore we have not needed to make the same distinction as we did for the reverse distribution systems within the industry agreement.

the commercial interests. Thus, the *market* is used as a governance mechanism for collection and transport activities.

The independent systems have to a large extent included the end-consumers as part of their systems, and regard them to be, more or less, their collection sites. In the terminology of the independent systems, the end-consumers are regarded as customers. However, the linking to the customers, and thus the acquisition of collection sites, is not straightforward and can be considered to be a sales and marketing task. The systems report that two types of relationships are established with the customers. They are either project returns (larger one-time volumes) or continuous returns (smaller volume over time)[70]. Project returns include situations such as when a company moves or when equipment is replaced because of up grading, and there is a need to dispose of large volumes. Continuous returns, on the other hand, represent the day-to-day generation of waste products. Thus, the independent systems coordinate these customer relationships through both continuous and discrete *contracts*.

The independent systems relate to stakeholders in the same way as the reverse distribution systems within the industry agreement, but there are some differences. The relationship towards the authorities is similar, which includes the reporting of collected volumes and members on a regular basis. However, the systems within the industry agreement are non-profit based, whereas the independent systems are not. They are privately owned and aim to make a profit on the tasks that are performed. Thus, the owners of the waste management companies are not industry organizations. However, the Eurovironment system is related to a branch of the ICT industry, from which their members come. RagnSells, on the other hand, is a private initiative that does not relate to a specific branch of the industry but serves a selection of customers. Eurovironment has a direct dialog with the members through the 'Green Team'. RagnSells does not report to have a forum of this type. Thus, the means to secure a common understanding of the system with the members are present in the Eurovironment system, but not directly in the RagnSells system. The RagnSells system is dependent on its 'every day contact' with the end-consumers.

The coordination of the commercial interests in the independent systems has not changed to any extent over the five-year period. The waste management companies are in control of the systems, and coordinate some of the transactions through the market and contracts. Thus, in

[70] It may be noted, however, that the customers with whom they have established a relationship of continuous returns, may from time to time also include project returns.

relation to our analytical framework, there is a mix of governance mechanisms, which include hierarchical mechanisms (authority mechanisms of the hierarchy), incentives (price mechanisms of the market) and norms (discrete and continuous contracts) in the independent systems. An overview of the coordination mechanisms are given below:

Table 8.6: The coordination mechanisms of the independent systems' commercial interests

	Coordination mechanisms	Characteristics
RagnSells	• Authority • Price • Norms	• Waste management company and the reprocessing unit is one company • Transport is supplied from the RagnSells system or spot market dependent on location • Volume is collected from customers (end-consumers) of the system on a one-to-one basis
Eurovironment	• Authority • Price • Norms	• Waste management company is privately owned • The reprocessing unit is fully owned by the waste management company • Transport is supplied from the reprocessing unit in the Oslo area, and the spot market for the rest of the country • Volume is collected from customers (end-consumers) of the system on a one-to-one basis

8.5.3 Coordinated action

Now we analyze the combination of coordination mechanisms in the independent systems, and the ability for these mechanisms to coordinate the system as a whole, and thus achieve coordinated action.

The independent systems have not changed to any extent over the period of our study. The coordination of the physical flow is achieved through mutual adjustment and planning. The coordination of commercial interests is achieved through the governance mechanisms of authority, price and norms. The table below summarizes the coordination mechanisms:

Table 8.7: An overview of the coordination mechanisms in the independent systems

	The Eurovironment system	The RagnSells system
Coordination of the physical flows	• Mutual adjustment • Planning	• Mutual adjustment • Planning
Governance	• Authority • Price • Norms	• Authority • Price • Norms

The independent systems are small-scale operations compared to the systems within the industry agreement. The Eurovironment system collects products within the ICT product category, and claims to fulfill the system goal of an 80 % collection rate. The RagnSells system, on the other hand, collects products within all categories and has a challenge in fulfilling the system goal of an 80 % collection rate.

The independent systems have a specific task, however, in identifying what the collection rate is measured towards. The independent systems are established in parallel to the industry agreement and are therefore not assigned to any specific product categories. The collection rate is, therefore, a function of both the members and product categories. The Eurovironment system has been specifically designed to collect ICT equipment at end-of-life. The RagnSells system has to a larger extent collected products from its pool of customers and, therefore, the products fall within a number of categories of EE-waste.

The independent systems work with the end-consumers on a one-to-one basis, adapting the systems to the needs of each end-consumer respectively. Thus, there is a need for flexibility in the system, as the needs of the end-consumers vary. In this manner, there is an *interaction effect* between the mutual adjustment and the governance mechanisms of price and norms, with respect to adaptation to the end-consumers. As the independent systems are in direct control of the reprocessing units, it also makes it possible to be flexible with respect to these services.

However, this also limits the system to some extent. Working with the end-consumer on a one-to-one basis is demanding (high level of resources for each collection task), and this limits the possibility of achieving large-scale operations. This is confirmed based on the collection rates of the two systems. Eurovironment has focused on one defined group of products (ICT equipment) and has, in this way, been able to achieve the system goal. RagnSells, however, has experienced a challenge in this respect, which may explain why it has been difficult to achieve the 80 % collection rate.

8.6 Case summary

In this chapter we have presented and analyzed the independent systems. These are reverse distribution systems that have been established as parallel alternatives to the systems within the industry agreement. The independent systems consist of two separate systems, namely the Eurovironment system and the RagnSells system. We have presented each of the systems separately but analyzed them as one case, as the systems have cooperated to some extent over the period in our study.

The independent systems are not a part of the industry agreement but they still have to fulfill the demands of the EE-regulations. The independent systems have operated during the five-year timeframe since the EE-Regulations came into force.

The systems are to a large extent coordinated in a similar way, using mutual adjustment and a certain degree of planning for the physical flows, together with a combination of authority, price and norms for the commercial interests. The cooperation between the systems has decreased over the period. This happened when the activities within the systems began to overlap.

A specific characteristic of these systems is that they seek to link directly with the end-consumers in the collection of EE-products at end-of-life. The choice of coordination allows the flexibility needed to adapt to the specific needs of the end-consumers. However, such adaptations are also evaluated to be demanding, which may explain why the systems are relatively small-scale in terms of the collection rate.

The Eurovironment system reports that it has been able to achieve the system goal of an 80 % collection rate. The system collects EE-products at end-of-life within one type of product category, ICT equipment.

RagnSells, however, has been challenged in this respect, as it collects products within all categories and it is, therefore, difficult to identify how they have performed in accordance with the goal of an 80 % collection rate.

9. CROSS CASE ANALYSIS

In this chapter we compare the cases. We have analyzed three cases at two points in time within a five-year time frame. The El-retur system and the RENAS system have two clearly defined contract periods and we compare the systems across these two periods. The independent systems do not have such defined periods but it can be seen that they have experienced some development within the same time frame. We compare the independent systems at the beginning and at the end of this overall time period. We include the comparison between the two periods in the cross case analysis as well.

The case description and analysis show that the El-retur system and the RENAS system are fairly similar in structure and concept. These systems have been established within the industry agreement, are non-profit based and offer reverse distribution systems that cover all product categories for EE-products at end-of-life. The independent systems have been established as alternatives to those in the industry agreement, are profit-based and cover the same product categories as the systems within the industry agreement. In the cross case analysis, therefore, we begin by comparing the El-retur system and the RENAS system and then we compare these systems to the independent systems.

The analysis is structured in accordance with our analytical framework and in the same way as the case analyses. We start by analyzing the coordination of physical flows, which is followed by analysis of the coordination of commercial interests. The chapter is completed with an analysis of system performance, i.e. to what extent the reverse distribution systems achieve coordinated action.

9.1 Coordination of physical flows

The physical flows in the cases we have studied are tied to the collection systems. The collection systems have the same tasks: they collect products[71], secure transport from the collection sites to the reprocessing units, dismantle products, sort out the hazardous materials, and secure the safe disposal and secondary (re)use of products and materials. In our study, we

[71] I.e. EE-products at end-of-life

have concentrated on the part of the system, which covers collection to reprocessing, as illustrated in the figure below:

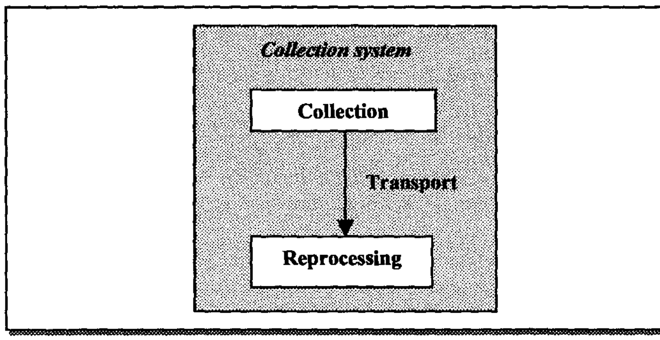

Figure 9.1: The part of the collection system that is included in our study

The collection systems in our study were organized and coordinated somewhat differently over the period of our study. In the first period, the El-retur system and the RENAS system started out in a similar way, with a high degree of standardization. The collection sites were assigned specific locations, the transport operations were adapted within geographical areas and were assigned to serve specific reprocessing units. In the second period, however, the collection systems were organized and coordinated differently. The El-retur system continued with a high degree of standardization and some planning. The collection sites remained the same and were coordinated in the same manner. The transport operations were organized in a similar way but the operators were allowed to plan with sub-suppliers. The reprocessing units were organized and coordinated in a similar manner. The RENAS system, however, changed considerably. It was organized through collectors and reprocessing units in the second period and the system was coordinated through planning. The collectors were expected to collect volumes of waste from the sites of end-consumers and to utilize collection sites if this was efficient for the operations. The collectors were expected to organize the transport operations and deliver the volumes to the sites of the reprocessing units. However, the reprocessing units were also allowed to collect and run transport operations. In summary, the El-retur system and the RENAS system established an infrastructure throughout the country consisting of collection sites, transport operations and reprocessing units.

The independent systems were based on one reprocessing unit each and were small-scale operations in comparison. The independent systems were organized differently and coordinated the operations through mutual adjustment and some planning. The collection and transport operations were adapted to each collection task. The systems changed to a limited extent over the period. The principles for organization and coordination remained the same. The table below gives an overview of the coordination mechanisms in the different collection systems for the two contract periods:

Table 9.1: The coordination mechanisms of the three reverse distribution systems

	The El-retur system	The RENAS system	The independent systems
Coordination mechanisms of physical flows 1st period	• Standardization	• Standardization	• Mutual adjustment • Some planning
Coordination mechanisms of physical flows 2nd period	• Standardization • Some planning	• Planning	• Mutual adjustment • Some planning

Coordination mechanisms are a means of achieving integrated activities in physical flows and correspondingly high performance. The mechanisms are taken from Thompson's (1967) argument about activity interdependence and variations in technologies. We have argued that the same types of variations are present in physical flows and that the mechanisms are readily applied to coordinate physical flows.

Our study has demonstrated that there are variations in the physical flows, as the collection systems in our cases are found to be coordinated with different mechanisms. The variations have become more visible over the two periods of our study as well. The two systems, the El-retur system and the RENAS system, were coordinated in the same way in the first period but in the second period the systems were coordinated differently. Thus, it is our argument that there are variations in the activity structures of physical flows and that different types of coordination mechanisms are necessary in order to achieve integrated activities and system performance.

All the physical flows in our study are coordinated in order to collect, transfer and reprocess EE-products at end-of-life. The product categories have been divided between the El-retur system and the RENAS system at the outset (cf. chapter 2), thus providing variation in the systems. It has become visible that the collection of EE-products in the El-retur system and the RENAS system face different challenges. The El-retur system collects products mainly from private end-consumers, while the RENAS system collect products mainly from commercial end-consumers.

The independent systems, on the other hand, have been established in parallel to the El-retur and RENAS systems and do not serve exclusive product categories. However, the independent systems have been coordinated to serve specific end-consumer segments. The Eurovironment system collects ICT equipment at end-of-life and has aimed to collect products from the sites of the end-consumers. The RagnSells system collects products from all categories but has aimed to collect products from the sites of the end-consumers. Thus, the independent systems have also established physical flows with specific activity structures and coordination needs.

One source of variation is, in other words, the *customer base* from which the EE-products are collected. The collection systems within our study serve different segments, i.e. private and commercial end consumers and to what extent the systems offer a pick up service. The pattern of collection varies amongst these customer segments. Thus, the activity structures necessary to serve these customer segments are different and the mechanisms to achieve integrated activities are also different. We continue the discussion with how each of the coordination mechanisms applies to the physical flows in our study.

Activities that have a linking purpose are coordinated with *the standardization mechanism* (Stabell and Fjeldstad 1998, Thompson 1967). The collection systems in our study all have a purpose in providing availability for end-consumers to return EE-products at end-of-life. In other words, the end-consumers are linked to the collection system. The El-retur system decided to use retailers and municipalities as collection sites and in this manner standardized the system to these locations. The sites linked the end-consumer to the collection system by providing local availability, and made use of the fact that the end-consumer would visit the sites for other purposes (i.e. the end-consumer is able to do more than one errand in one visit). The system was, in this way, able to create larger 'collectable' volumes as small, heterogeneous deliveries from private end-consumers were accumulated to a certain level that could justify the transport costs and provide a certain service (frequencies). The logic within the RENAS system was similar. However, they linked with business-to-business end-consumers that returned larger homogenous volumes at a less frequent rate. Therefore, the logic was to utilize regional collection sites with higher collection capacity, and the system was standardized to these locations. The El-retur and RENAS systems were both organized in geographical areas, where transport operators were assigned to service the collection sites and the reprocessing units were assigned volumes to be collected in each region. Thus, all the functions in the collection system were coordinated with standardization.

The systems experienced a lack of compliance from the end-consumers, who failed to some extent to link to the system in the way that it had been expected. The El-retur and RENAS systems faced coordination challenges in the first period. The El-retur system experienced that the end-consumers did not necessarily return the products to the collection sites as expected and the transport operators had a number of challenges in integrating collection and transport activities. The RENAS system experienced that the products were divided between two separate physical flows and, as a result, the activities were not integrated. It was in other words demonstrated that the standardization mechanisms were insufficient to coordinate the physical flows in the cases we have studied.

The RENAS system changed to utilize *the planning mechanism* in the second period. The planning mechanism is argued to be the coordination of activities that have a serial logic (Stabell and Fjeldstad 1998, Thompson 1967). In the RENAS system, this was demonstrated by the fact that the collection of EE-products at end-of-life were coordinated from collection through to reprocessing for each collection task. That is, the collection activities, transport activities and reprocessing activities were planned as one series of activities. The RENAS system experienced that the end-consumers traded the products themselves and had a need for transport. Thus, a number of the end-consumers actually planned the collection, transport and reprocessing activities. In this manner, the standardization of the functions was not adapted to the logic of the physical flow for RENAS. The planning mechanism was incorporated when functions in the collection system were integrated to a greater extent. Collection and transport activities were performed by the collectors and the reprocessing units performed all types of activities including collection, transport and reprocessing. The planning dimension was strengthened with the termination of the geographical areas.

In the El-retur system, however, the challenges bear evidence of a different kind. The end-consumers seemed to be more ignorant of the collection system. They were not attentive to the possibilities and were primarily occupied with convenience. That is, the most convenient collection point seemed to be the one utilized. This could explain why some of the products ended up at destinations other than the defined collection sites. Also, this lack of attention could explain why there was a challenge with volume at the collection sites. Thus, as opposed to the RENAS system, we argue that continuing the coordination of the collection system with standardization was the correct choice for the El-retur system. The customers do have a pattern of behavior that needs local availability. In fact, evidence of their lack of attention is an argument to make it convenient. However, in order to be able to integrate the volume that had been collected from other sites than the identified locations, the adaptation of using some planning has been evaluated as a proper additional coordination mechanism. Thus, in the El-retur system, the collection sites had a primary function in linking end-consumers to the collection system, while the transport activities had a primary function in linking the collection sites to the reprocessing units, and the reprocessing units received volumes within the geographical areas. Empirically this is supported, as the El-retur system can be argued to have increased the *standardization* somewhat in the second period, as the geographical areas were divided into smaller areas. The transport operations were adapted with an increased number of operators (one for each geographical area).

In comparison, the independent systems have organized a physical flow where some combination of collection activities, transport activities and reprocessing activities are utilized for each collection task. The coordination has been achieved with *the mutual adjustment mechanism*, where an object or task determines the logic of the activity structure (Stabell and Fjeldstad 1998, Thompson 1967). The independent systems' primary goal has been to adapt to specific end-consumer needs and therefore a fixed infrastructure for the physical flow is not relevant. The independent systems offer a set of activities that can be coordinated in a customer specific manner for each collection task. Evidence of the mutual adjustment mechanism has been found in the fact that the collection activity starts from the premises of the customers, and then the waste management companies adjust the collection and transport activities accordingly in terms of capacity and frequency. Each collection task is coordinated individually as the needs of the end-consumers are different. The products may be returned in batches (e.g. if a company replaces all its computers) or on a small-scale basis (e.g. one person replaces one computer). The choice of coordination has not changed in the independent systems over the period of our study. However, as the physical flow starts from the premises of the end-consumers, the independent systems have not faced the same challenges as the El-retur and RENAS systems in misinterpreting or wrongly adapting to the end-consumers.

In summary, we see that our three collection systems exploit different interdependencies. The El-retur system has to a large extent adapted the activity structure to pooled interdependencies, while the RENAS system exploits serial interdependencies and the independent systems exploit reciprocal interdependencies. In El-retur, the *system structure* is standardized, making it possible for consumers to link to the system. The scale effect is achieved as many consumers utilize the capacity or pool their EE-products at end-of-life. The transport and reprocessing functions are adapted accordingly, in the sense that the transport operators link a set of collection sites with the reprocessing units, and seek to reap scale economies from the transport capacity. The reprocessing units are also given defined areas to operate within in order to adapt and utilize capacity. RENAS, however, has adapted the activity structure to serial interdependencies. Planning coordinates the *flow of goods*, making it possible to adapt the collection, transport and reprocessing activities to the end-consumers. The collection is planned after the end-consumer has decided to return the products. That is, the input from the end-consumer is the condition to which the transport and reprocessing functions adapt. The independent systems adapt the collection system in a reciprocal manner to the *needs of the individual end-consumers*. The systems do not have a defined structure but their capacities are flexible depending on the collection task at hand. The coordination is, in other words, achieved through mutual adjustment between the needs of the end-consumers and the capacities of the systems. The table gives an overview of the coordination mechanisms and the perspective towards the physical flows as they were during the second period of our study:

Table 9.2: The coordination mechanisms and the perspective towards the physical flows

	Coordination mechanisms	Perspective towards the physical flow
The El-retur system	• Standardization • Some planning	• The system structure
The RENAS system	• Planning	• The flow of goods
The independent systems	• Mutual adjustment • Some planning	• The individual need of the end-consumer

The cases in our study demonstrate three ways to coordinate physical flows and it is our argument that it is possible to take three different perspectives towards the organization of physical flows. One perspective is that physical flows can be organized through the establishment of an infrastructure that consists of fixed distribution sites and transport routes. The second perspective is that the physical flow can be organized through adaptation to the flow of goods, where the distribution sites and transport routes are flexible. The third perspective involves a perspective where the physical flows are custom made and the distribution sites and transport routes are adapted to specific customers needs.

9.1.1 The effect on the performance variables

The performance of coordinating physical flow is reflected in operations costs and customer service level. Having identified the three perspectives towards the coordination of physical flows, we argue that these represent different combinations of costs and service. In fact we argue that the establishment of a physical flow through an infrastructure results in a low level of operations costs and a low customer service level. The reason for this is that this provides a fixed set of operations, with a cost minimizing focus and the customers have to adjust to the system. The opposite of this is the establishment of a custom made physical flow that reflects a high customer service level, as well as a high level of operations costs. This follows from a high level of adaptation to specific customer needs. The perspective where the physical flow is organized through adaptation to the flow of goods is placed in between the other two. That is, this kind of physical flow is expected to reflect an intermediate level of operations costs and customer service level. The costs and customer service level is in this respect argued relatively, which means that high and low levels are reflected in relation to each other. We are not arguing that custom made physical flows have a generally high cost level, but rather that it would incur a higher cost level compared to a physical flow established with a fixed infrastructure.

These three perspectives towards the organization of physical flows are cultivated forms but we also argue that physical flows can draw on several of the coordination mechanisms (Håkansson and Persson 2004). In this respect, the costs and customer service level may be adjusted to some extent. That is, if it is desirable to organize a physical flow with a high customer service level, together with low costs, it may be necessary to draw on both the fixed infrastructure and flexible flow of goods perspective. In other words, it becomes necessary to coordinate the physical flows with several of the mechanisms at the same time. For example, if a physical flow is established with a low cost and an intermediate customer service level, we expect that it would be coordinated with a combination of the planning and standardization mechanisms.

