



JÖNKÖPING INTERNATIONAL  
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# Strategy for the Reverse Supply Chain:

Applicability of the Lean and the Agile Concepts

Master's thesis within International Logistics and Supply Chain Management

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Jönköping, May 2010

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## Master's Thesis in International Logistics and Supply Chain Management

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### Abstract

The reverse part of the supply chain becomes more and more important due to the legislation, environmental concerns, higher volumes of returns, etc. As a result, companies cannot see the reverse supply chain as the additional costs only and have to think strategically. The right strategy for the reverse supply chain can help to achieve the competitive advantage. However, there are not so many researches made about strategies for the reverse supply chain yet, contrarily to the forward supply chain. Therefore, the need to adopt strategies for the reverse supply chain appears.

The purpose of this thesis is to analyze the applicability of the Lean and the Agile concepts in the Reverse Supply Chain strategy, and to investigate the driving forces and challenges for the implementation of the strategy in the Reverse Supply Chain.

The inductive research approach was applied in this thesis. The qualitative study was the most suitable for the better understanding of the point of view, the attitudes, the perceptions of the interviewed participants regarding a wide range of issues related to the choice, and the implementation of the strategy for the reverse supply chain. Multiple case studies as the research strategy was chosen, thus data was collected from 13 interviews conducted at four companies: Fläkt Woods, Systemair, Swegon and Rettig ICC.

The main conclusions from the analysis of the applicability of the lean and the agile concepts in the reverse supply chain are that the design of the reverse supply chain depends on the characteristics of the returns: the size, the volume, the life cycle, the B2B or the B2C returns; as well the reasons for the returns: the guarantee service/ after warranty service. When weighting the results about the lean and the agile concepts implementation in the reverse supply chain, it appears relatively more likely that none of the companies implement either only the lean or only the agile approach. Due to various reasons, there are different material flows and they require different strategic approaches. The agility is implemented close to the customer in order to ensure speed and high responsiveness. Lean flows are implemented from the manufacturer to the supplier or the third party (recycler, etc.). Even more, the companies seek to find the optimal combination of both strategies, or as it called – leagile. Two different approaches for leagile concept's implementation are used: preponement and de-coupling point. Driving forces for the strategy implementation are green forces, increasing the demand for improving customer service level, cost reduction, and the new retail marketing strategies. Main challenges for the strategy implementation are the lack of formal operating procedures, the lack of information sharing with the suppliers, 'false alarm' returns, the lack of local competence, and the lack of forecasting possibilities.

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# 1 Introduction

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*This chapter will begin with the presentation of the background and the problem formulation. Further, the purpose and the research questions will be defined and the delimitation and the outline of the thesis will be presented.*

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## 1.1 Background

Reverse supply chain has both the service (repair, recalls, etc.) and the environmental component (Harrison & van Hoek, 2007). During the past decades, people are talking more and more about the environment problems. To deal with it actions are taken into different levels: from global consideration to a single person consumer. In order to reduce the impact on the earth, there were new legislations introduced. Regulations on the waste management as well as promotion for recovery of resources exist in Europe, US and Japan, (Kumar & Putman, 2008). Most of the countries have directives on preventing and managing waste streams (municipal, industrial, hazardous). The European Union is developing regulations such as the End-of-life Vehicles Directive (ELV), Waste Electrical and Electronic Equipment Directive (WEEE), Restriction of Use of certain Hazardous Substances Directive (RoHS), and the Packaging and Packaging Waste Directive (Kumar & Putman, 2008). All of these legislations lead companies to include the reverse supply chain in their business processes, because the manufacturer is obliged to take the responsibility over the returned goods and manage a proper disposal. Even more, the rights of the customer are protected by law in the EU and the customer has a right to return the product under the range of circumstances. Thus, nowadays an importance of reverse flow of supply chain is growing.

The objective of a supply chain is overall generated value maximization. It is the difference between the worth of the final product to the customer and the costs the supply chain incurs to fill the customer's request. For the commercial supply chains, it would be strongly correlated with the supply chain profitability (Chopra & Meindl, 2006). Naturally, the company seeks to decrease the costs and increase the revenue. For achieving one or both goals different actions could be taken and in order to survive in a market a company must have a competitive strategy. Even more, the competitive strategy should be in alignment with the supply chain strategy because the company's success or failure is highly dependent on it. According to Chopra and Meindl (2006) there are three important steps in achieving the strategic fit. First, the competitive strategy and all the functional strategies must fit together, and each functional strategy must support other functional strategies to help to achieve a goal of competitiveness. Second, the different functions must properly structure their processes and resources to be able to execute strategies successfully. Third, the design of the supply chain and the role of each stage must be aligned to support the supply chain strategy. More or less most of the companies are successful in implementing their business strategy goals into the forward supply chain, but recently the growing importance of the reverse supply chain have created new challenges and problems.

The companies saw the reverse supply chain as the additional costs to the business. However, they have now started to realize that it could be beneficial. First, the economical value, as the product could be recycled, reused, remanufactured and secondary raw materials could be sourced back to manufacturing (Savaskan & Wassenhove, 2006). Second, the customer satisfaction could be achieved by a liberal return policy



and responsiveness (Meyer, 1999; Smith, 2005). In addition, it is an incentive for a customer to buy because the customer is not afraid of risk of damaged or not meeting the requirements product. It seems easy to notice the new opportunities within the integration of the closed loop supply chain. Anyhow, the challenge to deal with the reverse supply chain in effective and efficient way still appears due to the lack of knowledge and skills. Consequently, to keep on a right path the guidance of the supply chain strategy is very important.

### **1.2 Problem Formulation**

The problem appears when a company has to manage the reverse supply chain in a cost efficient way. Unlike forward supply chains, strategies for the reverse supply chain are undeveloped and unexplored (Blackburn, Guide & Souza, 2004). Moreover, forward and reverse supply chains have different characteristics and cannot be treated by the same strategy (Rogers & Tibben-Lembke, 2001). Furthermore, there are many factors and problems in the implementation of a strategy in the reverse supply chain. First, the environmental impact in designing a reverse supply chain is particularly high (Kumar & Putman, 2008). Second, high uncertainty of the product returns is involved and it leads to almost impossible forecasting. Third, a wide variety of the returned products requires different approaches and it raises a challenge for saving costs (Genchev, 2009). Forth, the speed is often not considered as a priority. Fifth, product life cycle issues are more complex (Harrison & van Hoek, 2007). However, the appropriate adaptation of forward supply chain strategies for the reverse supply chain is necessary.

In the previous studies on the reverse supply chains, researchers (e.g. Wang & Hsu, 2010; Min, Ko & Ko, 2006; Hu, Sheu & Huang, 2002) have focused on programming the optimization models in order to save the costs in reverse logistics. Fewer researchers have analyzed management issues and strategies. Banomyong, Veerakachen and Supatn (2008); Wikner and Tang (2008) focused on leagility concept in reverse supply chain. Blackburn et al. (2004) adapted Fisher's matrix for functional and innovative products in the reverse supply chain strategy. Krikke, Blanc and Velde (2004) have grouped the product returns into different categories (end-of-life returns, commercial returns, end-of-use returns, reusable items), have assigned responsive, efficient, and control supply chain strategies to them. However, there are more unexplored ways of adapting forward supply chain strategies for the reverse supply chain, and what is more there is a lack of analysis based on the strategies' applicability from a managerial point of view.

According to Christopher, Peck and Towill (2006) there are four generic strategies for the forward supply chain: lean (plan and execute and continuous replenishment), agile, and leagile, based on the demand and supply characteristics: predictable/unpredictable demand and short/long lead time. There are about five supporting strategies to the generic ones for the specific issues: network-relationships; postponement and speculation; asset and capabilities; TPL outsourcing; local –global. All of these concepts lead to a particular supply chain strategy for a company. When selecting a right strategy for the supply chain there is a need to look into one's product characteristics (demand, innovation, lead time, life cycle, etc.) as well as to ensure the compatibility with the company's competitive strategy. However, for the reverse supply chain, it becomes more problematic because of high uncertainties of the product returns and it leads to unused business possibilities, because of the pressure of the cost reduction and attractiveness of the product return possibilities for a customer. It raises a question about the factors that lead

to a successful strategy implementation. Thus, the need to analyze the applicability of the lean and the agile concepts in the reverse supply chain appears. Simultaneously, to explore the driving forces and challenges of the strategies implementation in the reverse supply chain.