We have illustrated our argument in a performance matrix. It shows the cultivated forms of organizing physical flows on the diagonal. It also indicates the directions in which the coordination mechanisms can be drawn in order to achieve the desirable levels of customer service and operations costs. To the extent that there are several coordination mechanisms involved, we expect the physical flows to be positioned reflected at other positions in the matrix. The performance matrix is shown below:

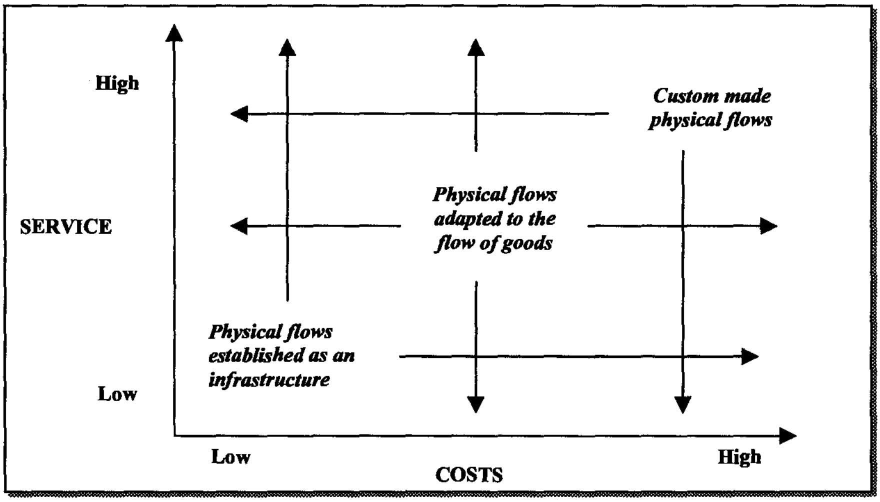

Figure 9.2: The perspectives of physical flows positioned in a performance matrix

In analyzing the performance across the cases in our study, we have identified that the collection systems are directed towards different customer segments and represent different customer service levels. The El-retur system has established a transport service to pick up waste from a set of collection sites, where the end-consumers may deliver their products free of charge. Thus, a collection service is available but the end-consumers have to perform most of the activities themselves. The RENAS system on the other hand has established a collection service to pick up waste from the site of the end-consumer and performs most of the activities on behalf of the end-consumers. The independent systems have taken the collection service one step further. They have established systems that are custom made for each end-consumer. Relatively speaking, we argue that the customer service level is highest in the independent system, intermediate in the RENAS system and lowest in the El-retur system.

In evaluating the operations costs, we see that the RENAS system report a lower level compared to the El-retur system. These figures are not available for the independent systems but we have seen that these systems are small-scale compared to the other two and would be more costly in principle. The collected volumes and operations costs are set out in the table below[72]:

Table 9.3: Operations costs for the collection systems

	Elektronikkretur	Hvitevareretur	RENAS	Eurovironment	RagnSells
Collected volume (tones)[73]	16 373	32 661	45 958	2 230	1 308
Total costs (NOK)	80.9 mill	108.9 mill	111 mill	*	*
Cost per collected tonne	4 940,-	3 334,-	2 415,-	*	*

*) Not available

Evaluating the performance, which includes both operations costs and customer service levels, we could argue that the RENAS system scores better than the other systems in the coordination of the physical flows. In fact, we can position the collection systems in a performance matrix as illustrated below:

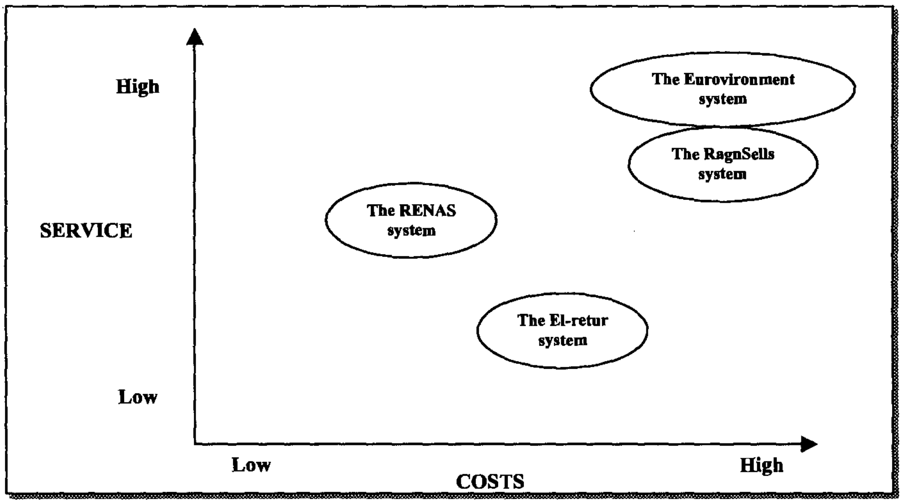

Figure 9.3: The physical flows in the cases positioned in a performance matrix

In the literature, it is argued that physical flows need to be customized to customer segments (Mentzer et. al. 2001). By viewing the collection systems as parts of the "industry for

[72] The numbers are taken from the respective case descriptions in chapters 6, 7 and 8.

[73] The numbers are reported to the government from the waste management companies. The waste management companies have individual responsibility and therefore the numbers for El-retur are reported separately.

collection of EE-products at end-of-life", we see that they have different positions towards the customers. As a result, we would expect the position in the performance matrix to differ. However, the position of the El-retur system, with respect to costs, is not as expected (relative to the RENAS system). Taking the thesis that both the El-retur system and the RENAS system have implemented coordination mechanisms that are well adapted to the activity structures in their collection systems, there is a relative mismatch in costs per tonne.

An identified challenge for the systems is the limited attention from the end-consumers, which results in a passive supplier to the collection system and is characteristic of collection systems (Barnes 1982, Zikmund and Stanton 1971). However, despite the low attention rate, the volumes being returned by business-to-business end-consumers are larger and more homogenous than the volumes that are being returned by the private end-consumers. In this perspective, the volume is more easily identified in the RENAS system than it is in the El-retur system.

A second effect is the transport function. RENAS integrated the collection and transport function in the second period, which allowed for the activities to be coordinated as one function. The business-to-business consumers did not have a logical connection to a collection site and so their products were picked up from their premises. The RENAS system had to secure a more flexible transport function that could be adapted to the end-consumers easily. The result was an increase in collected volume and a better utilization of transport capacity. In this manner, it was necessary to move the transport function 'closer' to the end-consumer.

In El-retur, however, the transport function has been adapted to the collection sites and the collection sites are responsible for generating volume. Exposed to a category of end-consumer that is passive in returning products, the volumes are not guaranteed but the transport operators have to standardize their operations towards a set of collection sites, irrespective of the volume. In this respect, the transport costs are a challenge. The standardization of both the collection function and the transport function separately creates an integration challenge between the functions.

In closing the discussion on the coordination of physical flows, we comment on the independent systems. These systems have been established to offer a high service level to the end-consumers. Without knowing their costs, it is difficult for us to evaluate the systems in relation to the performance matrix. However, the level of collected volume indicates that the independent systems are small-scale operations. We argue, therefore, that in order to service volumes on the same level as the other systems, it would be necessary for the independent systems to escalate the cost levels in order to provide the end-consumers with the high customer service level.

9.2 Coordination of commercial interests

In this section we discuss how the commercial interests are coordinated in order to ensure aligned behavior in the reverse distribution systems. The commercial interests are coordinated on a number of levels in 'the industry for collection of EE-products at end-of-life'. First, the authorities have taken centralized control through the EE-regulations. However, the decision control is decentralized to the EE-industry by means of the industry agreement. The EE-industry has then established the waste management companies to take the every day responsibility of the collection of EE-products at end-of-life. The waste management companies are the coordinators of the commercial interests in the reverse distribution systems. The companies have taken on the obligations for the EE-industry towards the authorities and are the central administrators of the collection systems. There is, in other words, a duality in coordinating the commercial interests for the reverse distribution systems. The waste management companies have to ensure coordination of the commercial interests towards the stakeholders on one side and towards the operators of the collection system on the other side. The stakeholders provide the waste management companies with funding and authority, while the collection system is the means to achieve collection rates. Representation of the commercial interests in the reverse distribution systems in our study are illustrated below:

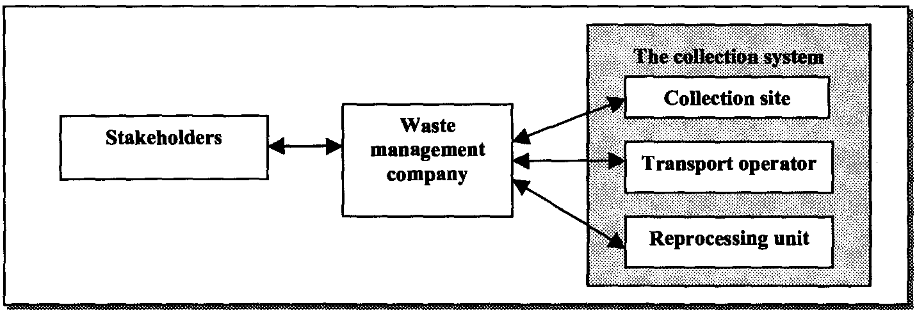

Figure 9.4: An illustration of the commercial interests in the reverse distribution systems

Next we discuss the coordination of commercial interests in relation to the stakeholders and the collection system separately. We start with the stakeholders and return to the collection system in the following section.

9.2.1 Coordination of the commercial interests and the stakeholders

Coordination of commercial interests and the stakeholders is primarily about funding and complying with the EE-regulations. The coordination mechanisms between the stakeholders and the waste management companies are similar across the distribution systems. An explanation is that the coordination is at the industry level and achieved through centralization (by means of the EE-regulations) and formalization (by means of the industry agreement). However, there are also differences between how the waste management companies coordinate the commercial interests towards the stakeholders. An explanation is that the industry agreement is voluntary. The agreement is signed at an industry level but it is an individual choice for each EE-company as to how they handle their responsibility for the EE-products at end-of-life. In this respect, the waste management companies' choice of how to coordinate the commercial interests is significant.

The EE-companies have the property rights to the collected volumes but delegate these rights to the waste management companies by means of membership. Membership fees represent the funding of the reverse distribution system and are administered by the waste management companies. The similarity between the waste management companies towards the memberships can also be explained at the industry level, as it is the authorities' task to control whether individual EE-companies are members to one of the waste management companies or have implemented a sufficient alternative collection system. The waste management companies report lists of members to the authorities every year. Thus, it is the authorities' responsibility to control for free riders.

Free riders are a reported challenge in the systems[74]. However, the free riders are assumed to consist of conscious and unconscious groups – i.e. those that *do not know* about these responsibilities and others that *try to avoid* the fee (SFT Dec. 02). The authorities have issued fines to some free-riding companies (SFT Aug. 03, SFT Aug. 04)[75]. Beyond these sanctions, the waste management companies can persuade EE-companies to become members by demonstrating efficient collection systems. However, the challenge for the waste management companies in this regard is the low attention rate that is reported about waste issues. The systems are therefore dependent on more effective mechanisms in controlling free riders. The waste management companies face a common challenge towards the stakeholders in terms of free riders in the reverse distribution systems.

The independent systems have been established as an alternative to the systems within the industry agreement and are based on the argument that each EE-company has an individual choice to decide how to solve their responsibility. Our study shows that there are challenges between the independent systems and the systems within the industry agreement. All the waste management companies have to report collection rates and numbers of members to the authorities every year to demonstrate compliance with the EE-regulations. It is argued that the independent systems do not have satisfactory collection rates and have difficulty in documenting a sufficient number of members. The question is, on one side, whether the independent systems fulfill the EE-regulations and, on the other, whether they free ride on the systems within the industry agreement. We will return to this question later in the analysis.

While the similarities are explained by the presence of coordination mechanisms at the industry level, the differences can be explained by the coordination mechanisms at the company level. The waste management companies have individual responsibilities, which include deciding the fee format and the fee level towards the members (i.e. the funding). Each of the waste management company has an individual responsibility to recruit members to their systems. Thus, the independent and industry agreement systems compete on funds. The interests of the owners also influence the dispositions of the waste management companies. The independent systems are based on making profits, while the waste management companies within the industry agreement are non-profit operations. Thus, there seems to be different motivations present between the waste management companies in the independent systems and those within the industry agreement. An example we have seen in the study is how the ownership structure has impacted Elektronikkretur AS. The heterogeneous interests of the owners led to a reorganization of the funding system in the first period. The fee format

[74] The possible number of free riders is assumed to be in the range of 5 – 10 000 companies but they represent a relatively small share of the market (approx. 20%).
[75] References in appendix C

has changed from upfront payment to payment in arrears. Rather than speculating on the cost level, the members pay for the actual cost of the collection system. Such a structure has contributed to a higher degree of cost control and less conflict of interests.

9.2.2 Coordination of the commercial interests and the collection system

The most significant differences in the coordination of the commercial interests between the reverse distribution systems in our study are found in how the waste management companies have coordinated the collection systems. The differences have increased over the five-year period our study covers.

The waste management companies within the industry agreement initiated the coordination of the collection systems in the beginning through the use of a common tender. However, the contracts were signed with the operators individually for each of the three waste management companies. In this sense, the waste management companies administrated the systems separately, allowing for separate systems to develop. The tenders were not coordinated in the second period. The RENAS system issued a new tender for a three-year period from 2002-2005[76], while the El-retur system implemented a one-year extension period from 2002 until 2003. A tender was issued during this one-year period and the system continued with a three-year contract from 2003-2006.

The waste management companies had decision control in the El-retur system[77] and they coordinated the commercial interests in the system through the centralization mechanism. The waste management companies governed transport operators and reprocessing units through the coordination mechanism of formalization, as the operators were given defined procedures to follow and areas to operate in. However, the waste management companies also had a focus on the operators' prices and, therefore, we argue that the commercial interests also were coordinated with incentives.

The collection sites, however, were not coordinated directly by the waste management companies within the El-retur system. Rather, the collection sites were governed based on the

[76] The contract periods run from July 1st.

[77] The two waste management companies Elektronikkretur and Hvitevareretur administer the system in cooperation.

EE-regulation. Thus, the waste management companies expected the authorities to ensure that the collection sites complied with the EE-regulations. The waste management companies did not implement additional coordination mechanisms towards the collection sites. There was some information exchange with the collection sites but this was reported to be limited and inefficient.

The El-retur system was coordinated in the same way for both periods. The waste management companies still had decision control and, therefore, continued with the centralization of the system. In fact, the decision control and centralization was increased to some extent, as the geographical areas were organized into smaller sizes and the number of actors increased for the same level of volume during the second period. The operators were still given formalized agreements, as the operators had specific partners to cooperate with and specific criteria to fulfill. The waste management companies in the El-retur system also continued with the explicit price negotiations, thus continuing with the incentive mechanism. The collection sites were coordinated in the same manner, based on the EE-regulations with some information exchange.

The waste management company in the RENAS system started with coordination through centralization and formalization. The waste management company had decision control in the system and issued formalized agreements to the operators. The operators reported to the waste management company on a regular basis and the compensation model was based on a gross amount, where costs and income were to be reported. The operators during the first period included collection sites, transport operators and reprocessing units.

The system was changed in the second period. The collection system was organized through the two operators of collectors and reprocessing units. The waste management company was still the centralized decision maker, in the sense that it issued contracts to the participating actors. The contracts were still formalized to the extent that activities and standard operating procedures were specified. Beyond this, operations were not divided into geographical areas and thus, to a large extent, it was the operators' task to identify where and how to operate. The operators' experiences, therefore, were the basis for the operations and provided the grounds for norms to develop and the coordination of commercial interests. In addition, RENAS negotiated the contracts with a focus on margins, with which it was expected that the actors would trade and negotiate with their partners. The actors were stimulated into improving performance, as they were able to keep the profits. In this respect, the contracts had become an element of the incentives.

The independent systems have a different model from the El-retur and RENAS systems for coordinating commercial interests. The collection systems are mainly based on reprocessing units. In the Eurovironment system, the reprocessing unit is fully owned by the waste management company, and in the RagnSells system, the waste management company and the reprocessing unit is one company. The system has not included collection sites or transport operators as a part of the system but buys these services from the market when needed. The collection function is based on achieving close relationships with the end-consumers and this provides the basis for norms to develop. The companies have not changed their structure over the five-year period to any extent.

The table below summarizes the different mechanisms that have been used to coordinate the commercial interests in each of the systems for both periods:

Table 9.4: Coordination mechanisms of the commercial interests in the cases

	The El-retur system	The RENAS system	The independent systems
Coordination mechanisms 1st period	• Formalization • Centralization • Incentives	• Formalization • Centralization	• Authority • Price • Norms
Coordination mechanisms 2nd period	• Formalization • Centralization • Incentives	• Formalization • Centralization • Incentives • Norms	• Authority • Price • Norms

The coordination mechanisms of commercial interests are means to achieve aligned behavior in distribution systems. The mechanisms aim to ensure that the self-interests of the individual actors in the distribution system are aligned with the common interests of the system as a whole. If aligned behavior is achieved in the system, higher performance in the distribution system is expected, as opposed to a situation with conflict of interests.

The literature on governance identifies that relations in distribution systems are regulated with contracts (Heide 1994, Stinchcomb 1985, Macneil 1980), and that a *combination* of coordination mechanisms, which includes hierarchical mechanisms, incentives and norms, are used (e.g. Bradach and Eccles 1989). The cases in our study demonstrate that a variety of mechanisms are utilized to coordinate the commercial interests in the reverse distribution systems. As change is demonstrated over the period we have studied, the variation does not seem to be arbitrary.

The findings in our study indicate that combinations of coordination mechanisms vary between the systems. In both the El-retur and the RENAS systems, the combination of formalization and centralization were utilized to coordinate the commercial interests in both periods. In the El-retur system, there was also an element of incentives in both periods, while incentives and norms were included in the RENAS system in the second period. The questions then are why did the systems start out with a high reliance on hierarchical mechanisms, and why were the systems coordinated differently in the second period?

The coordination mechanisms of formalization and centralization are hierarchical mechanisms that reflect the authority of the hierarchy (Stinchcomb 1985). The El-retur system and the RENAS system are both non-profit based and are, in many respects, cost centers for the EE-industry in taking on the responsibility of collecting EE-products at end-of-life. The systems were in a way established as 'a necessary evil' and it could be argued that the waste management companies' main task was to spend as little money as possible taking on this endeavor. In this sense, it can be argued that the perspective of the waste management companies was one of close control and therefore the choice of coordination mechanism resembled the authority of the hierarchy. The focus was to achieve (cost) control with the operators of the collection system.

However, the waste management companies of both systems reported that there were difficulties in making the operators align their behavior to the good of the systems. In the El-retur system, the volumes were reportedly returned to different actors than the collection sites defined within system, and the cooperation between the transport operators and the collection sites did not comply with the formalized agreement. In the RENAS system, it was reported that the volumes were separated into two streams, with the valuable products being traded outside the system, while the cost of the demanding products was left for the system to handle.

As discussed under the coordination of physical flows, the fact that the end-consumers were different categories was an explanation for why the El-retur and RENAS systems faced challenges. The behavior of the end-consumers was expected to be passive (Barnes 1982, Zikmund and Stanton 1971).

The El-retur system faced mainly private end-consumers and the collection system had to compensate for this passive behavior. If the collection sites yielded low[78] volumes, there was a risk that operators would lower their service and, therefore, it can be argued that a high level of authority through centralization and formalization was necessary to ensure a sufficient service level. This argument is strengthened because the El-retur system relied on the EE-regulations for the collection sites to align behavior to the system. That is, the collection sites had been given an obligation that was not directly compensated. To ensure that motivation was not reduced in finding volume, the El-retur system had to make sure that they kept their promised service level. Thus, it is our argument that the choice of coordination mechanism is based on a need for close control.

A second argument that can explain why the El-retur system continued with coordination mechanisms that promote close control of the commercial interests was the need for cost control. We saw that the owners and members of Elektronikkretur AS, in particular, faced a challenge in agreeing upon a funding model. The members fund the operations in the collection system, and there was a discussion on how to split the costs between the product categories. In this respect, there has been a strong focus on costs in the El-retur system.

However, the El-retur system reported to some extent similar challenges in the second period with regard to obtaining a satisfactory collection volume. It could be argued that the operators did not align behavior to a sufficient extent. A possible explanation can be found in the literature, where it is argued that a combination of coordination mechanisms, which includes all the dimensions of hierarchical mechanisms, incentives and norms, is expected to be more effective than utilization of only a selection of these mechanisms (John 1984). In fact, it is argued that the reliance on hierarchical mechanisms alone may be detrimental to the achievement of aligned behavior. An example of this from the El-retur system would be the transport operator that found it challenging to coordinate with both the collection sites and reprocessing units, as it was supposed to according to the formal agreement with the waste management company. However, when the system did not work out as expected the operator

[78] Reduced frequencies (service) because the volumes to collect were lower than expected.

had a limited possibility to make any adaptations, as there were a lack of alternative coordination mechanisms.

Our study seems to confirm this finding but at the same time it is also necessary to look beyond the direct choice of coordination mechanisms. A second explanation may be found in the *horizon of coordination*, as the systems did not include the collection sites as a part of the commercial interests. That is, the collection sites were coordinated through the EE-regulations and left as the authorities' responsibility. In this manner, the El-retur system was dependent on performance from actors whose commercial interests were not directly coordinated within the system. The ability to adapt the behaviors in the systems were to some extent placed beyond the waste management companies' horizon of coordination, which helps to explain why it was difficult to coordinate this function.