### **1.3 Purpose**

The purpose of this thesis is to analyze the applicability of the Lean and the Agile concepts in the Reverse Supply Chain strategy, and to investigate the driving forces and challenges for the implementation of the strategy in the Reverse Supply Chain.

### **1.4 Research Questions**

In order to achieve the aim of this thesis the following research questions have been formulated:

RQ1: How is the strategy for the reverse supply chain perceived?

RQ2: What are the driving forces for the strategy in the reverse supply chain?

RQ3: What are the criteria for selecting the lean and the agile concepts in the reverse supply chain strategy?

RQ4: How are the lean and the agile concepts implemented in the processes of the reverse chain supply chain?

RQ5: What are the challenges in applying the lean and the agile concepts in the reverse supply chain?

### **1.5 Delimitations**

Due to the restricted time and wide scope of the research subject, the authors of this thesis are limiting themselves:

- The focus will be on the general strategy for the reverse supply chain, and not seeking to find all side factors influencing the decisions on the strategy selection.
- Only the commercial returns will be taken into the account. As a result the authors will not analyze end-of-life, the end-of-use, re-usable items, or packaging.
- The analysis of the strategy in the reverse supply chain will be conducted in the specific industry – manufacturing of machineries for the indoor climate solutions (including cooling, ventilation and heating equipment), and focusing on the dominant production, produced in the visited production units.
- Only producers will be interviewed. Thus, suppliers, suppliers' suppliers, customers, recyclers or any other third party involved in the reverse supply chain will not be interviewed.
- When focusing on the processes and activities in the reverse supply chain, the authors will not analyse these processes or activities (e.g. refurbishing, remanufacturing, recycling, etc.) from the technical (or engineering) point of view.

## 1.6 Outline of the Thesis

The thesis is constituted of seven chapters – introduction, frame of reference, methodology, empirical study, analysis, conclusion, and discussion. Detailed summaries of the chapters are presented below (Table 1.1).

Table 1.1 Outline of the thesis

Chapter	Description
1. Introduction	<i>This chapter will begin with the presentation of the background and the problem formulation. Further, the purpose and the research questions will be defined and the delimitation and the outline of the thesis will be presented.</i>
2. Frame of Reference	<i>This chapter will focus on the reverse supply chain and the supply chain strategy related literature, theories and previous studies. The chapter will go through different theories on the reverse supply chain, its processes and design, the strategy, the lean, the agile and the leagile concepts and their applicability for the reverse supply chain.</i>
3. Methodology	<i>The chapter will start by presenting the research philosophy and research approaches applied for this study. Furthermore, the research strategy, the data gathering methods and data analysis procedures used to conduct this research will be described. The chapter will end by discussing the validity, reliability and criticism of chosen method.</i>
4. Empirical Study	<i>The chapter will present the empirical material collected from the interviews at four companies. For each company the empirical findings will be presented under the sub-chapters: general company information, products and returns, reverse supply chain processes, reverse supply chain strategy, driving forces and barriers.</i>
5. Analysis	<i>The chapter will present the analysis of this thesis. The findings from the empirical part are connected to the frame of reference. The structure of this part was selected to answer to the research questions, raised at the beginning of this thesis.</i>
6. Conclusion	<i>The conclusions of this research will be presented in this chapter. The aim is to answer the purpose by summarizing the findings for each research question.</i>
7. Ideas for Future Research	<i>This chapter will propose the ideas for the future researches in the field of the reverse supply chain and the reverse supply chain strategy.</i>

## 2 Frame of Reference

*This chapter will focus on the reverse supply chain and the supply chain strategy related literature, theories and previous studies. The chapter will go through different theories on the reverse supply chain, its processes and design, the strategy, the lean, the agile and the leagile concepts and their applicability for the reverse supply chain.*

### 2.1 Reverse Supply Chain

Getting products to the end customer means the end of the forward supply chain processes. It is just the starting point of the ‘new era’ of challenges for the reverse supply chain that requires to apply the appropriate reverse supply chain strategy, design and procedures to enable the optimization of flows of product returns, however (Dowlatshahi, 2000; Sahyouni, Savaskan & Daskin, 2007).