The RENAS system developed in a different direction from the El-retur system. One explanation is that the system experienced end-consumers that took an active negotiating role towards the system, as they were trying to recapture value from the products. In this manner, the RENAS system was dependent on the operators as negotiation partners towards the end-consumers in order for the operators to be able to integrate the volume in the system. The reliance on a higher degree of *incentives* and *norms* empowered the operators to adapt to the active business-to-business end-consumers. The first period showed that the operators' passive role - as they had limited negotiation abilities (i.e. no funds) - resulted in the end-consumers trading products outside the system.

The RENAS system reported a sufficient improvement in the aligned behavior after changing the coordination of the commercial interests. A significant element of incentives and norms were included as a part of the coordination mechanisms. In fact, it could be said that the RENAS system to a large extent left the operations in the hands of the operators, while the waste management companies still had close control of the operations in the El-retur system. Thus, this finding confirms that a combination of coordination mechanisms, which included all the dimensions of hierarchical mechanisms, incentives and norms, is expected to be more effective than utilization of only a selection of these mechanisms (John 1984). Thus, it may be argued that the RENAS system's choice of coordination mechanisms in itself is more effective than those of the El-retur system. John and Heide (1992) also recognize this: norms are found to operate as safeguards in a relationship to prevent misalignment of behavior because they deter the buyer from using decision control in a way that would be detrimental to the relationship as a whole.

The actors in the RENAS system were asked to identify how to operate individually. Through these types of contracts, the RENAS system has to a large extent facilitated the development of *norms*. The contracts have stimulated flexibility in the system. Also, as each operator of the system is given the same conditions through the contracts, a solidarity of the system is stimulated as the operators know about each other's intentions. However, since reprocessing units compete with the collectors on advantageous terms this may prevent solidarity. The latter dimension may also deter information exchange. The operators have been protected to some extent against competition from actors outside the system, but competition within the system is high due to RENAS' decision to terminate the geographical areas. On the other hand, competition is mitigated through RENAS as a centralized authority in the system and, to some extent, through the seminars and information exchange between RENAS and the operators. The operators are encouraged and asked to give feedback to RENAS about the system. The operators have directly participated in the system during the second period. Thus, the norms are advantageous to the RENAS system.

The norms of conduct have not been present in the El-retur system to the same extent, as the waste management companies have kept a high level of control. In the El-retur system, the actors are given a defined task of what to collect, from where and within specific geographical areas. The operators have limited dialogue with each other as they relate directly to the waste management companies. The system has a lower degree of flexibility and a limited expectation of information exchange compared to RENAS. El-retur coordinates to a larger degree the information exchange. The system is therefore to a limited extent stimulating the dimension of solidarity. An exception would be the coordination between transport operators and their sub-suppliers in the second period. The system is in this way able to integrate volume and to some extent compensate the actors that are linked to, but not included in the system.

However, similar to the El-retur system, it is also necessary to look beyond the direct choice of coordination mechanism in the RENAS system. The RENAS system has a contractual relation to all the parties of the collection system, thus it actually includes the commercial interests of all the actors within their horizon of coordination. As a result, RENAS had the opportunity to coordinate the commercial interests for all of the involved actors and adapt to the patterns of behavior in the system.

As we have seen, the independent systems have been coordinated differently from the systems within the industry agreement. The independent systems also coordinate the commercial interests with a combination of coordination mechanisms, but in a somewhat different way. An explanation can be found in the fact that the independent systems are profit based. The direct ownership of the reprocessing units ensures an ownership of the collected materials, and being able to control the collected products ensures a control of the income from the sales in the secondary market. The waste management companies within the industry agreement are not expected to make earnings on the sale of the collected products in the secondary market. This also explains why the independent systems have a close cooperation with the end-consumers. The systems' income is dependent on access to volumes and there is a risk in waiting for the end-consumers (passive or active) to act on their own initiative. The Eurovironment system is also dependent on higher quality products, as it uses the waste management option of reuse. Some end-consumers are linked to the system in an ad hoc manner and may be classified as coordinated through market-based relationships, while other categories of end-consumers are linked via more long-term relationships and these may be categorized as coordinated through relational contracting. In this perspective, there is development of norms between the end-consumers and the independent systems. This is the same for the RagnSells system. To minimize costs, the independent systems have reported that collection and transport services are bought in the market and coordinated through the price mechanism.

The waste management companies have, in other words, chosen different combinations of coordination mechanisms to coordinate commercial interests. To the extent that these have been able to align actor behavior within the collection system is reflected in the performance variables of transaction costs and transaction value. In the next section, we consider these levels.

9.2.3 The effect on the performance variables

It is argued that it is difficult to quantify the absolute magnitude of transaction costs but that they may be related to in a comparative institutional manner (Williamson 1985). Thus, in evaluating how effective the coordination mechanisms have been in aligning behavior in the reverse distribution systems, we compare the systems to each other. Transaction costs is a multidisciplinary concept (Dahlstrom and Nygaard 1999). In our study, we evaluate the direct transaction costs and the opportunity costs of the systems and we argue that our systems face different sources of transaction costs.

In the El-retur system, the transactions are characterized by stability and repetitiveness. The end-consumers take waste products to a fixed set of collection sites, the transport operators service fixed transportation routes from the collection sites to a set of reprocessing units that expect an agreed level of volume. In this way, the source of direct transaction costs are represented in ensuring stability in the performance of the activities and in the transfer between a set of clearly defined functions.

In the RENAS system, the transactions are characterized by change and flexibility. This varies from where the products are collected and the operators have to adapt both collection and transport activities. Also, the reprocessing units compete for volume and they too need to adjust their capacity accordingly. The source of direct transaction costs for the RENAS system is represented in terms of adaptations.

In the independent systems, products are collected at end-of-life by creating unique solutions for each transaction. The transactions are adapted to the end-consumers' needs and vary in types of activities and capacity. Also, the independent system has to establish a relationship with each end-consumer for each transaction. Thus, the source of direct transaction costs for the independent systems are adaptations. The costs are similar to that of the RENAS system but the adaptations are more demanding because end-consumer relations, collection and transport activities need to be established for each transaction.

The table below sums up the sources of transaction costs for each of the systems.

Table 9.5: Types of transaction costs addressed in the three reverse distribution system

	The El-retur system	**The RENAS system**	**The independent systems**
Source of direct transaction costs	Ensure stability	Adaptation	Adaptation

Our study shows that the El-retur and RENAS systems experienced high shares of opportunity costs (Rindfleisch and Heide 1997) in the first period. Both systems experienced that the operators did not align behavior as expected and agreed, which resulted in maladaptation and higher costs for the systems.

The waste management companies in the El-retur system replaced one actor with four new ones, which suggests they failed to identify appropriate partners in the first period. However, the operators in the El-retur system also reported that it was difficult to run operations in accordance with the agreement. The collection sites had to spend a great deal of time communicating the EE-regulations to the end-consumers and how the collection system could be utilized. The transport operators found it difficult to coordinate the activities towards the collection sites and the reprocessing units; they argued that it was costing them more than they had expected.

In the RENAS systems, the opportunity costs were reflected in volume that was traded outside the system. It was reflected in the loss of volume to the operators within the RENAS system, the loss of income from the valuable materials; and the risk of hazardous materials going astray. The operators did not achieve the expected volumes, which led to an opportunity cost from mismatch in capacity utilization and dimensionalization. In addition, opportunity costs resulted because the operators had reduced motivation to work actively in the system. The waste management company expected the profits to be returned to them and the operators had limited earning potential.

The adjustment that the RENAS system made for the second period resulted in significant cost improvements to the system. The operators reported a high level of satisfaction with the coordination of the system. In fact, it could be argued that the opportunity costs to some extent were eliminated, as there was a minimal level of maladaptation in the system. In comparison, however, the El-retur system operated with a higher level of total cost per tonne in the second period than the RENAS system. It could be argued that the difference was a result of higher levels of transaction costs.

The independent systems, however, have not encountered the same type of coordination challenges as the systems within the industry agreement. These systems have been coordinated through ownership and control of the operations. However, rather than opportunity costs of maladaptation, it could be argued that the independent systems have faced a high level of direct transaction costs. The waste management companies have had to establish relationships to end-consumers and develop collection systems for each collection task. Thus, the level of communication costs, negotiation costs and coordination costs have been high for these systems. We do not have cost data for these collection systems, but the low level of collection rates (relatively speaking) reflects that it was demanding to get a hold of volume.

However, the challenges have been somewhat different for the two independent systems. The Eurovironment system explains that it has actually been able to collect a high share of ICT equipment at end-of-life. One explanation for this could be that Eurovironment has concentrated on limited categories of EE-products and has collected volume for both reuse and recycling. Thus, the collection effort has been limited in scope, which has resulted in a lower level of direct transaction costs. The RagnSells system, however, collects volumes from all product categories but has not been able to produce documentation to confirm whether they have, in fact, fulfilled the demands of the EE-regulations. Instead, there seems to be evidence of the opposite.

The systems in our study have faced different sources of transaction costs, as well as different levels of transaction costs. During the first period, both the industry agreement systems faced a high level of opportunity costs. However, during the second period, these opportunity costs were largely eliminated from the RENAS system, while the El-retur system continued to face opportunity costs. We therefore argue that the RENAS system implemented coordination mechanisms for commercial interests that aligned behavior in the second period, while the El-retur system did not succeed to the same extent.

Based on this finding we can draw some insights. First, there is the issue about time. Both systems were established for the first time and there was limited knowledge of how to coordinate such systems. Thus, the experience that the systems acquired in the first period was important input in deciding how to coordinate in the second period. The findings from our study indicate that both the waste management companies and the operators faced the challenge of lack of knowledge. In this manner, the actual misalignment of behavior seems to have been a result of not knowing how to coordinate and operate, rather than conscious deceit.

The fact that the El-retur system seems to have faced a challenge in achieving the same performance improvement in the second period, as compared to the RENAS system, is primarily found in the horizon of coordination. Coordination towards the collection sites has generated a high level of transaction costs and these transaction costs have not been addressed in the coordination of the commercial interest. The collection sites have not been addressed directly within the system.

Closing this chapter, we want to address the dimension of transaction value. It is clearly the waste management companies that have been able to utilize contracts and coordination mechanisms to coordinate commercial interests between stakeholders and the operators of the collection systems. In this respect, governance has been a means of creating value for the reverse distribution systems. The adjustments in coordination mechanisms during the second period have in fact contributed to the increase in value for the participating actors. The stakeholders have achieved a higher collection rate at lower costs and the operators of the collection system have achieved greater profitability.

9.3 System performance and coordinated action

So far in the cross case analysis we have analyzed coordination of physical flows and commercial interests separately, as well as the effect of the coordination mechanisms on performance in isolation. The thesis for this study, however, is how the coordination mechanisms for both these categories *interact* and contribute to coordinated action. In this section, we analyze whether this interaction contributes to system performance and coordinated action in the reverse distribution systems.

In our terms, system performance is assumed to reflect the extent to which the coordination mechanisms in the reverse distribution systems contribute to coordinated action. System performance is reflected in the collection rates that are produced in the reverse distribution systems. In our cases, the system performance level is measured towards the expected collection rate of 80 %, which has been established in the industry agreement[79]. We assume that the reverse distribution system has achieved coordinated action if the collection rate is 80 % or more. In the table below we summarize the collection rates for the reverse distribution systems within our study in the first and second periods:

[79] The independent systems also have to ensure a collection rate of 80 %.

Table 9.6: An overview of collection rates in the reverse distribution systems

	El-retur[1)]	RENAS	Eurovironment[2)]	RagnSells[3)]
Collection rate – 1st period (2002)	61 %	64 %	26 %	0,7 %
Collection rate – 2nd period (2003)	66 %	88 %	28 %	1,2 %

1) The collection rate is accumulated for Elektronikkretur and Hvitevareretur.
2) The collection rate is measured against the product category for ICT equipment and has to be evaluated against the sales volume of Eurovironment's members. This number is not available but the manager has stated that the collection rate is within the 80 % collection level.
3) The 80 % target has to be measured against the share of members within the product categories. The number is not available.

Following our argument, the table shows that the RENAS system in the second period achieved coordinated action of the reverse distribution system. The other systems have not passed the 80 % collection rate[80] and have, according to our reasoning, not implemented sufficiently effective coordination mechanisms.

Our main thesis is that the choice of coordination mechanisms for physical flows and commercial interests are not independent. Rather, we argue that there are certain systematic patterns between the two categories of coordination mechanisms. If there is a match in the coordination mechanisms for the two categories, we expect the interaction effect to have an extra effect on performance compared to the systems where the sets of coordination mechanisms have not been adapted to each other. Thus, from our point of view, RENAS has been able to achieve an interaction effect between the sets of coordination mechanisms, while the other systems have not managed this to the same extent.

During the second period, the coordination mechanisms of the RENAS system are planning for the physical flows, and a combination of hierarchical mechanisms, incentives and norms for the commercial interests. It was demonstrated in the RENAS system that the end-consumer took an active negotiation role towards the system. The end-consumers had (have) two basic needs: to dispose of the EE-waste and to recapture a certain value for the products. These needs represented both a physical dimension and a commercial dimension. It was demonstrated that the physical flow had a need for planning because each collection task was characterized by specific (collection and transport) needs. It was also demonstrated that the commercial interests had a need for negotiation because the EE-products at end-of-life did have a secondary value. However, in order for the operators of the collection system to be able to plan and adapt the flow of goods actively to the needs of the end-consumers, they

[80] An exception may be the Eurovironment system. However, they have not been able to provide figures to support this claim.

depended upon decision control to manage the negotiations. Thus, when the operators in the RENAS systems were allowed to negotiate how and where to collect products, they achieved an interaction effect between the coordination of the physical flow and the commercial interests.

The challenge from the first period in the RENAS system was the actors' lack of negotiation possibilities. The end-consumers addressed the waste actors in order to dispose of EE-products at end-of-life. However, the actors were given specific directions from the waste management company (RENAS) in how to operate. Thus, they did not have the opportunity to adjust the services in accordance with the requests from the end-consumers. The result was that waste actors external to the RENAS system traded the positively valued products. The first period indicated a lack of interaction between the coordination mechanisms for the physical flow and commercial interests. We argue that the coordination of commercial interests was implemented to address a cost minimizing focus, which was an important issue to the stakeholders. In this perspective, accommodation of the physical flows was not prioritized. The result was a limited system performance and a lack of coordinated action.

From this line of reasoning, we argue that for physical flows coordinated with planning, it is necessary for the operators to maintain decision control and coordinate the commercial interests based on their experiences. There is a flexibility within these coordination mechanisms that demands adjustment and adaptation in parallel. The RENAS system has, in this way, been able to address the cost structures within the reverse distribution system during the second period. The operations costs are minimized as a consequence of the operators' ability to plan the physical flow. The transaction costs are minimized as a consequence of the operators' ability to be flexible in adapting to the changing needs of the system.

The El-retur system on the other hand, has not been able to address the costs structures within the reverse distribution system to the same extent. We have identified that there is a challenge with the operations costs and transaction costs within the collection function. The lack of compliance from the end-consumers and the collection sites created a challenge for the transport operators to achieve efficient operations (capacity utilization and frequency adaptation). The transport costs were higher than expected. Additional transaction costs were created as a consequence of the extra coordination needs that arose between the transport operators and the waste management companies, as well as those between the collection sites and the transport operators. The coordination between the collection sites and transport operators was a source of opportunity costs. The fact that the waste management companies in the El-retur system did not directly control the collection sites had an impact on the performance of the transport operators and reprocessing units. The actors were dependent on aligned behavior from the end-consumers and the collection sites. However implemented coordination mechanisms were not there to regulate decision control of these actors within the system[81]. This was a major difference between the El-retur system and the RENAS system. The interaction effect between the two sets of coordination mechanisms in the El-retur system was influenced negatively.

Our analysis tells us, in other words, that the El-retur system's performance is lower than the expected 80 % collection rate because of a lack of sufficient interaction between the coordination mechanisms of physical flows and commercial interests. However, an explanation for this performance gap is a mismatch in the coordinated horizon rather than the choice of coordination mechanisms per se. The commercial interests towards the collection sites are not addressed within the El-retur system and as a result there is only the one set of coordination mechanisms for the physical flow towards the collection sites.

However, we argue that despite this seemingly obvious conclusion that the choice of coordination mechanisms for the El-retur system is an effective combination. In order to link a high number of end-consumers with a heterogeneous waste portfolio, we argue that the standardization mechanism is a necessary choice for the physical flow. In this respect, the commercial interests are of stability and repetitiveness, which ensure that the operators within the system provide an identical and predictable service. Facing such commercial interests, we argue that formalization and centralization provides effective coordination. These mechanisms leave the actors with low decision control, which results in compliance to an agreed standard of operations. A challenge, however, is that coordination based on hierarchical mechanisms alone may have a negative effect on performance (John 1984). This is a second difference between the El-retur system and the RENAS system, which can help to explain the differences in performance between the systems.

One area where this negative effect has been seen is in how the waste management companies in the El-retur system have demonstrated a higher level of confrontational behavior towards the operators in the collection system. The waste management companies have reported an

[81] The end-consumers and collection sites are regulated by the EE-regulations, which are assumed external to the El-retur system.

orientation towards getting the best prices and in trying to achieve a favorable bargaining position. The extended contract period from 2002-2003 represented an initiative to cooperate with the Swedish market to include extra volume in order to get increased negotiation power toward the operators in the collection system. The cost focus in the relationship with the stakeholders also explains why the waste management companies have taken this approach towards the operators in the collection system.

The coordination of the collection function through the EE-regulations is also means of keeping costs down. The collection sites are, in accordance to the EE-regulations, expected to perform activities that comply with the collection system. Thus, as the activities are a requirement of the EE-regulations, it is not necessary for the El-retur system to compensate the effort. The alternative way in which the El-retur system coordinates the collection function ensures a transport service to the collection sites. However, this implies that the collection system does not necessarily have to deliver its products to the El-retur system. The collection sites have the property rights to the EE-products at end-of-life and have the freedom to choose how to dispose of the collected products. Thus, this effect creates uncertainty for the El-retur system. This coordination challenge for the El-retur system is an explanation as to why the system faces a challenge in meeting the expected level of 80 % collection rate. The EE-regulations seem like an inefficient mechanism to regulate the commercial interest of the collection function.

The freedom of choice given in the EE-regulations is a reason for the establishment of the independent systems. The Eurovironment system has been established as an alternative to one category within the El-retur system. An argument for the establishment of this company is that the activity structure and service that the El-retur system provides are not sufficient for the ICT-products category. The Eurovironment system has been able to collect a high share of ICT products at end-of-life, which indicates that their choice of coordination mechanisms achieves system performance and coordinated action. Thus, their system for ICT equipment seems to be a viable alternative to the El-retur system.

In this manner, the coordination mechanisms of mutual adjustment for the physical flow, together with the direct involvement through ownership, the flexible adjustment that the market provides and the establishment of relationships for the commercial interests are argued to contribute to an interaction effect with positive system performance results. The end-consumers serviced by the independent systems are argued to have individual needs for collection, transport and reprocessing activities, and therefore it has been necessary to adapt the physical flow for each end-consumer separately. The ways in which the commercial interests are coordinated have been able to align the behavior of the involved parties to adapt to the individual needs of the end-consumers.

The combination is not so obvious for the RagnSells system, as they have demonstrated a low collection rate. As mentioned previously, we have not been able to evaluate fully the collection rate, as the share of members is unknown. However, despite this, the pattern of collection indicates a lower collection rate than the expected 80 %. However, we argue that the concept of servicing end-consumers directly and the choice of coordination mechanisms that RagnSells has implemented do match. The challenge for RagnSells, however, seems to be a lack of identified customer segments and products categories (report volume in all categories), and in this respect it is difficult to evaluate whether the coordination mechanisms are the most suitable choice.

To evaluate system performance, it is therefore necessary to relate this towards the waste management companies within the industry agreement, which argue that the independent systems are free riders in the industry for collection of EE-waste at end-of-life. The reason for this accusation is that the independent systems do not have their own collection system infrastructure and are, therefore, seen to be free riding on the El-retur and RENAS systems and not complying with the EE-regulations. The argument is reasonable to some extent, given the demands from the EE-regulations and the independent systems having chosen to coordinate the physical flows directly from the end-consumers. However, the El-retur and RENAS systems have been established with standardization and specific planning requisites, and have excluded to some extent some of the customer segments that the independent systems service. In a sense then, the independent systems contribute to the system goal from the authorities' point of view, in terms of collecting a high total share of EE-products at end-of-life. However, there are some challenges concerning the commercial interests across the independent systems and the systems within the industry agreement on an industry level. One explanation is that the latter systems are non-profit while the former are profit based.

Our evaluation of the reverse distribution systems in the study is that each system has implemented well-adapted coordination mechanisms for both the physical flows and commercial interests during the second period. However, only one of the systems (the RENAS system) is seen to achieve coordinated action. The RENAS system has been able to achieve an 80 % collection rate and it has successfully addressed the cost structures within the reverse distribution system. The El-retur system has not been able to collect sufficient volumes to document an 80 % rate and has a higher cost level.

The independent systems performance varies between the two systems. The Eurovironment system states that it collects an 80 % rate but this is difficult to evaluate from the given information. The RagnSells system, on the other hand, faces a challenge in documenting an 80 % collection rate. The independent systems run cost demanding operations because the systems are adapted to each end-consumer. However, their challenge is to demonstrate availability of collection services for end-consumers vis-à-vis the systems within the industry agreement. In this respect, there is an argument that the independent systems free ride on the system within the industry agreement. Thus, it is argued that the independent systems have not taken on a sufficient cost level for the reverse distribution systems.

As a result of our analysis, we see that the interaction effect between coordination mechanisms is not only dependent on the type of mechanisms, but also on how they are organized. The RENAS system seems to have incorporated all the parts of the reverse distribution system with its chosen mechanisms, while the El-retur system has not managed this to the same extent. The independent systems face a challenge in demonstrating how they are able to service the end-consumers sufficiently and whether they have taken on a sufficient cost level for the reverse distribution system.

The performance effects have become visible over time, as the systems were developed in different directions during the second period. A question then arises of why the systems needed this time? The systems were initiated simultaneously as a result of an overall industry agreement and therefore had the same starting point. The common tender evidences that there was high industry cooperation at the outset and the common starting point can explain the similar choices of coordination mechanisms. The systems have been through a period of relationship initiation and maintenance (Heide 1994) and awareness and exploration (Dwyer, Schurr and Oh 1987). The lack of variation in the first period can be argued to result from the limited knowledge about how to coordinate such systems, as they were among the first of their kind in the world. The systems started with limited experience and knowledge about the collection activities and the partners they had to cooperate with. The starting point in an early phase of relationship is dominated with the authority-based governance mechanism (Ness and Haugland 2005). That relational factors are time dependent may suggest that misalignment of behavior in the beginning was inevitable. The coordination between the systems was not present during the second period, to which the separate tenders bear witness. In addition, past experiences were available from which coordination mechanisms could be developed. The basis for developing a combination of coordination mechanisms was present to a larger extent in the second period.

9.4 Summary

In this chapter, we have analyzed three reverse distribution systems for collecting EE-products at end-of-life. We have analyzed the coordination of the physical flows and commercial interests, and have argued how each of these coordination mechanisms contributes to performance. Latterly, we proposed how the coordination mechanisms interact and contribute to overall system performance.

From analyzing the coordination of the physical flows, we find variation within the three cases in our study. We argue that the suggested mechanisms of standardization, planning and mutual adjustment are readily applied to physical flows, and that the end-consumer segments greatly influence the choice of coordination mechanisms. Based on the analysis, we suggest that there can be three perspectives towards physical flows. One is to organize a physical structure to which the flow of products adapts. A second perspective is to pay attention to how products flow and organize the physical flow accordingly. The third perspective is to adapt the physical flow to the individual needs of the end-consumers, which results in custom made solutions. We suggest that each perspective provides a unique combination of costs and service for the physical flows.

The performance combinations for our cases are suggested in a performance matrix. We find that not all the cases perform satisfactorily and that the explanation for this is found on examination of how the commercial interests are coordinated.

Commercial interests are represented at different levels in the context of our study and we see that there are both industry and company effects of coordination. The waste management companies are established and engaged to coordinate the reverse distribution systems, which includes both the stakeholders and the collection systems. With respect to the stakeholders, there is a high degree of similar coordination across the systems in our cases, which can be explained on an industry level. In this respect, a comparison across industry levels may be necessary in order to find higher levels of variation. There are some differences, however, which seem to be dependent on the owners and types of members. With respect to the collection systems, on the other hand, there is a higher level of variation in how the commercial interests are coordinated across the three cases. Based on our analysis, we have found that the manner in which the commercial interests are coordinated seem to be good solutions for the cases. However, there are some challenges but these are explained by factors other than the choice of coordination mechanisms. The horizon of coordination is one specific area. The actors and functions that collection systems depend on are not included as a part of the coordination scheme, which incurs higher levels of transaction costs.

In fact, through our analysis, we have found that all the reverse distribution systems in our study have made sound choices of coordination mechanisms. However, as only one system is found to achieve an interaction effect between the coordination mechanisms for physical flows and commercial interests, which has led to satisfactory system performance and coordinated action, we have argued that the explanation lies beyond the choice of coordination mechanisms. However, the analysis of system performance demonstrates that the interaction of coordination mechanisms is not only dependent on the type of mechanisms, but also on how these mechanisms have been organized and put into play. We specifically address the matching horizon of coordination as important and we demonstrate the system effect in coordination.

Our analysis shows that the systems were coordinated in a similar way at the beginning of the first period but over time variation has developed. We argue that a lack of knowledge when relationships are initiated is an explanation to the change over time. An explanation to the similarity in the beginning is that the initiative was taken on the industry level and that the individual interests of the companies have influenced the systems over time.

There are also some conflicts of interests between the systems within the industry agreement and the independent systems. The systems have chosen significantly different ways of organizing. With one being profit based and the other being non-profit based, their motivations towards the task are different. The systems address different end-consumer segments and the systems within the industry agreement have taken on a high cost level to make the systems available in the market. The independent systems, however, adapt the systems to each end-consumer and have chosen a flexible system without high fixed costs.

The conflict of interests relate to whether these types of systems also to some extent imply limited availability for some end-consumers. When evaluated on an industry level, on the other hand, all the systems contribute to the authorities' goal of gaining the highest possible collection rate. Thus, there is no obvious answer to the conflict of interests, as each system contributes to the overall goal of an 80 % collection rate.

10. DISCUSSION AND IMPLICATIONS

The phenomena in our study have been reverse distribution systems and we have considered the issues of how to achieve coordinated action in such systems. In particular, we have studied coordination of physical flows and coordination of commercial interests. Our argument has been that these areas in distribution systems need to have specifically adapted coordination mechanisms. Our thesis has also pointed to the fact that there are interaction effects between these mechanisms. In this chapter we continue with the explicit discussion and development of these interaction effects.

The reverse distribution systems we have studied demonstrate that the physical flows and commercial interests are separated between different sectors and actors and, therefore, have a specific need for coordination. We have specifically analyzed three different types of reverse distribution systems, which have been coordinated differently. The coordination mechanisms that are implemented are evaluated to be well adapted. However, in spite of this, the interaction effects have not contributed to the expected level of system performance in all of the cases. Facing this shortcoming, we have explicitly developed three conditions that are argued to also effect coordinated action in distribution systems. Our contributions are formulated explicitly as propositions.

In addition, we have addressed two areas in more detail that stand out to be especially important in the reverse distribution systems. One area discusses the waste management companies and their role as coordinators in the reverse distribution systems. Secondly, we discuss the significance of the collection function. Our study has demonstrated that this area has a significant impact on the performance level of reverse distribution systems. We close the chapter and the thesis with theoretical and managerial implications, limitations and suggestions for further research.

10.1 Coordinated action

Coordinated action means, in our terminology, the extent to which the coordination mechanisms for different types of flows in interaction contribute to high system performance. That is, we argue that the coordination mechanisms have separate means and separate goals, but that there are extra positive effects when the coordination mechanisms are well adapted to each other. In this section we develop the argument for how these interaction effects are achieved, by explaining and detailing how the different coordination mechanisms correspond. We also propose three different conditions from our empirical study that we suggest influence to what extent reverse distribution systems are able to achieve coordinated action.

10.1.1 Interaction effects between coordination mechanisms

A challenge with the extant literature on coordination in distribution systems is that coordination of all the flows is achieved implicitly through the coordination mechanisms for the commercial interests (Rosenbloom 1995). We have investigated an additional flow and found separate coordination needs. Specifically, we have argued that physical flows follow the same variations that Thompson (1967) proposes for technologies. The question then has been how the coordination mechanisms interact between the physical flows and the commercial interests to achieve coordinated action.

Governance has been combined with interdependencies in previous research. Interdependencies are taken into consideration in a study on *hybrids* (Borys and Jemison 1989). It is argued that the interdependencies between the partners in hybrids determine how the hybrid needs to be organized. Hybrids are defined as "organizational arrangements that use resources and/or governance structures from more than one existing organization" (Borys and Jemison 1989:235). The interdependencies determine in other words the coordination mechanisms between actors. Developing the reasoning further, Hammervold (2003) explores how coordination of *relationship components* is achieved between actors who are dependent on the type of interdependencies. The study investigates coordination of vertical relationships and how the interaction between governance mechanisms and interdependencies influence value creation. The study reveals that different governance dimensions have different effects across relationship components. It is specifically recognized that investments and logistical components call for different types of coordination but the study is not able to distinguish how (Hammervold 2003:161). In our view, the investments and logistical components represent commercial interests and physical flows respectively, and the study does not separate the coordination issues nor specifically differentiate coordination mechanisms for the two areas. Our thesis is that such a separation is necessary, and we have developed three propositions that address this aspect.

Our study has demonstrated that the physical flows and commercial interests in the reverse distribution systems are closely related. The relation between the two flows becomes visible in our study as they are separated between two industries (the EE-industry and the waste management industry). The commercial interests are coordinated in a way that takes best possible care of the interests of the EE-industry, while the waste management industry adapts operations to the interdependencies of the physical flows. The waste management companies administer the coordination mechanisms across the flows, and the adjustments that are made to the coordination of the reverse distribution systems over the period of our study, demonstrate that the combination of mechanisms are not arbitrary.

In the El-retur system, we have clarified that the physical flows are coordinated mainly with standardization. This is based on defined collection sites, transport routes and reprocessing operations. The commercial interests are coordinated with formal governance mechanisms such as centralization, formalization and incentives. The coordination mechanisms are retained from the first to the second period. Even though we have identified that the El-retur system has a coordination challenge, which we return to in some of the propositions that follow, the combination of coordination mechanisms has been evaluated to be a match.

Having identified that the activity structures are characterized by pooled interdependencies, standardization (Thompson 1967) and specialization (Milgrom and Roberts 1992) is a way to achieve coordination of operations. In the El-retur system, the collection, transport and reprocessing functions have been standardized in order to achieve economies of scale. However, standardization of functions creates a need for coordination between the functions, which is not automatically taken care of. That is, standardization of one function creates a clearly defined passage to the next function, which creates an integration challenge between the functions. The structuring of the physical flows therefore indicates that the commercial interests need to handle stability in transactions. The transfer between the functions becomes a transaction cost source because linking standardized activities generates coordination costs (Milgrom and Roberts 1992). It represents the cost of information and communication in order to make pieces of the systems fit together. To economize on the transaction costs both centralized and decentralized decision making may be implemented. However, if the system has design attributes, a centralized decision making unit is preferred (Milgrom and Roberts 1992). The design attributes for the El-retur system are those that adapt the capacities and frequencies across the collection, transport and reprocessing functions, even though each operation is structured to exploit pooled interdependencies. In this manner, centralization and formalization are effective ways of organizing (Milgrom and Roberts 1992). However, Milgrom and Roberts (1992) refer to intra-firm coordination mechanisms, where such mechanisms are also readily applied to achieve governance across inter-firm relationships (Stinchcomb 1985). Inter-firm relationships are the nature of distribution systems (Alderson 1954), and centralized and formalized agreements are ways to achieve coordination (Stern and Reve 1980).

In this manner, we suggest that if the physical flows of a reverse distribution system are characterized by pooled interdependencies and coordinated with standardization, the commercial interests need to be coordinated with formal governance mechanisms in order for the reverse distribution system to achieve coordinated action. Reformulated as a proposition, it can be presented as follows:

P1: If physical flows are coordinated with *standardization*, the commercial interests need to be coordinated with *formal governance mechanisms* in order to achieve coordinated action in reverse distribution systems

In the RENAS system, we have found that the coordination of the physical flow has been changed from standardization to planning from the first to the second period. The commercial interests have been coordinated mainly with formal governance mechanisms in the first period, while in the second period the system has also been coordinated with informal governance mechanisms. The coordination of the collection system has been to a large extent left to the actors in the waste industry. The actors are allowed to negotiate directly with each other and are measured based on outcome. The RENAS system has experienced a reduction in costs and an increased level of system performance and, as a result, the coordination mechanisms have also been evaluated to be a match.

The activity structures are characterized by serial interdependencies, and in order to achieve integration and cost minimization, planning is the corresponding coordination mechanism, which is appropriate for dynamic situations (Thompson 1967). In RENAS' collection system, the operators needed to adapt each delivery and integrate the activities from the end-consumer through to the reprocessing units. The dynamic structuring of the physical flow indicates that the commercial interests need to handle dynamic transactions. Dynamic situations are a source of transaction costs because of the adaptation needs (Rindfleisch and Heide 1997) and informational incompleteness and asymmetries (Milgrom and Roberts 1992). The types of transaction costs are referred to as motivation costs (Milgrom and Roberts 1992). Economizing on motivational transaction costs is difficult with formalization because dynamic situations are rather dependent on informal elements, or relational contracting (Macneil 1980). The choices RENAS has made for the coordination of commercial interests, with a high degree of informal governance mechanisms, are in accordance with theory. However, informal governance mechanisms in RENAS have not replaced the formal governance mechanisms, rather they are complementary. The waste management companies have developed formalized agreements for the actors in the collection system, but decision-making has been decentralized in order to enable the actors to adapt to the operations in the best possible way. The fact that the governance mechanisms are complementary to one another is in line with theory (Poppo and Zenger 2002).

In this manner, we suggest that if the physical flows of a reverse distribution system are characterized by serial interdependencies and coordinated with planning, the commercial interests need to be coordinated with formal and informal governance mechanisms in order for the reverse distribution system to achieve coordinated action. Reformulated as a proposition, it reads as follows:

P2: If physical flows are coordinated with *planning*, the commercial interests need to be coordinated with a combination of *formal and informal governance mechanisms* in order to achieve coordinated action in reverse distribution systems

In the independent systems, the physical flow is coordinated with mutual adjustment, while the commercial interests are partly coordinated with formal and informal governance mechanisms. The combination of coordination mechanisms in the independent systems is also evaluated to be a match. We return later to explain why RagnSells faces challenges.

The independent systems have developed a collection system that adapts to the individual needs of end-consumers. The activity structure for the physical flow is identified in the collaboration with the end-consumers. The activity structure is characterized by reciprocal interdependencies, and the coordination mechanism is mutual adjustment (Thompson 1967). In these coordination tasks, the information is processed during action. They also represent dynamic situations that are more variable and unpredictable than serial interdependencies.

Complex situations are assumed to incur transaction costs (Williamson 1979). The suggested means of coordinating commercial interests is therefore vertical integration (Williamson 1979), which controls behavior rather than outcome (Milgrom and Roberts 1992). However, it is assumed that total vertical integration is not a viable governance mechanism for distribution systems (Alderson 1954). An alternative strategy for coordination under conditions of high uncertainty is use of informal governance mechanisms (Macneil 1980). Even though informal and formal governance mechanisms are assumed to be complementary, in situations of exchange hazards it is expected that the level of relational exchange will be higher (Poppo and Zenger 2002). The hazards in the independent systems are represented by a need for high flexibility, and the actors adapt the systems for each collection task.

In this manner, we suggest that if the physical flows of a reverse distribution system are characterized by reciprocal interdependencies and coordinated with mutual adjustment, the commercial interests need to be coordinated with informal governance mechanisms in order for the reverse distribution system to achieve coordinated action. Reformulated as a proposition, it reads as follows:

P3: If physical flows are coordinated with *mutual adjustment*, the commercial interests need to be coordinated with *informal governance mechanisms* in order to achieve coordinated action in reverse distribution systems

We have argued that there are interaction effects between the coordination mechanisms for physical flows and commercial interests. The reasoning for this is that the characteristics of the physical flows contribute to the generation of systematically different types of transaction costs. Thus, achieving economies in the physical flow has an impact on the commercial interests. This gives an indication of how the commercial interests need to be coordinated in order to economize on the transaction costs. From this perspective, the interdependencies within the physical flows become influential factors on the commercial interests, as well as aiding identification of how to structure the physical flows. They also contribute to an understanding of how the commercial interests are dependent on other elements and not just the exchange attributes.

Recent studies of governance have expanded the 'original' analytical model of transaction cost economics. One specific area has been the governance value analysis (Ghosh and John

1999), where strategy is argued to be a factor for differentiating the exogenous attributes of an exchange. In the same manner, we argue that the inherent logic of the physical flows, i.e. the type of activity interdependence, has a systematic influence on the choice of governance mechanisms used to coordinate the commercial interests. Grandori (1997) has suggested a number of specific governance structures for the different types of interdependencies. Therefore, by breaking these governance structures into mechanisms and categorizing them along the different types of interdependencies, we suggest the following typology for how the coordination mechanisms interact to achieve coordinated action:

Table 10.1: A typology of coordination mechanisms for physical flows and commercial interests

Type of flows	Corresponding coordination mechanisms		
Physical flow	Standardization	Planning	Mutual adjustment
Commercial interests	Formal governance mechanisms	Formal and informal governance mechanisms	Informal governance mechanisms

The propositions are developed based on the findings from our study and reasoning from theory, and they contribute by filling a void in the literature on how coordination of physical flows and commercial interests interact. The evaluation of our empirical study shows that the reverse distribution systems have implemented well-adapted coordination mechanisms across the flows. However, the systems have not been successful to the same extent in achieving system performance and coordinated action (measured against the 80 % collection rate). We have found that the RENAS and Eurovironment systems have performed better than the El-retur and RagnSells systems. Since the coordination mechanisms are considered to be a match for each case, we have found alternative explanations for the challenges the systems face. The conditions that affect the coordination of the systems are addressed in the next section.

10.1.2 Conditions that effect coordinated action in systems

We have identified three conditions that effect coordination of reverse distribution systems. The conditions are the horizon of coordination, the relationship phase and the chosen set of coordination mechanisms. In addition to the interaction effects between coordination mechanisms, the conditions are argued to affect the extent to which the distribution systems are able to achieve coordinated action.

The first condition we address is the *horizon of coordination*. Distribution is per definition the intermediation between manufacturing/production and consumption. In this perspective, the borders of distribution are found at the interfaces vis-à-vis manufacturing/production and vis-à-vis the end-consumer. The concept of horizon refers to the chosen scope of coordination in the distribution system. That is, the scope of activities that is included in the coordination scheme. Our study indicates that the horizons of coordination between commercial interests and physical flow need to *harmonize*. If the coordination mechanisms for the physical flow are based on a certain scope of activities within the distribution system, our argument is that the same horizon has to be in view for the coordination of the commercial interests in order to achieve coordinated action. If not, crucial components that contribute to the performance may not be taken into consideration when implementing coordination mechanisms.

The concept of horizon of coordination is found in the case of the El-retur system. There is a clear separation between the collection function and the transport and reprocessing functions, with respect to coordination of commercial interests. In the El-retur system, the commercial interests of the collection function are coordinated through use of the EE-Regulations, while the transport and reprocessing functions are coordinated with contracts between the waste management companies and the operators. In the physical flow, the collection sites provide direct input to the transport operators and reprocessing units. Thus, the collection, transport and reprocessing functions of the physical flow are coordinated within the El-retur system, whereas for the commercial interests, it is the transport and reprocessing functions are coordinated within the system. In other words, the horizon of coordination between the physical flow and the commercial interests in the El-retur system do not harmonize. In the other two cases, however, the horizons of coordination do harmonize to a larger extent. This could explain why the El-retur system faces a challenge in meeting the system goal of an 80 % collection rate. The El-retur system is dependent on the input from the collection sites but there are limited governance mechanisms in place to ensure control and motivation of the actors involved.

The importance of harmonizing horizons is visible in the El-retur system also because of the choice of coordination mechanisms. Standardization creates clearly defined passages between functions and, therefore, the integration challenge between the collection function and the rest of the system becomes visible. In the El-retur case, the transport operators have to adapt their operations to a function that is 'external' to the coordination of the waste management companies. Yet, the transport operators still have performance measures towards the collection sites in accordance with specific demands vis-à-vis the waste management companies. Having argued that the integration challenge between standardized functions creates transaction costs, this particular case shows that there are, insufficient tools implemented to address these costs. The first proposition argues that the standardization mechanisms are dependent on the commercial interests being coordinated with formal governance mechanisms, but this is not implemented vis-à-vis the collection function from the El-retur system.

Theory on coordination has recognized that there are system effects (Wathne and Heide 2004, Reve and Stern 1979). We argue that the horizon of coordination within the distribution system has an effect on the ability to achieve coordinated action. Formulated as a proposition, we suggest that:

P4: The horizons of coordination of physical flows and commercial interests need to harmonize in order to achieve coordinated action in reverse distribution systems.

The second condition we address is *the relationship phase.* Distribution systems are known to have specific characteristics when they are established for the first time (Ness and Haugland 2005, Heide 1994, Dwyer, Schurr and Oh 1987). The reverse distribution systems we have studied have been established within the time frame of our study. Once the waste management companies had been established, tenders were issued to actors that had not been working in this particular area previously. There were challenges associated with establishing the relationships, as the actors on both sides of the relationships were without prior experience and reference. From such a start point, it is not possible to initiate relationships with skill or value training (Heide 1994), as there are neither the skills nor the values to train. In our study, the systems were designed based on ex ante expectations. The coordination mechanisms that were implemented ex ante were centralization, formalization and standardization. The choice of coordination mechanisms did not fully contribute to coordinated action. The results were non-integrated activities, misalignment of behavior, high operations and transaction costs, and low scores in relation to the system goal (i.e. low collection rates).