Due to the economic, competitive and political factors, reverse supply chains are becoming a vital element of companies’ business (Guide & Wassenhove, 2002). Reverse supply chains represent an opportunity to generate a value for companies. Thus, reverse supply chains require as much or even more attention than forward supply chains (Blackburn, Guide, Souza & Van Wassenhove, 2004).

#### 2.1.1 Definition and Scope

Analyzing the reverse supply chain is a new area of research. Most of the articles are practitioner-oriented and published in the industrial rather than academic journals, thus even the term ‘reverse supply chain’ is not clearly defined and widely accepted by academia researchers (Dowlatshahi, 2000; Prahinski & Kocabasoglu, 2005).

Guide and van Wassenhove (2002, p. 25) by applying an activity based view, defined reverse supply chain (further - RSC) as - ‘*the series of activities required to retrieve a used product from a customer and either dispose of it or reuse it.*’ Further, Guide and van Wassenhove (2002) divided the reverse supply chain into five key components: product acquisition, reverse logistics, inspection and disposition, reconditioning, distributions and sales. This definition was applied in a number of studies (e.g. Blackburn et al., 2004; Krikkle, le Blanc & de Velde, 2003). Based on the mentioned definition Prahinski and Kocabasoglu (2005) defined reverse supply chain management (further RSCM) as - ‘*the effective and efficient management of the series of activities required to retrieve a product from a customer and either dispose of it or recover value.*’ The simplified model of reverse supply chain is presented in the figure 2.1.

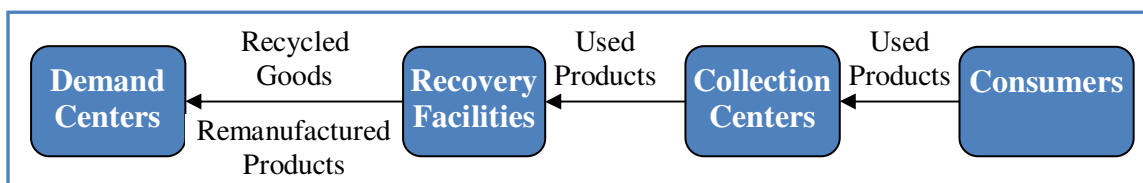


Figure 2.1 The Generic Reverse Supply Chain (Pochampally, Nukala & Gupta, 2009, p. 4).

It is important to note that in the reverse supply chain literature besides the term *reverse supply chain* the reader may meet other terms such as *reverse chain*, *reverse logistics* or *reverse distribution* that are referring to approximately the same research area. For instance, Rogers and Tibben-Lembke (1999, p. 2) defined reverse logistics (further - RL)

as – ‘*the process of moving goods from their typical final destination for the purpose of capturing value, or proper disposal.*’ RL includes various activities such as return products to supplier, resell, sell-via-outlet, reconditioning etc (ibid). In fact, both RSC and RL definitions are rather broad and similar. However, Prahinski and Kocabasoglu (2005) noted that while RL focuses on the movement and storage of returns, i.e. transportation, warehousing and inventory management activities, the concept of RSC is boarder – it requires the holistic view on reverse supply chain business processes, network design, relationships and coordination between RSC members. As the authors of this thesis consider analysing processes of the reverse supply chain, they would like to stress that the research focuses on the reverse supply chain and reverse logistics is seen as an essential part of it.

Besides, according to de Brito (2003) backward flows include not only *used* products (as suggested by Guide & van Wassenhove, 2002), but also *unused* (e.g. stock adjustment) products, as well as not only *products* but also parts, inventory, packaging and even raw materials. Thus, in this thesis the returns include used or unused products, and parts.

Moreover, even if the legislation regarding environmental impact is one of the main driving forces for establishing and developing of reverse supply chains, the primary focus and scope of the RSC is the processing of backward flows (Krikke et al., 2003). Of course, ‘green practises’ are considered to be important and can be implemented in the RSCs due to recycling, remanufacturing, etc., however such issues as air and noise emissions, environmental impact of mode selection are out of scope of RSCs and should be addressed to *green logistics* instead (Rogers & Tibben-Lembke, 1999).