Our study supports that relationships often start with formal governance mechanisms (Ness and Haugland 2005), but we also show that this does not necessarily lead to high performance. On the other hand, the literature predicts that formal mechanisms are satisfactory to guide relationships with supportive norm-based mechanisms (John 1984). Our study supports this finding that without supportive norm-based governance mechanisms, hierarchical mechanisms cannot not be effective. Norm-based mechanisms are ex-post in nature, in the sense that their development is dependent on experiences in the relationship. Thus, as norm-based mechanisms are, by nature, limitedly present in the initiation of a relationship, the balance between the different types of governance mechanisms is not present to the extent that they ideally should be.

From this reasoning, we may conclude that relationships at an early stage incur a higher level of costs. The costs are a result of the lack of balance between the governance mechanisms. In an early relationship phase, a distribution system may experience misalignment of behavior. This results in a reduced level of system performance and a limited degree of coordinated action. Costs in relationships are reported to be of a higher level during an initiation phase (Buvik and John 2000). In this respect, there is a challenge when it comes to relationship initiation because it is difficult to specify behavior expectations ex ante when partners do not know each another. In this manner, the alignment of behavior in a relationship initiation phase is characterized by *bounded rationality*, and mechanisms have to address such dimensions.

Operators within the distribution systems of our study reported that the activities were different than expected and, therefore, they had to adjust operations to the actual activity pattern, rather than being able to focus on the fulfillment of the specified contract with the waste management companies. In the El-retur system, the EE-waste was not necessarily returned to the 4000 collection sites, as the end-consumers in some cases chose different collection sites/operators. As a result, the operators faced a challenge in exploiting the capacity and providing the promised frequencies. In the RENAS system, the operators were not prepared for the separation into positive and negative flows of waste. The operators were thus unable to achieve the expected volumes and the costs were higher for the waste management company than expected. The concept of bounded rationality denotes that individuals attempt to make rational decisions but often lack important information in the definition of problems (Bazerman 1994). Constraints such as time and costs on intelligence and perceptions, and the ability to process available information, create limitations. Thus, decision makers face a challenge in making optimal decisions in accordance with the rational model. Our study has demonstrated that the decision makers within the reverse distribution systems did not fully comprehend the needs of the systems. There were deviations from the contracts and adjustments had to be made. Our argument is that these effects are present during the early phase of the relationship and that therefore, these need to be taken into consideration when choosing governance mechanisms. Thus, we propose that:

P5: Governance mechanisms implemented to coordinate commercial interests during a relationship initiation phase need to align behavior characterized by bounded rationality

A second element to the condition of the relationship phase then are the type of governance mechanisms utilized during this phase. The literature on governance mechanisms has pinpointed that there is a need for balance between formal and informal governance mechanisms in order to achieve effective coordination of commercial interests. In the previous proposition, we have argued that the early stages of a relationship phase have a characteristic that needs specific types of governance mechanisms. It is reported that not only are governance mechanisms complementary, but that they also function as facilitators for each other (Olsen et. al. 2005). It is therefore argued that there is a need to broaden our knowledge on how mechanisms interact. While proper use of mechanisms are argued to facilitate and increase the efficiency of other mechanisms, inadequate use of mechanisms may disturb and hamper the use of other mechanisms (Olsen et. al. 2005). Based on this and the insights from P5, we argue that the choice of governance mechanisms in the initiation of a relationship is a vital decision.

We have found that understanding the combination of governance mechanisms help to explain why the El-retur system and the RENAS system[82] have differences in performance. Both systems implemented primarily formal mechanisms at the outset of the relationship. The RENAS system has shown a development of informal governance mechanisms, in addition to the formal mechanisms from the first to the second period. The El-retur system has continued with a reliance primarily on formal mechanisms. At the same time, it has made changes in partners because it found that one actor did not comply with the specified contract. The actor, however, argued that the terms of the contract had been impossible to comply with. The perception of the situation was different between the two parties.

[82] We limit the comparison to the El-retur system and the RENAS system because the systems are of a similar structure.

This observation supports the finding that a one-sided reliance on formal mechanisms is said to have a negative effect on alignment of behavior (Heide and John 1992, John 1984). However, when informal governance mechanisms are ex-post in nature, they are therefore difficult to specify or design ex ante. Informal mechanisms are a result of experience, or the so-called tit-for-tat behavior (Axelrod 1984). Thus, finding a balance between formal and informal governance mechanisms during the initiation of a relationship seems to be an inherent challenge of the process.

When faced with this challenge, we argue that the reliance on incentives in the early stages of a relationship phase may facilitate the establishment process. By acknowledging that the actors are subject to bounded rationality in a relationship initiation phase, it is therefore necessary to provide adaptation possibilities. Incentives address informational incompleteness (Milgrom and Roberts 1992) in both ex ante and ex-post situations (Bergen, Dutta and Walker 1992). The incentives reward outcomes and thus leave the choice of process to the actor (Bergen et. al. 1992, Eisenhardt 1989). Thus, the use of outcome-based incentives during the initiation of a relationship allows to a larger extent the partners to adapt to unforeseen circumstances. As the relationship continues, informal mechanisms continue to be developed and these contribute to balance the relationship. To reformulate this argument as a proposition, we suggest that:

P6: In a relationship initiation phase, commercial interests needs to be governed with outcome based incentive mechanisms

The third condition we want to address is the chosen *set of coordination mechanisms*. On choosing a set of mechanisms to coordinate physical flows and commercial interests, one has to leave out other options. The literature reports that a choice of position influences the type of coordination mechanisms (Mentzer et. al. 2001, Ghosh and John 1999). It is, therefore, a question of how well the choice of coordination mechanisms are adapted to the specific needs of the position in question.

In our cases we have seen that the El-retur system and the RENAS system cover all the categories of EE-products at end-of-life. The systems have chosen different positions as they cover complementary categories of products. In principle, every end-consumer of EE-products has the opportunity to return products at end-of-life to either the El-retur system or the RENAS system. However, two alternative reverse distribution systems for EE-products at end-of-life have been established. The Eurovironment system and the RagnSells system cover subsets of the same categories of products, but have chosen somewhat different positions as compared to the El-retur system and the RENAS system. The Eurovironment system competes in the product categories (ICT equipment) that are the responsibility of Elektronikkretur AS. RagnSells competes across all the product categories in both the El-retur system and the RENAS system.

All the reverse distribution systems have chosen somewhat different sets of coordination mechanisms. The El-retur system has implemented standardized coordination mechanisms for the physical flows, and primarily formal governance mechanisms for the commercial flows. The RENAS system has implemented planning coordination mechanisms for the physical flows, and both formal and informal governance mechanisms for the commercial interests. The independent systems, however, have chosen mutual adjustment coordination mechanisms for the physical flows, and primarily informal governance mechanisms for the commercial interests. These chosen sets of coordination mechanisms provide both possibilities and limitations.

The choice of a standardization mechanism in the El-retur system gives a lower potential for adaptations. It is expected that the more standardized the operations, the higher the availability for the users (Thompson 1967). Therefore, adaptations to alternative activities are neither possible nor desirable. However, since a segment of the members and end-consumers in the El-retur system wanted to perform alternative activities, an alternative system was seemingly their only option. Eurovironment developed a system for *reuse* of ICT equipment, which was not possible within the El-retur system. The system was therefore complementary in the beginning but over the period it has also developed to include recycling activities. It may in other words be argued that the standardization of the El-retur system has given room for an additional system.

The Eurovironment system has also chosen to serve a specific end-consumer segment. Mentzer et. al. (2001) argue that systems have to be adapted to specific customer segments. The Eurovironment system has adapted the reverse distribution system to ICT equipment and facilitates a pick-up service from the premises of the end-consumers. Regarding the RagnSells system, however, there is a lack of specific consumer segments, although it does offer a pick up service from the end-consumer premises. The lack of specific consumer segments may, therefore, explain why the performances are significantly lower than the other systems. The independent systems offer a tailor-made service towards end-consumers (by collecting at the end-consumers premises). These types of activities are to a limited degree available within the El-retur system, but to some degree available in the RENAS system. Systems that are adapted to activity structures with serial interdependencies and coordinated in terms of planning are more appropriate for dynamic situations (Thompson 1967). Adjustments in activities are both possible and desirable in order to include end-consumers that are borderline to the system. During the second period, the RENAS system has been able to include the physical flows for both positive and negative valued products.

Based on this discussion, we argue that the set of coordination mechanisms have to be adapted to specific positions and segments, and this naturally leaves out other options. For example, if a system is coordinated with standardization, it cannot be coordinated with planning at the same time. From the discussion, we see that there are fewer adaptation possibilities if the chosen set of coordination mechanisms is standardization. From such a position, it is therefore more likely an alternative and additional system will be established and introduced to handle the adaptation needs. Thus, we propose that:

P7: The set of coordination mechanisms in reverse distribution system need to be adapted to a specific position and segment to be effective.

P8: A reverse distribution system that is coordinated with standardization has a lower level of adaptation compared to systems that are coordinated with planning and mutual adjustment.

We have investigated the interaction between mechanisms for coordination of physical flows and commercial interests within reverse distribution systems. We have proposed a typology for how the coordination mechanisms interact. In addition, we have addressed three conditions that we argue influence the ability to coordinate in reverse distribution systems. Given these additional insights, we believe that there is an increased understanding of how reverse distribution systems can achieve coordinated action. If we recall Alderson's (1954:25) statement: "Only when someone in the marketing channel takes responsibility for co-ordinated action can it be expected that anything more than routine operations will be carried out effectively", then we claim that we have developed an argument towards what that "someone" has to do.

In this thesis, the 'someone' refers to the waste management companies in the reverse distribution systems. In our cases, the commercial interests and physical flows have been separated between two different industries[83], and there has been a necessary role for 'someone' to contribute to the coordination of the reverse distribution systems. However, it has not been our aim to address this actor in particular, as we have been focused on understanding how to coordinate the transfer that is conducted between actors in reverse distribution systems. Having completed the thesis, however, we see that the role of the waste management company as a coordinator of the reverse distribution system has been an important factor. Recognizing that the coordinator role has been specifically addressed in the distribution literature as, for example, channel leader (Etgar 1977), we therefore want to draw some reflections about the coordinator role of a reverse distribution system, which are based on the understanding that we have gained from this thesis.

10.2 A coordinator of reverse distribution systems

Leadership in distribution systems is defined as a situation where one member of the system possesses control to the extent that it is able to stipulate policies to other members (Stern 1967). Control is defined as being a function of market concentration, which results in higher exercise of control when there are few buyers and sellers, and less exercise of control when there are many buyers and sellers (Stern 1967). Leadership of a distribution system is also expected to arise when the environment is threatening (Etgar 1977). It is found that a distribution system with a higher degree of coordination has efficiency advantages, as compared to one with a lower degree of coordination (Etgar 1976a). In other words, it is argued that leadership in a distribution system is positive, which supports Alderson's argument.

The ability to exercise control over other members in a distribution system is viewed as having power (Etgar 1976b), or access to power sources (Etgar 1977). The members of distribution systems have been known to struggle for control in order to be able to dictate the

[83] The EE-industry and the waste management industry.

policies of the channel (Edwards 1937). Traditional distribution is characterized by confrontation, which creates tensions between its members (Gadde 2004). Traditional distribution had 'classic' members such as manufacturers, wholesalers, dealers and distributors (Gadde 2004, Edwards 1937). The goods were produced and distributed based on the principle of speculation (Bucklin 1965), which contributed to members trading on who was to carry the costs.

Gadde (2004) argues that a new reality in distribution has other characteristics than the traditional distribution. The evolving distribution reality is argued to be collaborative because of a high degree of actor specialization and activity integration across companies (Gadde 2004). In this distribution reality, goods are to a larger extent produced and distributed based on the principle of postponement (Bucklin 1965), which drives costs out of the systems rather than them being traded off. Gadde (2004) argues that power and control is present to a greater extent in these distribution systems because of the higher degree of interaction and interdependence between the actors. However, it is also argued that power is *used* to a lesser extent because it might be detrimental to the collaboration in the long run.

In this distribution reality, we may argue that the leadership role has gone from being explicit to being implicit. With an increased number of specialized actors that are increasingly becoming more mutually dependent on each other, it is not obvious which one of them will take a traditional leadership role. The literature predicts that such a role is dependent on the use of power (Etgar 1976b). In the evolving distribution reality, therefore, the leadership of the distribution system has become a function of relational behavior. The partners have an interest in finding ways of collaborating and thus develop ways of cooperating in the distribution system. Gadde (2004) argues that the "reservoirs of power" are present in these evolving distribution realities, and that power becomes a foundation of the relationship behavior by its mere presence, rather than its application. It is in the nature of 'trust-games' (Gadde 2004) that members of the evolving distribution realities know misaligned behavior will be punished.

Following this argument, there is a reduced need for 'someone' to take explicit responsibility for coordinated action. The high level of interdependence and need for integration is expected to balance the power between the members, and the mutual dependence contributes to system performance and coordinated action. In this respect, the evolving distribution reality includes both power and countervailing power (Etgar 1976b). The control in traditional distribution was needed because the dependence between the members was low (Gadde 2004). The theory of leadership argued that explicit use of power was needed in order to have control, so that the leader could discipline the other members to engage in coordinated action. The result of increased specialization and activity interdependence in the evolving distribution reality means that implicit coordination forces are created.

The presence of the waste management companies in the reverse distribution systems is a clear manifestation of 'someone' taking responsibility for coordinated action. It is not difficult to argue that the waste management companies have an explicit leadership role. However, we argue that this is not evidence to show that reverse distribution systems are of a traditional nature. On the contrary, we suggest that the waste management companies have been established because there is a need for *mediating* (Stabell and Fjeldstad 1998) in the reverse distribution systems. Explicit and implicit leadership is dependent on members of a distribution system having direct experience of each other, which exposes the power sources on a continuous basis. In our cases, however, there are mainly two elements that hinder the ability to achieve direct cooperating experiences, which therefore prevent the direct exposition of the power sources. One factor is that funds are generated in one sector and used to compensate services in another. The sectors are dependent on each other and this, therefore, constitutes power sources, however, there is a need to link these sectors together. There is a division of flows between the two industries, which makes it necessary for the waste management companies to take on the mediating role between the two. Secondly, the power bases are composed of a large number of actors and this requires the actors to be gathered into groups. That is, the waste management companies need to recruit members to ensure sufficient funding, and to contract actors in the waste management industry to constitute a collection system in order to be able to produce collection rates.

Mediators facilitate exchange relationships among actors that are distributed in time and space, and mediating is about providing a networking service (Stabell and Fjeldstad 1998). The rationale for mediation is that it provides linking, which is the organization and facilitation of exchange between actors (Stabell and Fjeldstad 1998). Mediation and mediator roles may be argued to become increasingly visible in distribution systems. In line with Gadde (2004), we argue that power and control are present in all types of distribution systems, but that it takes different forms. A mediator controls power bases and gains control by being able to group and link (groups of) actors that want to be linked. Actor specialization and interdependencies in the (reverse) distribution systems require coordination and integration.

Mediators will take a more significant role in linking specialized and interdependent actors to each other. The integration is partly left to a third category of actors, rather than being based on direct exposure and experience between actors.

Mediation applies clearly to reverse distribution systems. The systems have specialized actors that perform separate functions (i.e. collection, transport and reprocessing). These set of activities are integrated across companies, as well as the waste management industry and the EE-industry. We can argue, therefore, that the EE-industry has chosen to face the new regulations by exploiting existing distribution resources rather than designing new systems from scratch. In principle, the EE-companies have had the opportunity to integrate the activities of the reverse distribution systems with their already established forward distribution systems. However, the adaptation of the already specialized forward distribution systems would probably have incurred a high level of costs. In fact, the reverse distribution systems that have been described in this thesis are quite in accordance with the evolving distribution reality pointed out by Gadde (2004), where the actors specialize and face increasing activity interdependence, which calls for coordination, and they rely on distribution resources made available by other firms.

The need for mediation is also heightened because reverse distribution systems have the characteristic of passive or inactive supplies from the end-consumers. It is necessary to actively generate a demand for waste in the reverse distribution systems. In this respect, the collection activities stand out as a particularly important with respect to coordination in a reverse distribution system. We therefore draw reflections and implications specifically about the collection function as well.

10.3 The significance of the collection function

The collection activities play a significant role in the reverse distribution systems. The 'production' in these systems is represented by consumption. In theory it is argued that the end-consumers do not take an active role in returning products in these systems (Barnes 1982, Zikmund and Stanton 1971). A non-active return behavior from the end-consumers has resulted in reverse distribution systems being subject to a high level of supply uncertainty

(Fleischman et. al. 1997). Thus, the coordination mechanisms in the reverse distribution systems have to compensate for the non-active end-consumer[84].

In our study we have argued that there are three different ways in which to work towards the end-consumers. One is to establish a collection site infrastructure, a second is to adapt to the flow of goods, and the third has been to establish custom-made collection systems. The latter two strategies represent a higher level of working actively towards the end-consumer, while the infrastructure strategy represent a more passive relation to the end-consumer. The collection strategies have advantages and disadvantages.

The infrastructure strategy has advantages in the broad availability towards the end-consumer. It is also an advantage that these collection sites are linked to sites that the end-consumer visits for several purposes. Thus, the infrastructure strategy promotes a high level of convenience towards end-consumers. However, the disadvantage of the system is that it is dependent on the end-consumers actively bringing the products to the system or getting in contact with the collection sites to organize the return. There is, therefore, some level of uncertainty in the system. A challenge in this respect is the fact that the end-consumer has a low attention towards information about waste issues[85]. Alternative marketing campaigns, in forms of projects, have been reported to be more successful[86]. This indicates that it is necessary to integrate the end-consumer in the collection activities.

To work actively towards the end-consumer is resource demanding and we have seen that it is more relevant for business-to-business markets, where the volumes are larger and more homogenous[87]. In these cases, collection activities may be adapted to the needs of the end-consumers, and the volume and value of products justifies the costs for the collectors to take the initiative towards the end-consumer. The system is, in this sense, active towards the end-consumer. However, it is dependent on the collection sites and collectors, and the waste management companies to recruit and inform the business-to-business end-consumers about the collection possibilities, and to obtain a direct relationship with these actors. However, contrary to the theory on end-consumer behavior, our study shows that some of the end-

[84] There are differences between the private end-consumer and the business-to-business end-consumer. The first group returns, in most cases, small volumes with high frequency, which consist of a heterogeneous flow of goods. The latter has larger volumes, batch deliveries, which consist of homogenous flow of goods. From the point of view of the collection system, it is more challenging to work with the heterogeneous flow of goods, in terms of adapting transport capacity and running the dismantling activities.
[85] Marketing campaign experiences, reported in interviews with the waste management companies in El-retur.
[86] Project reported: The Big Small Appliance Collection (www.elretur.no)

consumers take an active part in the return of products. In the RENAS case, we have seen that the end-consumers have been negotiating partners in the collection system. Thus, in these cases, our study suggests that it is necessary to work actively with the end-consumers.

Information, in the context we have studied, is an important issue. It is stated in the regulations that the actors involved have obligations to provide end-consumers with information. The authorities have reported that two out of three retailer collection sites do not inform end-consumers sufficiently about the possibility of returning products[88]. In the interviews, it was also commented upon that the collection systems were experienced as "huge pedagogical challenges[89]". The waste management companies have also reported information to be a challenge. The number and types of actors that need information are many, and information also has to be adapted over time and in level to be effective. This reminds us that the third category of flows, namely *the information flow*, needs to be considered when achieving coordinated action in a reverse distribution system. In our thesis, we have considered physical flows and commercial interests, and our contribution lies in identifying that each flow has separate coordination mechanisms, and that there is a systematic relationship between the flows. If we apply this to information flows, our reasoning remains the same: Information flows are expected to have specific coordination mechanisms that have to be related in a systematic way to the other flows in reverse distribution systems.

Information has proven to be particularly important with respect to collection activities. Therefore, the information flow is expected to have a significant impact with respect to the relationship between the reverse distribution system and the end-consumer. The case studies in this thesis have indicated that this area poses great challenges. As we have studied the coordination of reverse distribution systems, the boundaries of the systems are areas to investigate further. This is also strengthened when related to the finding from Mentzer et. al. (2001), where it is argued that logistics systems have to be adapted to specific customer segments to be truly effective.

In connection with our reasoning from the previous section, we speculate that actors that are able to coordinate information to the end-consumers may gain access to a power source in the

[87] Compared to the private end-consumer markets where the volumes are small sized and heterogeneous.
[88] Stated in a press release from the Norwegian Pollution Control (SFT) March 18th 2004.
[89] Comment from the interview with a municipality collection site: ROAF Bøler.

reverse distribution system. Thus, speculating further, this may enable a mediator to linkto the reverse distribution system. Continuing with these types of speculations brings us to the implications of our study.

10.4 Implications

The implications are separated between theoretical and managerial implications and we start with a discussion on theoretical implications.

10.4.1 Theoretical implications

The main ambition of our research has been to investigate the interaction between coordination of physical flows and commercial interests. The research has been initiated by the idea that physical flows have a significant impact on the coordination of distribution systems. In the literature, commercial interests have received the main focus in studies on coordination of distribution systems. In fact, it is argued that to a certain extent commercial interests dictate the physical flow (Roosenblom 1995). Our argument, however, is that the physical flows influence distribution systems on an individual basis.

Having investigated the coordination mechanisms for physical flows, we have identified that the physical flows follow the same variations that Thompson (1967) suggested for technologies. Physical flows can be set up to exploit pooled interdependencies, serial interdependencies or reciprocal interdependencies. As a consequence, we have found that the coordination mechanisms of standardization, planning and mutual adjustment are readily applied to physical flows. Our study supports the utilization of these concepts to physical flows. The coordination mechanisms are found in our cases and we have argued that they are well adapted to the physical flows in question. Coordination of physical flows is a means to achieve integration of activities, as the level of integration is expected to lead to increased performance in physical flows (Lambert et. al. 1998). A contribution from our study, therefore, is how these coordination mechanisms can be adapted to physical flows. We argue that the logistics literature needs to be more specific as to how integration is achieved in activity structures.

The coordination mechanisms of commercial interests in distribution systems are thoroughly studied (e.g. Heide 1994, Rindfleisch and Heide 1997). We have learned that the contract is the proper institution to regulate relationships in distribution systems, but we have also learned that the contract needs to be based on a *combination* of coordination mechanisms (Poppo and Zenger 2002, Heide 1994, Heide and John 1992, John 1984). In fact, we have identified that there needs to be a combination of hierarchical mechanisms, incentives and norms mechanisms. Such combinations provide a relationship with both formal and informal coordination mechanisms, which are argued to be necessary in contributing to both control and motivation. The literature has argued that there is a need to attend to such duality in order to achieve true effectiveness in the relationship (John 1984). In our study, we have identified that the distribution systems that have mainly utilized formal mechanisms, have achieved a lower system performance compared to the systems that have implemented both formal and informal mechanisms. As a result, our study supports John's (1984) finding. However, we have also seen that the lack of sufficient performance is not only explained by the choice of coordination mechanisms. We have argued that it is also a question of how the coordination mechanisms are *organized* in the distribution systems. Our study shows that if important elements in the distribution system are left out of the coordination scheme, performance levels can be severely affected. Specifically, we have addressed the horizon of coordination as a concept to explain this. This is an important contribution from our study.

We address the *system* as a level of analysis. This level has been addressed in literature on distribution (Stern and Reve 1979, Van de Ven 1976, Alderson 1954). It argues that the system level is difficult to measure and therefore recommend that distribution systems should be investigated at the dyadic relationship level (Stern and Reve 1980). Recently, however, some studies have argued that it is necessary to address the system level of analysis, as there are effects to be recognized beyond the dyadic relationships (Gripsrud 2004, Wathne and Heide 2004, Heide 2003). Our study supports this argument, as system effects are demonstrated in our study. We have seen that it is necessary to organize a distribution system across several functions simultaneously (in the RENAS system). There is also evidence that systems need to be established for each transfer of goods (in the independent systems). Plus, there is evidence that the lack of a system perspective influences performance negatively (in the El-retur system). These effects, we argue, would have been difficult to identify if we had utilized levels of analysis other than the system level.

The system level of analysis also brings us to the topic which has been our study's main interest: the interaction effect between the coordination mechanisms of the physical flow and the commercial interests. We believe we have enlightened an area that is valuable in research on distribution systems. Our point of departure has been that the physical flow has an impact in its own right when it comes to distribution systems, rather than 'just being guided' by the commercial interests. We believe our cases have demonstrated this point. Our argument is that the different types of physical flows promote different types of commercial interests, and therefore the coordination mechanisms vary accordingly. In this manner, we have contributed to an understanding of how the physical flows and commercial interests interact in distribution systems. It is a contribution both to the literature on physical flows and on commercial interests. In logistics and supply chain management, one needs to become more aware of how the physical flows are both promoted and limited by related areas such as commercial interests. Also, the governance literature, which handles the coordination of commercial interests, needs to be made aware of how a related topic influences the choice of governance tools. Recent studies have addressed this point (e.g. Ghosh and John 1999) and we believe we have demonstrated further potential in the area of physical flows.

An important issue in our study, of course, has been the *reverse* dimension of the distribution systems. We have worked with general principles on coordination of distribution systems and they have been applied to the phenomenon of taking back products at end-of-life. We have clarified that there are certain characteristics in the reverse distribution systems that are different from forward systems, which include the fact that products are collected and dismantled rather than manufactured and distributed. Also, the end-consumer is in theory argued to have a passive role (Barnes 1982, Zikmund and Stanton 1971). Our study partially supports this argument. We have found that end-consumers are a significant part of the reverse distribution system, but we have also found that they take both a passive and an active role to the system, which varies across the private and business-to-business end-consumers. There are clearly different *end-consumer segments* facing the reverse distribution systems. Our study contributes by differentiating the end-consumer unlike the extant theory. This development is in accordance with the findings of Mentzer et. al. (2001), who argue that logistics systems need to be adapted to specific customer segments to ensure true service quality. We have found that the reverse distribution systems in our study are adapted to and shaped by separate end-consumer segments.

We have also contributed to the understanding of *new roles* of the actors involved in reverse distribution systems. Of specific interest is the role of the waste management companies. The reverse distribution systems in our study consist of actors from several sectors, and the waste management companies are central administrators of the systems. The actors are responsible for administering the funding from the stakeholders into producing collection rates from the collection systems. These performances are then reported back to the stakeholders. The waste management companies have utilized different coordination mechanisms across the cases we have studied. A number of similarities can be found when we link the role of the waste management companies to that of channel leadership (Edgar 1977, Stern 1967). However, our contribution lies in identifying that the waste management companies take the role of a mediator (Stabell and Fjeldstad 1998), rather than of a 'channel leader'. One of the main reasons for this is the need to link a number of sectors to each other. This is a significant contribution to the knowledge of how to achieve coordinated action in (reverse) distribution systems. The evolving distribution realities consist of a large number of autonomous but interdependent companies in need of coordination (Gadde 2004). Distribution systems have a need for actors that are able to take the overall view of the system in order to achieve satisfactory system performance and coordinated action.

10.4.2 Managerial implications

One important managerial implication from this study is the system perspective. The actors that participate in a reverse distribution system have to realize that their efforts are part of a larger system, and that their actions may influence and be influenced by activities that are not directly obvious. As a consequence, it is important for managers to reflect on the system they are a part of. This is one of the main arguments in the supply management literature (see e.g. Lambert et. al. 1998) and it has also been an issue in the distribution literature (see e.g. Reve and Stern 1969). The issue has also been addressed in the reverse distribution literature, but most of the focus has been on closed loop supply chains (see e.g. Krikke et. al. 2004), which is intra-organizational to a large extent. Coordination in reverse distribution systems has to a limited extent been studied in inter-organizational settings. This study has demonstrated that there are a number of coordination issues also on the inter-organizational level. Managers need to take the reverse issues into account also in inter-organizational settings.

In addition to the system effect, it is important to understand the connection between different categories of flows. If a partner is breaking the rules of the contract, it may be worthwhile for managers to check whether the rules are a just representation of the exchange. Our work shows that this may not always be the case. It is important to realize that actors that take part in a reverse distribution system, or any system for that matter first seek to secure their self-interests. In systems design, it is therefore necessary to align self and common interests in order to ensure that goals can be fulfilled. Managers that are establishing and setting up systems need therefore to be fully aware of actors' interests in participating. System performance is also dependent on the ability to integrate activities in the physical flows well. If coordination mechanisms are implemented to ensure alignment of behavior *and* integration of activities, managers can expect to minimize both operations and transaction costs.

In addition to implications from the coordination issues, we have found elements that give insights into the context specific challenges in the industry for collection of EE-products at end-of-life. There has been debate and conflict between the systems within the industry agreement (El-retur and RENAS) and the independent systems (Eurovironment and RagnSells) with respect to their roles and activities. The systems within the industry agreement argue that the independent systems do not take on a sufficient investment (in the collection infrastructure) to provide the end-consumer with a collection system according to the EE-regulations. As a consequence, the independent systems are said to free ride on the systems within the industry agreement. The argument for free riding is that a lack of collection infrastructure makes it difficult to collect all the products for which they are responsible, and this leaves parts of their responsibility to the systems within the industry agreement. Products at end-of-life are not easily (being too costly) identified and traced back to a specific member and, as such, it is difficult to detect free riding. The independent systems, however, argue that they do in fact collect the necessary volume within their responsibility. Through this study we have learned a few facts that shed light on this debate. The issues are tied to the collection function and we address the three areas of waste management option, availability and information.

One aspect tied to collection of EE-products at end-of-life is the choice of waste management option. The reverse distribution systems within the industry agreement are established for *recycling* of EE-waste. As a consequence, there is no option within these systems for *reuse*. Actors that believe in alternative waste management options are therefore dependent on establishing additional activities and links to systems for recycling. One of the independent systems has also established the option of reuse. The collection systems are to some extent tied to these choices. The independent systems have argued that a collection infrastructure is not easily applied for the reuse option. A general collection infrastructure, it is argued, risks loosing the value of the reusable products when they are collected.

It is in many respects a philosophical question whether reuse is better than recycling, as it is difficult to quantify. It is also a question of whether reuse is useful at all. We do not make any comments in this direction. Managers need, however, to be aware of the differences if they choose to go into different waste management options. In our opinion, reuse and recycling are quite different ballgames. The people we have talked to during this study have on some occasions confronted the actors that oppose reuse and vice versa. Our message is that there are dilemmas with both views. It seems that a certain level of reuse is sensible but setting up systems for reuse is also dependent on the systems for recycling. The managers need, therefore, to be aware of the activities they want to provide to the end-consumer and understand how this influences the system as a whole.

End-consumers have low attention towards these types of systems, and therefore it is important for managers to make this a visible part of everyday operations. It is a challenge for the reverse distribution systems that the collection sites do not provide sufficient information about the system. Managers need therefore to continue working with information and availability. We argue that a collection infrastructure increases the availability for the end-consumers and should generate a higher collection rate. The establishment of a collection infrastructure is a significant investment. It demands cages and containers, transport routes and frequencies, and a certain capacity at the reprocessing units. Recognizing that informing the consumer is difficult, and experience shows that the end-consumer's return behavior does not necessarily follow the expected plans, managers need to be very conscious of this issue when they establish the collection activities and collection sites, and when they invest in collection facilities.

We have identified the collection function as a significant factor in the collection system. Therefore managers have to be fully aware of the challenges in accessing the end-consumers, both in terms of information and physical collection. In the systems, we have studied there are several routes to the end-consumers. Firstly, the authorities have issued EE-Regulations that give the end-consumers rights and duties. Secondly, the EE-companies have access to the end consumer through marketing and sales. Thirdly, the waste management companies have access to the end-consumer through their information tasks. Fourthly, the collection system has access to the end-consumer through the collection activities. We have seen that the collection activities are fragmented in that either end-consumers bring the products to a collection site, or that the collection sites/collectors/transport operators provide pick-ups from the site of the end-consumers. The end-consumers are also composed of several segments, i.e. private and business-to-business end-consumers, which have specific behavioral patterns with respect to returning products at end-of-life. The managers involved in reverse distribution systems need, therefore, to be aware of the highly complex information challenge.

10.5 Limitations

Our interest has been to study coordination in distribution systems. The thesis is derived from an interesting phenomenon (reverse distribution systems), which is studied in a specific context (industry for collection of EE-products at end-of-life). In order to get a broader view of coordinated action, it is also necessary to study the subject in related reverse contexts and for distribution systems in general.

In order to understand coordinated action in reverse distribution systems, we have been dependent on choosing *a system level of analysis* in our study. The goal has been to get an understanding of flows that cut across several stages of the distribution system. The overall perspective has to some extent been achieved at the expense of details. Therefore nuances in the cases may not be covered to the level of detail that they rightfully deserve.

We have isolated the systems that depart from the waste management companies, and have included in those systems all the actors that have a formal relationship to the waste management companies in question. In real life, however, the systems are somewhat related in the sense that actors have a relationship to more than one waste management company. In this perspective, there may be spillover effects in the system. That is, the same partner has a contract with more than one waste management company and, therefore, the different choice of governance forms may create effects on the actors that are a result of the other waste management company's governance. This is especially relevant for the development of norms within the RENAS system and its effect on the actors' behavior in the El-retur system.

We have described three cases but, as the description and analysis show, the El-retur system and the RENAS system are quite different from the independent systems. In this manner, we have to some extent compared 'apples with oranges'. However, we believe that the independent system provides added information to the study (e.g. about reuse and the need for custom made solutions), and that this has contributed to the understanding of coordinated action. Thus, the independent systems contribute positively to the internal validity of the study.

Validity is always challenging in case studies, and our study is no exception. Specifically, external validity in case studies is about analytical generalization, which is generalizing back to theory. That is, we find suggestions on how to develop more precise theoretical relationships. Our case study has contributed to a number of theoretical propositions for further investigation, thus meeting the demand for external validity in a case study. However, the fact that we have conducted our study within one specific context is a limitation on whether the propositions apply to other reverse contexts and to distribution systems in general. An advantage, however, is that our study includes the whole population within the chosen context.

10.6 Suggestions for further research

The aim of this study has been to investigate coordinated action in reverse distribution systems. Our main argument has been that distribution systems consist of several flows and that each flow needs to be coordinated individually. However, these coordination mechanisms cannot be implemented irrespective of the coordination mechanisms of the other flows. There are efficiencies in matching coordination mechanisms across flows in distribution systems. In ongoing research within this area, there are several topics that may be subject for further investigation.

We have specifically investigated coordinated action within a context of reverse distribution systems and, in particular, the industry of collection of EE-products at end-of-life. Distribution systems are being established for a number of wastes, and it would be a natural continuation to investigate coordinated action for other waste areas in order to identify the specifics and variations for coordination in those reverse distribution systems.

An area for further investigation is coordination on the system level. The *reverse* distribution systems provide a unique context in which to investigate distribution on a system level. The parts of a reverse distribution systems are separated between industries and sectors, which reflects a separation of flows. In this manner, it is fairly straightforward to identify the components of the systems. Studies on a systems level have been suggested in research within distribution (e.g. Van de Ven 1976, Reve and Stern 1969, Alderson 1954), however, it has been to a lesser extent investigated in recent research. The dyadic level has rather been the unit of analysis in recent distribution systems (Gripsrud 2004, Stern and Reve 1980). However, some recent studies have started to investigate the distribution on systems level (Heide 2003, Wathne and Heide 2004) and other studies have recognized effects beyond the dyad (e.g. Fein and Anderson 1997). Also, a very useful limitation exercised in our study has been the comparison of contract periods. In working with contract management and governance, we suggest further development using such comparisons. This also goes for time. Having compared the systems over time, significant insights into the material have been gained.

The types of interdependencies Thompson (1967) developed have proved useful in investigating physical flows. Based on our study and related research (Håkansson and Persson 2004), we believe that these concepts are valuable in investigation of the coordination of physical flows. Coordination is an important part of logistics and supply chain management (e.g. Lambert et. al. 1998). However, it has only been investigated to a limited extent and this has been rather intuitively referred to. The same goes for the reverse distribution literature, where the coordination issue is separated between open and closed systems. Closed systems are investigated within operations research (e.g. Krikke et. al. 2004). We have investigated open systems in this study but further research is needed on the coordination of open reverse distribution systems.

Further investigation is also justified within the area of minimizing costs and generating value. In distribution research, and particularly that on governance, the focus is on minimizing transaction costs. Transaction costs are often related and compared to production costs. In our study we have also reflected on a third cost category, namely *operations costs*. In addition to production costs, there are some costs tied specifically to physical flows. These are, for example, the costs tied to collection, transport and reprocessing. We believe that this cost category has been somewhat neglected in studies on distribution and therefore we argue that it gives added insight into the coordination of business relationships. On the other hand, studies (Ghosh and John 1999, Dyer and Singh 1998, Zajac and Olsen 1993) have addressed value creation vs. cost minimizing. In our study, we have primarily had a cost minimizing focus, which optimizes to some extent the goal function of the distribution systems. However, a related area for research in the understanding of value would be to investigate the establishment and development of common goals for distribution systems.

Antecedents to transactions are an important area within the governance and transaction costs literature. To some extent, this is the premise of identifying the type of governance structure and mechanisms (Williamson 1979). In our research we have been investigating coordination mechanisms and their effect on behavior. To some extent, the coordination mechanisms of the physical flows are types of antecedents to the governance mechanisms. However, with a view to taking this research further, it is an important to understand more fully how antecedents to transactions influence the coordination mechanisms when several flows are taken into account.

We have, at the end of our study, reflected on two particular areas, namely leadership in distribution systems and information flows as the third flow in distribution systems. These areas represent important understanding in taking the knowledge on coordinated action further. In particular, the context of reverse distribution systems has represented a novel arena for understanding the concept of distribution system leadership through mediation because collection systems for waste in practice are structured based on a start point from the waste management companies.

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Appendix A: Overview of Expected volumes of EE-Waste

Nr:	Category:	No of subgroups	Hjellnes Cowi report (1999[90])	Deviations 99-02	Deviations 99-02	1999-2002	2003	WMC
1	Vending machines	3	470			470	470	Hvitevareretur AS
2	White goods	21	41 000	28 493	41 000	28 493	41 000	Hvitevareretur AS
3	Brown goods	19	11 000			11 000	11 000	Elektronikkretur AS
4	Cabling and wiring	8	26 000	13 000	12 330	13 000	12 330	RENAS AS
5	ICT equipment	8	7 800			7 800	7 800	Elektronikkretur AS
6	EE-toys	9	1 700			1 700	1 700	Elektronikkretur AS
7	Heating, air-conditioning, and ventilation	3	4 100		5 024	4 100	5 024	RENAS AS
8	Lighting	11	6 700		4 340	6 700	4 340	RENAS AS
9	Medical equipment	14	2 700			2 700	2 700	Elektronikkretur AS
10	Equipment for measurement and control	28	11 000			11 000	5 765	RENAS AS
11	Office equipment	12	3 400			3 400	3 400	Hvitevareretur AS
12	EE-tools	41	12 000		14 925	12 000	14 925	RENAS AS
13	Telecommunication	8	2 400			2 400	2 400	Elektronikkretur AS
15	Clocks and watches	7	300			300	300	Hvitevareretur AS
17	Security equipment, smoke detectors	2	190		221	190	221	RENAS AS
18	Electro equipment	11	9 300		9 573	9 300	9 573	RENAS AS
14	EE-components (taken out)	8	53	-		-		
16	Batteries (taken out)	5	3 800	-	Adjusted according to new Hjellnes Cowi report			
	Total	**218**	143 913	114 553		114 553	122 968	
	Renas					**56 290**	**52 198**	
	Hvitevareretur					**29 153**	**41 691**	
	Elektronikkretur					**35 500**	**38 425**	

90 The report was printed in 1996, but the systems became operative in 1999.

Appendix B: Collected volume 2003

Category	Renas AS	Hvitevare retur AS	Elektronikk retur AS	Ragn Sells El.Gjenvining AS	Hatteland	OSO	Data-metrix	Euro vironment AS	AS Batteri retur	Total	
Vending machines	-	42,0	-	32,0				-		74,0	H
White goods	-	25 405,0	-	611,0				-		26 016,0	H
Brown goods	-	-	7 514,2	25,0				11,0		7 550,2	E
Cabling and Wiring	10 412,2	-	-	16,0				9,0		10 437,2	R
ICT equipment	-	-	5 174,2	26,0				2 196,0		7 396,2	E
EE-toys	-	-	722,5	20,0				-		742,5	E
Heating, air-conditioning, ventilation	2 610,1	606,0	-	45,0		323,0		-		3 584,1	R
Lighting	3 594,1	-	-	212,0				-		3 806,1	R
Medical equipment	-	-	218,4	3,0				-		221,4	E
Electric car components	-	-	-	1,0				-	20,0	21,0	
Equipment for measurement and control	3 776,7	-	-	11,0				5,0		3 792,7	R
Office equipment	-	-	2 369,5	11,0				-		2 380,5	E
EE-tools	15 521,1	-	-	93,0				-		15 614,1	R
Telecommunication	-	-	377,4	102,0				9,0		488,4	E
Clocks and Watches	-	1,2	-	3,0				-		4,2	H
Security equipment, smoke detectors	15,5	-	-	38,0				-		53,5	R
Electro equipment	9 814,3	-	-	60,0				-		9 874,3	R
Totalt	45 744,0	26 054,2	16 376,3	1 309,0		323,0		2 230,0	20,0	92 056,5	
	28194	20383	12063	460,5				1522	8	62630,5	
	35912,0	22575,3	13211,1	757,0		334,0		2016,0	12,0	74817,4	

Appendix C: Sources in chapter 2

The sources are printed and published in Norwegian. We have translated the title into English. The heading 'reference' is referring to how it is denoted in the text.