### 2.1.2 Driving Forces

In the literature of reverse supply chain, authors have pointed out the number of driving forces that increase interest in reverse flows and affect reverse supply chain strategy, design, and management. These forces are:

- *The volume of returns* – return rates vary from industry to industry, in some industries (e.g. magazine publishing) returns expressing up to 50 percent of turnover (Rogers & Tibben-Lembke, 1999).
- *Green forces* – customer’s attitudes and governmental regulations regarding environmental impact of products and processes is forcing companies to explore ‘greener’ alternatives and implement new practices of product returns management (Prahinski & Kocabasoglu, 2006; Pochampally et al., 2009).
- *Increasing demand for improving customer service level* – competitive pressure requires to discover new ways to improve customer service level. By speeding up reverse flows and increasing responsiveness through the reverse supply chain design the customer service level can be improved significantly (Blackburn et al., 2004; Prahinski & Kocabasoglu, 2006).
- *New retail marketing strategies* – requirements to make stock adjustments increased due to unsold merchandises (Blumberg, 2005; de Brito, 2003).
- *Changes in buying behaviour* – due to increasing e-commerce the customers are shifting towards non-store purchasing, which, in turn, raises amount of product returns including products that have never been, used (Rogers & Tibben-Lembke, 1999; Blumberg, 2005).

- *Changes in product return policy* – on the one hand, sellers' (or manufacturers') responsibility regarding product returns has increased - '*In many countries, home-shoppers are legally entitled to return the ordered merchandise*' (de Brito, 2003, p. 50). On the other hand, companies, in order to increase competitiveness, may apply even more liberal return policies such as extended warranties time, after-warranties services etc. (Guide, Harrison & van Wassenhove, 2003; Rogers & Tibben-Lembke, 1999).
- *New types of return alternatives* – including product recalls, leasing, short or long-term rents (Blumberg, 2005).
- *Business opportunities in secondary markets* – globalization increased the possibility to re-distribute and re-sell products' returns to secondary markets (Meyer, 1999).
- *Shortening product life cycle* – the shorter product life cycle the faster returns have to be processed (e.g. repaired, re-manufactured, and upgraded) in the reverse chain, which leads to increasing requirement for speed and responsiveness of the reverse supply chain (Krikkle et al., 2004; Blackburn et al., 2004).
- *Cost reduction* – companies, by reusing, remanufacturing or recycling, are striving to extract potential value of product returns (e.g. in many cases it may cost less to produce an item from reprocessed materials than from raw resources) (Pochampally et al., 2009). Ford Motor Company, for instance, produces tail light housings from recycled plastic bumpers (Blumberg, 2005).

According to de Brito (2003) there are three main motives that drive companies to implement and develop RSCs, i.e. economics, legislation and corporate citizenship. RSCs can bring direct economic benefits (e.g. reducing of raw material usage, adding value through recovery and reselling valuable product returns) as well as indirect economic gains (e.g. improving customer's or supplier's relation, market protection and image-building) (ibid). Legislation refers to customers' rights (e.g. in UK customers can return ordered product within 90 days) and environmental legislation (e.g. recovery quotas, take back responsibility) (de Brito, 2003). Corporate citizenship is the expression that describes company's actions in a responsible to society way – '*corporate citizenship concerns a set of values or principles that impels a company or an organization to become responsibly engaged with reverse logistics*' (de Brito, 2003, p. 51).

### **2.1.3 Types and Characteristics of the Returns**

According to Sahyouni et al. (2007) in order to be able to determine strategic requirements for design and management of the reverse supply chain, it is necessary to differentiate among sources and flows of returns.