Reference:	In Norwegian:	In English:
Hjellnes Cowi AS, 1996	Rapport: Elektrisk og elektronisk avfall; Omsetningstall, Avfallsmengder og Håndtering, Mars 1996, Oslo	Report: Electrical and Electronic waste; Turnover, Volumes and Handling, March 1996, Oslo
ME 1996	Rapport: Miljøverndepartementet (1996/ T-1135): "Innsamling og behandling av avfall fra elektriske og elektroniske produkter"	Report: Ministry of Environment (1996/ T-1135): Collection and treatment of waste from electrical and electronic products.
SFT 1998	Pressemelding: 16. mars 1998. Ny forskrift sikrer innsamling og forsvarlig behandling av elektrisk og elektronisk avfall.	Press release: March 16th 1998 New regulations ensure collection and sound treatment of electric and electronic waste.
St. meld. nr. 8:91	St. meld. nr. 8 1999-2000: Regjeringens miljøvernpolitikk og rikets miljøtilstand	Parliament white paper – Report to the Storting no. 8 1999-2000: The Government's Environmental Policy and the State of the Environment.
SFT Feb. 6th 2001	Pressemelding: SFT ilegger importører av elektriske og elektroniske produkter tvangsmulkt	Press release: SFT are giving importers of electric and electronic products fines.
SFT March 29th 2001	Pressemelding: SFT truer med tvangsmulkt overfor elektro- og elektronikkbransjen	Press release: SFT threaten the EE-industry with fines.
SFT Oct 8th 2001	Pressemelding: Elektronikkavfall på avveier	Press release: EE-waste gone astray
SFT Oct. 9th 02	Pressemelding: Ingen informasjon hos elektroforhandlere	Press release: No information at electro retailers
SFT 11th Dec. 2002	Brev til Miljøverndepartementet: Forslag til endringer i forskrift om kasserte elektriske og elektroniske produkter.	Letter to the Ministry of Environment: Suggestions of changes to the EE-Regulations
SFT Jan 14th 2003	Brev fra SFT til Miljøvernedepartementet: Referanse: 2002/1392-1. Oversendelse av SFTs forslag til løsninger for å redusere gratispassasjerproblemet.	Letter from the SFT to the Ministry of Environment: Reference: 2002/1392-1. Regarding SFT suggestion of solutions of how to solve the free-rider problem.
SFT Aug. 27th 2003	Pressemelding: 'Gratispassasjerer' må betale 2,5 millioner	Press release: 'Free-riders' have to pay NOK 2.5 million
SFT Nov 19th 03	Pressemelding: Kontrollerer forhandlere av EE-produkter	Press release: Controlling retailers of EE-products.

SFT March 18th 04	Pressemelding: Informerer ikke om gratis retur av EE-avfall	Press release: Do not inform about free take-back of EE-waste.
SFT 2004 (april)	Notat: Implementering av EU-direktiv om EE-avfall (2002/96) i norsk rett. Revisjon av norsk forskrift om EE-avfall. Forslag til revidert forskrift med begrunnelse og konsekvensutredning.	Paper: About implementation of the EU-directive (2002/96) in Norwegian law. Revision of the Norwegian EE-Regulations. Suggestions for revised EE-regulations, including arguments and consequences.
Aftenposten Aug. 6th 2004	Artikkel: "Gjør halve jobben – får full betaling"	Article: "Perform half the job for full pay"
SFT Aug. 16th 2004	Pressemelding: Anmelder importør av elektriske produkter	Press release: Files a complaint against an importer of electrical products

Appendix D: Interview Guides

Content:

1. Waste management company
2. Members (EE-companies)
3. Authorities
4. Collection site/collector & transport operator
5. Reprocessing unit

1. WASTE MANAGEMENT COMPANY

- Background information about the company
- What products do the company cover?
- What are the company's activities and main responsibilities?
- What is the main difference between this waste management company and the other waste management companies?
- Who are the customers? Who are the competitors?
- How is the funding of the company?

About the members

- Who are the members? No of members?
- Are you satisfied with the no of members?
- What do the company do to get new members?
- How is the member contract?
- Are the member's involved/interested in your activities/responsibilities?
- What are the main challenges towards the members (free riders, cross subsidizing, fee)?
- Do you know how the members react to the biases with respect to competition (konkurransevridningen)?

The collection system

- Explain the process of the collection system?
- How was the tender? Who are the partners?
- How is the cooperation with the partners – an evaluation?
- How are the contracts? Any particular demands, e.g. ISO?
- Is there any need for renegotiation of the contracts with the partners?
- How are the products collected?
- How is the link between the end-consumer and the system?
- What happens to the products once collected?
- An evaluation of the system – challenges, advantages, disadvantages?
- What kind of costs do you have in the system?
- What kind of investments have you made in the system?

Performance – coordinated action

- Volume? Collection rates?
- Evaluation of how easy/difficult it is to run the system?
- The cost level of the system?
- The income levels?
- Any challenges with the partners of the collection system?
- Any challenges towards the stakeholders?

2. MEMBERS (EE-COMPANIES)

- What is your position/role in the organization?
- How was the decision with respect to join as member to a waste management company?
- Did you consider any alternative systems/establish a system within the company?
- Did you evaluate type of consequences with respect to join a system?
- Did you make any adjustments and/or specific investments with respect to join as members?

- How is the work internal to the organization with respect to the system/ collection of EE-waste? What kind of activities do you do?
- Do you cooperate with other actors than the waste management company with respect to collection of EE-products at end-of-life?
- Does the system for collection of EE-products at end-of-life contribute to any particular value for the company, or save costs?
- Did you do any additional efforts with respect to collection of EE-product at end-of-life.

- The length of the contract with the waste management company?
- How do you work towards the waste management companies?
- Does the waste management company's systems cover all your products?
- What kinds of costs and benefits do you have in connection with the systems?
- Are you satisfied with the system?

3. Authorities

- Does the industry agreement work to your satisfaction?
- Does the EE-regulation work to your satisfaction?
- Are there any challenges?
- What are the adjustments with respect to the WEEE directive?

- What activities are you involved in with respect to the systems for collection of EE-products at end-of-life?

- How do you accept a company as a waste management company?
- Are you satisfied with the performance of the systems/ waste management companies?
- What do you do with respect to EE-companies and the free rider challenges?

- Printed information?
  - Overview of waste management companies
  - Lists of members
  - Financial statements
  - Collection rates

4. COLLECTION SITE/COLLECTOR & TRANSPORT OPERATOR

- About the company
  - Size, strategy, organization
- Printed material
  - Annual reports, financial statements

The Process

Explain the logistics process

- What types of activities they perform and how
- Partners
- Any challenges?

- How are the products collected?
- How are the products handled? Capacities?
- How are the products categorized, sorted and stored?

- How are the products transported, from where to where?
- Frequencies, capacities?
- Sorting, accumulation?
- Quality?

- Who is the customer of the products?
- Any sub-suppliers, and how is the relationship with sub-suppliers?
- What kinds of costs do you have in the system?

The contract

- What type of contract do your company have with the waste management company?
- To what extent is the cooperation with the waste management companies formalized, i.e. governed by procedures, rules and regulations?
  - negotiations/renegotiations?
  - follow up activities?
  - terms?

- How did the tasks fit with your prior business? Any adjustments?
- Were you allowed to participate in defining the content of the tasks?
- Did you have to make investments to get the contract?
- How does the geographical areas work?

- How do you report your activity to the waste management company(ies)?
- How is the reported information used/ followed up from the different partners?
- Evaluation of the cooperation with the waste management company?
- Are there any challenges with respect to the cooperation with the waste management company(ies)?

- *Collection sites/collectors?*
  - How do you work with the end-consumer?
  - What are the collection services you provide?
  - What kind of partners do you have with respect to collection?
  - Evaluated the relationship?

- *Transport operators:*
  - To what extent are you allowed to take any initiative towards the collection sites?
  - How is the collection planned towards the collection sites?
  - Are you involved in generating volume?
  - Are there any problems with partners with respect to collection?

- Do you have any contact (formal/informal) with other actors in the system?
- Who are your customers?
- To what extent are the customers interested in what you do?
- Who are competitors? What is competition about?
- Any cooperation with competitors?

Coordinated action

- Comment on the integration between the activities?
- The costs of operations?
- Profitability?
- Level of volume?
- Predictability in planning? Is there a need for planning?
- Where is the volume generated? From what actor? Transporters, other?

- What costs/ types of cost are generated as a consequence of the contract/ assignment?
- Have the operations been in accordance with the contract?
- Did you fulfill your part of the agreement?
- What is your goal with the contract/ assignment?
- Did you achieve the goals?
- To what extent has your effort contributed to the collection of EE-products at end-of-life?
- Are you satisfied with the cooperation with the waste management companies?

A site visit to look at the processes and activities

5. REPROCESSING UNIT

- About the company
    - Size, strategy, organization
- Printed material
    - Annual reports, financial statements

The process

Explain the logistics process

- What types of activities they perform and how
- Partners
- Any challenges?

- How are the products collected and delivered to your premises?
- How are the products handled? Quality?
- How are the products categorized?
- How are the products dismantled?
- Any particular challenges?

- Who is the customer of the products?
- Any sub-suppliers, and how is the relationship with sub-suppliers?
- What kind of costs do you have in running the system?

The contract

- What type of contract do your company have with the waste management company?
- To what extent is the cooperation with the waste management companies formalized, i.e. governed by procedures, rules and regulations?
  - negotiations/renegotiations?
  - follow up activities?
  - terms?

- How did the tasks fit with your prior business? Any adjustments?
- Were you allowed to participate in defining the content of the tasks?
- Did you have to make investments to get the contract?
- How does the geographical areas work?

- How do you report your activity to the waste management company(ies)?
- How is the reported information used/ followed up from the different partners?
- Evaluation of the cooperation with the waste management company?
- Are there any challenges with respect to the cooperation with the waste management company(ies)?

- How is the cooperation with other actors?
- What are the products that you dismantle used for?

- Do you have any contact (formal/informal) with other actors in the system?

- Who are your customers?
- To what extent are the customers interested in what you do?
- Who are competitors? What is competition about?
- Any cooperation with competitors?

Coordinated action

- What kind of products do you dismantle? Categories?
- Time and resources to dismantle one product?
- Comment on the integration between the activities?
- The costs of operations?
- Profitability?

- Level of volume?
- Predictability in planning? Is there a need for planning?
- Where is the volume generated? From what actor? Transporters, other?

- What costs/ types of cost are generated as a consequence of the contract/ assignment?
- Have the operations been in accordance with the contract?
- Did you fulfill your part of the agreement?
- What is your goal with the contract/ assignment?
- Did you achieve the goals?
- To what extent has your effort contributed to the collection of EE-products at end-of-life?
- Are you satisfied with the cooperation with the waste management companies?

A site visit to look at the processes and activities

Appendix E: An overview of the interviewees for the thesis

Company:	Manager:	Address and phone:
Elektronikkretur AS	General Manager	Fyrstikkallèen 3B, Oslo Phone: +47 23 06 07 42
Hvitevareretur AS	General Manager	V/ NEL Fyrstikkallèen 3B, Oslo Phone: +47 23 06 07 55
RENAS AS	General Manager	Karenlyst Allè 9A, Oslo Phone: +47 22 13 52 00
Eurovironment AS	General Manager	Snarøyveien 73, Snarøya Phone: +47 67 59 10 87
RagnSells AS, Elektronikkgjenvinning	General Manager	Skårersletta 45, Lørenskog Phone: +47 08899
ROAF Bøler AS	Operations Manager	Bøler Avfallsdeponi, Bøler Phone: +47 64 83 57 20
Follo Truck Utleie AS	General Manager	Regnbueveien 4, Langhus Phone: + 47 64 86 10 16
Hermod Teigen	Operations Manager	Lierstranda Industriområde, Drammen" Phone: + 47 32 24 46 50
Norsk Gjenvinning Oslo	Operations Manager	Haraldrudveien 31, OSLO Phone: + 47 09700
Norsk Gjenvinning Skien	Operations Manager	Rødmyrsvingen 63, Skien Phone: +47 35 50 50 50
Haukedal Transport	Operations Manager	Hjortlandsveien 1, Flaktveit Phone: +47 55 53 56 00
Elektronikkgjenvinning AS	General Manager Operations Manager	Barkåker Industriområde, Tønsberg Phone: +47 33 37 21 10
Elektronikkgjenvinning VEST AS	General Manager	Skaganeset Industriområde, Skogsvåg Phone: +47 56 33 96 94
Stena Miljø	General Manager	Tretjernsdalsveien 70, Frogner Phone: +47 63 86 86 00

Appendix F: Overview of secondary data

The table gives an overview of the secondary data that is used for the thesis. The sources are grouped in accordance with the chapters and cases it is used for.

CASE:	Secondary data:
Chapter 2: EE-context	• Volume report from Hjellnes Cowi 1996 (in Norwegian) • Report on Electric and Electronic waste, Ministry of the Environment 1996 (in Norwegian) • Parliament white paper – report to the Storting no 58. (in Norwegian - St meld nr 58 (1996-1997): Miljøvernpolitikk for en bærekraftig utvikling – dugnad for framtida) • Parliament white paper – report to the Storting no 8. (in Norwegian - St meld nr 8 (1999-2000): Regjeringens miljøvernpolitikk og rikets miljøtilstand) • Public report NOU 2002:19 (in Norwegian - NOU 2002:19 "Avfallsforebygging – En visjon om livskvalitet, forbrukerbevissthet og kretsløpstenking.") • EE-regulations (in Norwegian - Forskriften om kasserte produkter, 16. mars 1998) • Industry agreement (in Norwegian - Bransjeavtalen) • Press releases and letters from SFT (in Norwegian) • Revision of the EE-regulations (in Norwegian - SFT: "Implementering av EU-direktiv om EE-avfall (2002/96) i norsk rett: Revisjon av norsk forskrift om EE-avfall – Forslag til revidert forskrift med begrunnelse og konsekvensutredning" (april 2004))
Chapter 6: El retur	• www.elretur.no • Tender (December 1998) • Environmental report 2000, 2001, 2003 • Example of an advertisement in the press (in Norwegian - Eksempel på annonse i dagspressen (pr 24.februar 1999)) • Information to members with contracts and regulations – spring 1999 (in Norwegian) • Various articles in the media • Project material for collection of small sized appliances (in Norwegian - Prosjektmappe: Ideer til informasin om innsamling av småapparater (2002)) • News letters (nr. 1,2,3 –2003, nr. 1,2,3,4 – 2004) (in Norwegian) • Contract about collection (in Norwegian - Avtale om innsamling av kasserte småapparater for Elektronikkretur AS og Hvitevareretur AS (01.06.2004)) • Various brochure material
Chapter 6: Elektronikkretur	• www.elretur.no/elektronikkretur • Preliminary information about fees (in Norwegian - Foreløpig informasjon om gebyr på Elektrisk og elektronisk utstyr) • Annual report 2000 (in Norwegian) • Environmental report 2001 (pr. June) • Environmental report 2001 • Membership agreement (in Norwegian - Avtale om returordning i Elektronikkretur AS (12.09.01))
Chapter 6: Hvitevareretur	• www.elretur.no/hvitevareretur • Preliminary information about fees (in Norwegian - Foreløpig informasjon om gebyr på Elektrisk og elektronisk utstyr) • Environmental report 2001 • Administrative guidelines for members (in Norwegian - Administrative retningslinjer for tilsluttede produsenter og importører – juni 2002) • List of fees (in Norwegian - Miljøgebyrliste per 1 juli 2002) • Form for reporting of volumes (in Norwegian - Skjema - Månedsrapportering for EE-avfallsmengder) • KFK – report (in Norwegian - Hvitevareretur AS – KFK-rapport 2003)

Chapter 7: RENAS	• www.renas.no • Tender (December 1998) • Tender (November 2001) • Membership agreement (in Norwegian - Avtale om medlemsskap i RENAS AS) • Contract about collection (in Norwegian - Standardavtale for innsamling av næringselektroavfall) • Contract about reprocessing (in Norwegian - Avtale om behandlingsanlegg for næringselektro) • Information about fees in RENAS (in Norwegian - Informasjon om miljøgebyr ved norsk produksjon av EE-produkter, underlagt RENAS ansvarsområde, i henhold til EE-forskriften.) • Various presentations • Annual reports 2000, 2001 • Norwegian Environmental reports (Miljørapport 2001, 2002, 2003) • English environmental reports 2001, 2002, 2003 • Information from RENAS (in Norwegian - RENAS informasjon: (nr. 2,3,4-2003, nr.1,2-2004)) • Presentations and brochures: RENAS member seminar (March 2003) • Presentations: RENAS reprocessing unit seminar (September 2003) • Presentations: RENAS collector seminar (Fall 2003) • Evaluation report on volumes (in Norwegian - EE-avfallsanslag innenfor RENAS sitt ansvarsområde (October 2003)) • Presentations: RENAS member seminar (March 2004)
Chapter 8: RagnSells	• www.ragnsells.no • Various brochures
Chapter 8: Eurovironment	• www.eurovironment.no • Various brochures

Appendix 6: NETLOG case - the RENAS system

BUSINESS UNIT CASE – A WASTE MANAGEMENT COMPANY

Team: Bente Flygansvær

Written by: Bente Flygansvær

0. BACKGROUND/CONTEXT

Question or problem statement

- Why are waste management companies, like RENAS, established?
- Why did RENAS restructure their reverse logistics system?

General context

The waste management company discussed in the case is RENAS. The company was established March 16th 1998 as a result of an agreement between the industry and the government, i.e. the Ministry of Environment (ME). The content of the agreement is that the industry takes a responsibility to collect 80% of the waste from electric and electronic (EE) products. The industry is given a five-year trial period to demonstrate that they are able to take this responsibility. The period runs from July 1999 to July 2004. Sanctions and fines are the threat the industry faces if they do not fulfill their part of the agreement.

The industry has answered the responsibility by setting up waste management companies. These companies are responsible to structure systems to collect 80% of EE-products at end-of-life. The work from the industry is supported by an EE-Act that the government introduced July 1st 1999. The Act makes it mandatory for every company in the EE-industry to collect 80% (every company that import or produce EE-products). Additionally, in a report presented in 1996 the expected volumes of EE-products at end-of-life in Norway is calculated. The same report has also prepared a list of all EE-products, covering 18 groups and 219 subgroups. The industry has established three waste management companies, which are given their separate products to work with. RENAS cover general electric products.

The EE-companies may sign up for memberships to the waste management companies. The waste management companies then take the responsibility on behalf of their members to collect 80% of their EE-products at end-of-life. The waste management companies are funded through the memberships. The members pay an initial fee and a product-based fee.

RENAS established a reverse logistics system from July 1st 1999. The system consisted of a set of actors that was to collect, transport and reprocess products. The actors tied to the system were given a three-year contract until 2002. The system was evaluated towards the end of the first contract period. RENAS decided to restructure the system to a great extent, going from few to many actors in the systems. The result was a 50% decrease in cost and a 50% increase in the collection rate.

1. DESCRIPTION OF THE FOCAL RESOURCE–THE BUSINESS UNIT

The focal resource is RENAS, a waste management company. The company is an administrative unit with a responsibility to structure and manage a reverse logistics system for general electric. In addition, the company has to relate to a number of stakeholders. Within these two areas there are a number of different tasks to address. In this case, we will focus on their work with the reverse logistic system.

- **The rationale of the company**

RENAS is a non-profit company that administers a system for collection and recycling of general electric products at end-of-life. RENAS has four employees, and is based in Oslo. The system that is administered is countrywide. Two industry organisations are owners of RENAS with a 50/50 % share.

RENAS is a member organisation, and works to fulfil the obligations from the EE-Act on behalf of their members. In return, the members pay a fee. The fee is supposed to harmonise with the costs of the system. In this sense, it is expected that the fee will be regulated according to the costs. However, there are two aspects that keep RENAS from regulating the fee too often. The first is predictability. RENAS realise that their members work in an area where there are a high degree of long-term contracts. Regulating the fee too often would offer problems for the members with respect to their contracts. The second is expected imbalance between the volumes and fees for the future. The volume of returned products in the future is expected to increase more than import and production. Thus, the imbalance at present when the import and production is larger than the return of products is expected to level out.

The primary purpose of the reverse system is to secure environmental proper treatment of hazardous materials. Products like general electric, and the other EE-products, are a fairly new type of waste. In this sense there is not much knowledge concerning the environmental consequences of these types of materials when they end up as waste. However, certain materials like mercury, lead, cadmium, PCB, and SF_6 gas are proved to have severe influence on the heritage material and the climate. RENAS has a responsibility to engage in finding secure ways to handle dangerous materials, and to research into materials of which we do not yet know the consequences. Looking for new knowledge goes for both the product itself, and for the process of returning the products.

RENAS also has a responsibility to provide information about the system. Being the center of a relatively large system there are many actors to inform, and correspondingly type of information to provide.

- **The stakeholders to the system**

Stakeholders to the system are multiple. The illustration below gives an overview:

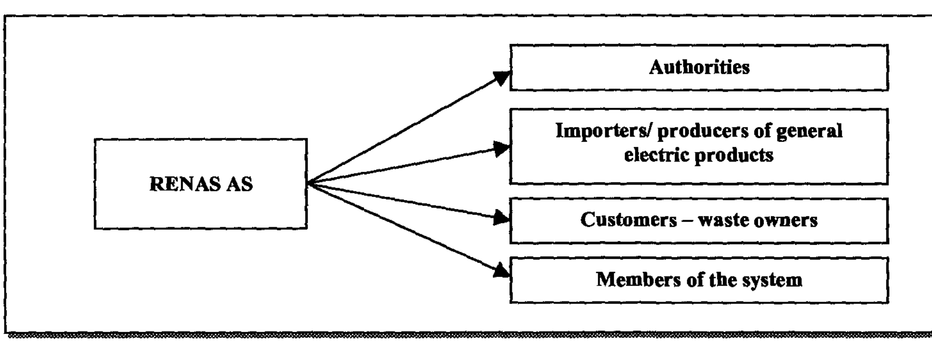


Figure 1: Stakeholders to the RENAS system

The relation that RENAS has to each of its stakeholders is somewhat different. The authorities have an interest in the fulfillment of the EE-Act, and as such RENAS has to provide reports of the compliance on behalf of their system. The importers and producers of general electric represent the potential members to RENAS, and it is in their interest to acquire as many members as possible. As such, RENAS need to inform this stakeholder group of the benefits of becoming a member in the RENAS system. The customers[91] are the owners

[91] The 'customer' represents the buyers, and product owners, of the general electric products. This stakeholder group are, in a reverse perspective, the suppliers to the system.

of the products that are to be returned in the system. RENAS need to inform this group about the services of the system. The interests of the members are that RENAS fulfil the responsibilities on their behalf at the lowest possible costs. In this sense, it is necessary for RENAS to inform the members that they fulfil their obligations.

- **The reverse logistics system for general electric products**

RENAS has set up and structured a reverse logistics system taking back general electric products. The system is managed from RENAS, but structured based on external companies. The companies in the reverse logistics system are actors from the waste industry.

RENAS operates with a three-year contract period. The system was first introduced July 1st 1999. It is the first system in the world of its kind. As a consequence, there were no examples to look for when setting up the system. Based on a discussion within the industry in advance, a particular structure was decided upon. The structure is presented below:

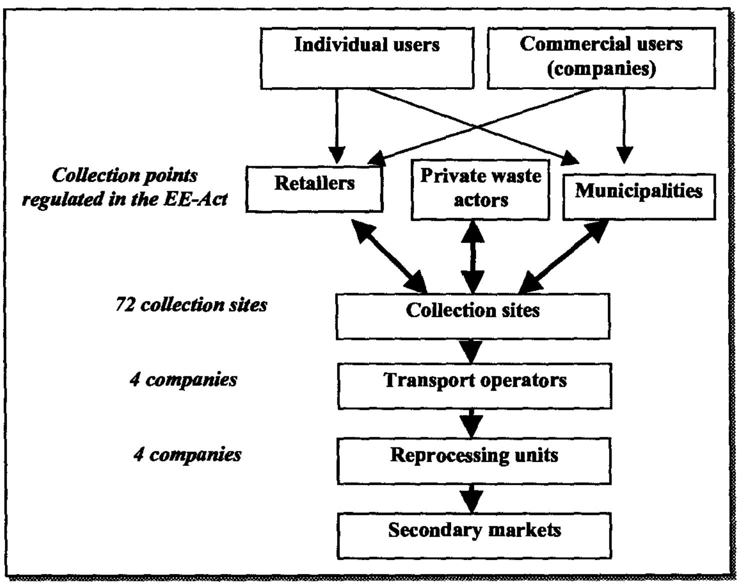


Figure 2: Reverse logistics system in the contract period from July 1999 to July 2002

The products that are being returned are generated from both private and commercial consumers[92]. The consumers are free to return their products to the collectors. In principle without cost, because a fee paid at time of purchase funds the system, but if there are extra

[92] Consumers and customer are used interchangeably.

costs generated as a consequence of the actual return (i.e. extra transport) it needs to be covered from the customers. The collector receives the products returned, sort them and gather a certain volume. The transporter brings the volumes from the collector to the reprocessing unit. A reprocessing unit dismantles the products into materials, and sells the materials in a secondary market.

The actors were given dedicated geographical areas to work with, which where supposed to give a certain level of volume. Guarantees of a certain volume where to secure an economic viable business for the actors. The actors on their side had certain criteria to fulfill with respect to service towards their cooperating partners in the logistics process (i.e. collection capacity, transport frequencies, number of dismantled fractions). Based on the reported activity (i.e. collected, transported and dismantled volume) the actors were paid according to the contracted prices.

Experiences over the contract period demonstrated weaknesses with the system. RENAS worked with the actors in the waste industry, both actors included in the system and not. The result was a restructuring of the system for the next contract period. The type of actors was rearranged, and the number of actors was increased. Additionally, the incentive structure was changed. The new structure is illustrated in the figure below:

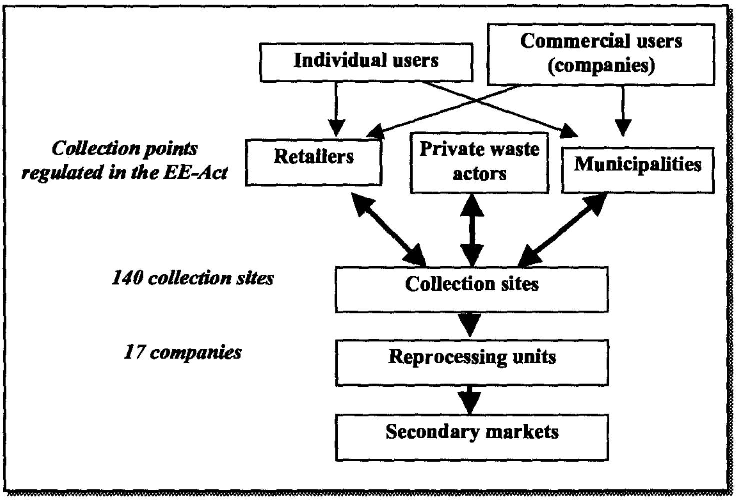


Figure 3: Reverse logistics system in the contract period from July 2002 to July 2005

The changes in the new structure compared to the old are several. The main differences include introduction of increased competition within the system (increased number of actors) and a new incentive structure. The changes are discussed in more detail below.

- **Competition**

In the new model there are no geographical limitations for the actors. An experience from the first model was that the actors were sole operators within their area, which lead to a tendency of monopolistic behavior. In the second model, the actors can work with customers all over the country. Additionally, the number of actors has increased dramatically. In this sense RENAS stimulates competition between the collectors, which is expected to result in a better service towards the customers. Secondly it is expected to secure an increase in collected volume. Thirdly, a larger number of actors involved will secure a broader operational experience. RENAS argues that this will secure a base of suppliers for the future. Too few actors involved in the system, placed RENAS in a vulnerable position. Fourth, competition put pressure on the costs of the companies, leading to an increased efficiency in the system.

- **A new incentive structure**

RENAS realized that products in the system had both a so-called positive and negative value. A positive value means that the products have a net value. That is, the products may have a high share of e.g. steel, copper, and aluminum. Such fractions have a secondary market value.

Products with positive value had a tendency to not entering the system, but were traded directly in the secondary market. As such, the hazardous materials were not removed from the products. Products with negative value means that they do not have a value in a secondary market, and were in most cases returned to the system. In order to secure that both groups of products were returned to the system, RENAS redesigned the incentive structure. The actors are paid a given price per ton of products, and are individually responsible for the cost. In the previous system, the actors were supposed to report their actual cost generated from the performed activities. This resulted in manipulation of costs and opportunistic behavior.

2. INTERFACES WITH SIMILAR RESOURCES –OTHER BUSINESS UNITS

The business unit is an administrative unit with a few employees. However, it is their responsibility to structure a reverse logistics system with the use of sub-suppliers. Going through the interfaces that RENAS are related to, the most central are considered to be the following:

- The collectors
- The reprocessing units
- The members
- The customers
- The authorities

RENAS – the collectors:

RENAS and the collectors have a common interest in finding volume of general electric at end-of-life. RENAS has to follow up the 80% level towards the authorities. The collector is RENAS' tool to obtain this goal. 140 collectors are included in the system. The collectors on their side have an interest in making money. The more volume they are able to collect the more revenue they have a possibility to generate.

RENAS – the reprocessing units:

RENAS and the reprocessing unit have a common interest in extracting hazardous materials of the products. The general electric products have a number of poisonous materials that can harm the environment. The reprocessing unit is RENAS' tool in order to fulfil their obligation towards the EE-Act with respect to hazardous materials. 17 reprocessing units are part of the system. The reprocessing units are paid according to the sorting and dismantling of products into seven fractions.

RENAS – the members:

The members are the fundament to the system. The interface towards RENAS covers two dimensions. First, it is a question of the actual membership per se and second about the fee that funds the system. RENAS has per June 2003 approximately 1300 members. The members on their side need RENAS in order to fulfil their obligations towards the EE-Act and the authorities.

RENAS – the customers:

The customers of general electric need an option to get rid of their waste from general electric products. RENAS' main task is to provide such an option on behalf of its member companies. The interface between RENAS and the customers is the system. The presence of 140 collectors countrywide provides such a service. The customers in the RENAS system, are primarily commercial customers, and are numerous.

RENAS – the authorities:

The EE-Act is the main interface between RENAS and the authorities. RENAS has to fulfil the demands on behalf of the members. RENAS relates to one party, the so-called SFT[93]. The authorities needs RENAS to perform accordingly in order to attain their political goal towards sustainable development. The direct contract that give RENAS the mandate to take such a responsibility on behalf of the authorities are directed through the industry agreement.

3. INTERFACES WITH OTHER RESOURCES

3a) Business unit vs. Products

The business unit interfaces with a range of general electric products. The report published in 1996[94] has a detailed description of which products that is within the RENAS responsibility range. The products are sorted according to the customs tariff numbers. RENAS has on their side divided the products into seven fractions. The fractions are divided according to nature and character of the products, i.e. whether it is metals, plastics, glass, light bulbs etc. However, the main interest for the business unit towards the products is to ultimately divide them into hazardous materials and non-hazardous materials.

[93] SFT is short for The Norwegian Pollution Control Authority.

[94] Hjellnes Cowi AS, "Elektrisk og elektronisk avfall; Omsetningstall, avfallsmengder og håndtering, Oslo.

The products mark the business unit to a maximum degree. RENAS entire existence is based on the product category, i.e. general electric. The system that they work with is set up in order to fit the products, and the information that they provide to all their stakeholders are based on the product in some form or another. The business unit however, does not mark the products. The products' main functions are in the service of customers, prior to end-of-life. The products are neither designed, produced nor used with respect to the work of RENAS. The materials that the products are made of, are chosen with respect to their functioning for the customers. It is an ideal wish from an environmental perspective that the demands of recycling are considered in product development for the future. At present however, this is not the case.

The fee that RENAS acquire based on the products amount to 100% of their turnover. The fee itself represents the business unit share of the products total costs. Per June 2003 the fee is divided in three intervals, amounting to 0,1%, 1% or 5% of the product value.

3b) Business unit vs. Facilities

The business unit relates to three main facilities. It concerns the standards of the collection site, the collection equipment (vehicles included) and the dismantling facility.

First, the business unit has certain demands towards the collection site. It concerns the layout of the area. The primary purpose is to secure proper handling of the products. Damage to the products at the collection site, may cause hazardous materials to leak into the environment. In such a case, RENAS has not fulfilled its goals towards the authorities. The collection site therefore marks the business unit. The activity at the collection site however, is not dedicated to RENAS. Other products may very well be collected at the site. The business unit marks the collection site to some degree, as they have to ensure the fulfillment of the demands that RENAS pose. The RENAS products are one of many incomes to the collection sites. The collection sites represent however 100% of RENAS capacity.

The collection equipment is the collectors' responsibility, and not RENAS'. However, the quality of the product handling is dependent upon the proper collection equipment (i.e. cages and containers). The collection equipment therefore marks the business unit. The business unit does however not mark the collection equipment. All the volume are returned in some form of equipment, resulting in the equipment being 100% of RENAS' capacity. The collection equipment consist of some directly dedicated to the RENAS products (e.g. cages), but other equipment are generic (e.g. large containers and vehicles). For the dedicated equipment the business unit amount to 100% of the turnover, but for the generic equipment the share of turnover is lower.

The dismantling facility is in most cases set up as a result of the contract with RENAS. That is, when the reprocessing unit entered into the contract with RENAS, they had to invest in the dismantling facility that is necessary to handle the general electric products. As the system is new such specific dismantling equipment did in most cases not exist previously. In those cases where there are manual dismantling, it is expected that the employees existed prior to the RENAS contract, but may have increased in numbers. Again, RENAS is dependent on the dismantling facility, which amount to 100% of RENAS' capacity. However, the reprocessing unit may also process additional products, making the RENAS share of turnover lower than 100%.

3c) Business Unit vs. Business Relationships

RENAS interfaces with a number of relationships. RENAS is a coordinator for the system, but does not take directly part in the operations. Thus, the operating parties relate directly to each other. These relationships interface with RENAS.

Business unit		Business relationship	
• RENAS	and	Customers	vs. Collectors
• RENAS	and	Collectors	vs. Reprocessing unit
• RENAS	and	Collectors	vs. the other waste management companies
• RENAS	and	Reprocessing unit	vs. Secondary market
• RENAS	and	Reprocessing unit	vs. the other waste management companies

Additionally, there are relationships between RENAS' stakeholders, which are of interest to the business unit as well. The relationship between stakeholders interfaces with RENAS.

• RENAS	and	Members	vs. Customers
• RENAS	and	Members	vs. EE-companies that are not members
• RENAS	and	Customers	vs. EE-companies that are not members
• RENAS	and	Authorities	vs. EE-companies that are not members

- **RENAS vs. relationships in the operations of the system**

The relationship between the customers and the collectors are relevant, as this is the key in generating the 80% collection rate. In the new system, RENAS has structured the incentives so that the collectors need to actively look for customers in order to get volume. The collectors have different strategies toward this issue, in the sense that they are more or less active in looking for volume. The customer behavior is different dependent on the products having a positive or negative value. When the products have a positive value, the customers usually try to sell the products and often discuss the sales with more than one collector. However, if the products have a negative value, the customer looks for the most convenient return possibility. RENAS is marked by the relationship in both ways. It is important for RENAS to get a hold of products with both positive and negative value, and need their collectors to be active towards the customers. Also, they are dependent upon the collectors to be active toward the customers to achieve the 80% collection rate. For RENAS the relationship represent 100% of the turnover, while collectors and customers may exchange products that are beyond the product categories of RENAS.

The relationship between the collectors and the reprocessing unit is also highly relevant. When RENAS left the principle of dedicated geographical areas, the collectors and reprocessing units had to start individually decide whom to cooperate with. That is, the collectors have to deliver their products to one of the 17 reprocessing units, but which one is up to them to decide. The new structure has resulted in the parties becoming contract partners with each other, rather than just coordinating a process like before. Again, RENAS is totally marked by the relationship, while the parties to the relationship may trade products beyond that of general electric. The relationship then is 100% of RENAS turnover, but it is less vice versa.

RENAS also interfaces with the relationship between the reprocessing unit and the secondary market. It is important for the total process that the reprocessing unit finds secondary markets for the materials, however this is their responsibility. RENAS is not involved in the process, but has as a condition that the secondary markets needs to be environmental conscious choices. RENAS is in principle done with the responsibility when the products are collected, the hazardous materials extracted and destructed. In this sense the RENAS is only partially marked from this relationship, and the relationship is partially marked from RENAS. The economy from the secondary market is not an issue to RENAS.

Relationships that are somewhat relevant are the collectors and reprocessing units relationship to the other waste management companies. Both the groups of actors may participate in other system in addition to RENAS. To the extent that they do, is of some relevance for RENAS.

Customers have stated that they would like to relate to one, or few, waste actor(s). The customers in most cases possess products belonging to all the waste management companies. To the extent that RENAS' collectors are part of the systems, which are managed by the other waste management companies, it is a higher probability of getting a hold of volume. Collectors that have contracts with RENAS only, are known to collect products from the other systems for free in order to please the customers in this respect. The relationships between the collectors and the other waste management company companies marks in this case RENAS, and RENAS marks the relationship in the sense that it enables their collectors to be a total service provider in waste handling. In those cases that RENAS' collectors take back products from other systems for free, the relationship can be said to have some share of RENAS turnover. Also, the scale economies are relevant to RENAS' turnover.

The argument towards the relationship between the reprocessing unit and the other waste management companies are one of scale economy, and simplicity towards the collectors. To the extent that the reprocessing unit can dismantle products from more than one system, they are able to get better capacity utilization of their facilities, and better prices in the secondary markets. In the long run, being more competitive and economic viable. RENAS is therefore marked from the relationship between reprocessing units and the other waste management companies, and vice versa. The relationship has a share of RENAS' turnover in the sense that it keeps RENAS' costs down.

- **RENAS and the relationship between stakeholders**

RENAS interfaces with relationship between their stakeholders. One of importance is the relationship between the members and their customers. If members inform their customers about RENAS, it can to some degree influence the level of volume. However, the system is not dependent upon such communication. These relationships therefore mark RENAS to a low degree. RENAS however, marks the relationship to a higher degree. The fact that EE-companies are regulated with the EE-Act, the customers can have environmental criteria in choice of partners. In these cases it will be important for the members to refer to a relationship with RENAS. RENAS' turnover is directly tied to the sales from members to their customers, and in this case is marked 100% by the relationship. Vice versa the relationship is marked to the level of the fee.

The EE-companies that are not members of RENAS do not have to pay the fee. In this sense they get some kind of advantage compared to the members. RENAS may over time be influenced if the members have a disadvantage in the market. However, RENAS report that 70% of the EE-companies has joined the system. In this sense RENAS is marked to some degree of the system, and the relationship is somewhat marked by RENAS. The latter depends to what extent the parties are given advantages or disadvantages as a consequence of RENAS. The same goes for the relationship between the EE-companies that are not members and their customers. The customers may choose to work with companies that has an environmental conscious strategy, compared to those that are not. However, in some cases the lower prices may tempt customers more. The relationship will to some degree influence RENAS, and therefor marks the business unit to some degree. RENAS turnover is marked in the sense that EE-companies that are not members to the system do not pay any fees. Still, it is not possible to leave products out of the system based on which company it originates from. RENAS may therefore pay for products from non-members.

An important relationship to RENAS is that between the authorities and the EE-companies that are not members. RENAS do not have authority to control actors beyond the system, and are dependent on the government to do so. The extent of the authorities' control of non-member is therefore relevant to RENAS. It will provide RENAS with legitimacy for their operations, and secure the memberships. The relationship between the authorities and the EE-companies mark RENAS to a high degree. It does not directly influence with the turnover, but does so indirectly. To the extent that the authorities' control generates new members to RENAS, the fee will increase.

4. CONCLUDING REMARKS

Talking about RENAS, we are in principle talking about four employees, but referring to an entire network of actors, activities and resources. The discussion discloses that the business unit is a true administrative co-ordinator.

It is very dependent on its partners. However, the partners are not that dependent on RENAS. The partners to the system have in all cases alternative business. The attractiveness of RENAS is then to what extent they are able to generate business to the system. The members are the key to this matter. In other words, RENAS is vulnerable in the system, but balances the vulnerability with the power over possessing the large amount of memberships. The stakeholders however, are dependent on RENAS in order for the system to attain their goals.

The change of system structure has shown a dramatic improvement to RENAS. The cost is reduced with 50% and the collection rate having increased 50%. An important aspect in this change has been that the actors are allowed to trade the goods and choose their partners based on individual criteria.

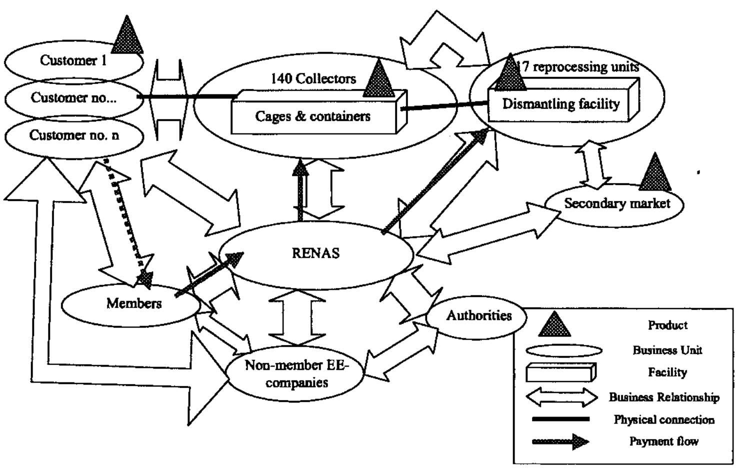
An important aspect as well is the economy of scale that is generated from the collectors and reprocessing units' participation in more systems. This effect is not directly taken into consideration by the waste management companies, and show that it is not necessarily an advantage to set up a separate system. The view of the customer is of importance in this argument. It may also influence the possibility to develop and innovate within the area.

5. INTERVIEWS CONDUCTED FOR THE CONSTRUCTION OF THE CASE

1. Interview by Bente with manager RENAS – Gunnar Murvold – July 2002.
2. Interview by Bente with two collectors and two reprocessing units – May 2003.

6. ILLUSTRATION OF THE FOCAL AND MAIN RESOURCE INTERFACES

Figure 4: The important resource interfaces



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