Researchers have suggested different basis for classification of returns. Rogers and Tibben-Lembke (1999) distinguished returns depending on the type of origin – items returned by supply chain partner (business to business, further - B2B) or items returned by the final customer (business to customer, further - B2C). De Brito (2003) differentiated types of origin according to generic supply chain phases – from manufacturing through distribution to the final customer. Thus, returns can be classified as: manufacturing returns, distribution returns and customer returns (ibid). Besides, de Brito (2003) classified returned products based on returning reasons i.e. – function failures (e.g. warranty and service returns) or function of the product is no longer needed (e.g. functional returns). Sahyouni et al. (2007) suggested to classify the returns depending on whether re-

turns are 'pushed' in or 'pulled' through the reverse chain. Fleischmann, Bloemhof-Ruwaard, Dekker, van der Laan, van Nunen and van Wassenhove (1997) distinguished between spare parts, packaging, and consumer goods. Krikke et al. (2004) suggested applying a product life cycle based classification that allows evaluating business opportunities and requirements for processing the particular type of product returns. According to the author there are four types of returns:

- *End-of-life returns*. This type of returns refers to the products or the components whose economic or physical lives are ended;
- *End-of-use returns*. This type of returns refers to the products or the components that are returned by customers after some period of usage (including leased products, trade-in offers and products replacements);
- *Commercial returns*. This type of returns is linked to the sales process and often has a high value and business opportunities;
- *Re-Usable Items*. This type of returns refers not to the product itself but contains or carries a particular item and can be linked to the consumption or the delivery of the main product; and can be used several times (Krikke et al., 2004).

In this thesis, only the reverse supply chain strategy for commercial returns will be analyzed. Commercial returns refer to both B2B and B2C products (De Brito, 2003). The B2B commercial returns include wrong deliveries, damaged, outdated or unsold goods (De Brito, 2003; Rogers & Tibben-Lembke, 1999). The main causes of returns are overstock and stock adjustment (de Brito, 2003). The volume of the B2B commercial returns can be controlled by contractual agreements between supply chain partners (Rogers & Tibben-Lembke, 1999). The B2C commercial returns refer to products that are returned by the end customers shortly after having purchased in cases when customers' expectations (e.g. colour, size, etc.) were not met (Krikke et al., 2004; de Brito, 2003; Rogers & Tibben-Lembke, 1999) or wrong product was delivered (Sahyouni et al., 2007). Development of e-commerce practices or liberal return policy may increase the volume of commercial returns significantly (Krikke et al., 2004; Rogers & Tibben-Lembke, 1999).

Sahyouni et al. (2007) founded that the volume of the commercial returns is higher at the introductory phase of product life cycle. The commercial returns according to de Brito (2003) also include returns under warranty, service returns (repairs, spare-parts, etc) and product recalls. Furthermore, according to Blumberg (2005) they can be returned as parts and subassemblies or whole unit equipment and products. Thus, depending on return reasons, type and origin, and product vs. part returns the economic values, impact of environmental policies and business opportunities for commercial returns, the requirements for handling reverse flows may vary significantly. These may require establishing several reverse flows with contradictory focuses in cost, speed and quality (Krikke et al., 2004; de Brito, 2003; Rogers and Tibben-Lembke, 1999).

De Brito (2003) also pointed out three product characteristics that affect reverse chain organizational decisions and impacts on its profitability. These characteristics are:

- *Composition* – complexity of components and materials, and how these components are combined together, size of returns, disassemblability and testability;
- *Deterioration* – physical (homogeneity of deterioration) and economic;
- *Use pattern* – the end user is individual or organization (individual or bulk use) and level of usage (de Brito, 2003).

According to de Brito (2003), these characteristics may significantly affect reverse supply chain profitability, organization and sequence of reverse supply chain processes, and arrangements of reverse flows.

#### **2.1.4 Reverse Supply Chain Processes**

According to Blackburn et al. (2004) depending on strategic goals, the reverse supply chains strive to focus either on the cost efficiency or on the speed of response. Blumberg (2005) identified key issues that need to be considered when organizing and controlling reverse supply chain processes. These key issues are:

- *customer diversity* – returns flows depend on users/customers and may require precise knowledge and understanding of specific users/customers;
- *time value* – from cost perspective processes need to be organized in a manner to enable making returns available for reuse (especially for the returns that have high marginal time value);
- *value maximization* – choosing the most appropriate recovery alternative to maximize revenues or reduce costs;
- *flexibility* – due to the high uncertainty the processes need to be organized to support flexible capacity (transportation, space, etc.);
- *coordination* – since usually there are many parties involved in the reverse chain, the control and the coordination of activities is needed (Blumberg, 2005).

Guide and van Wassenhove (2002) has identified five business processes in the reverse supply chain – product acquisition, reverse logistics, sorting and disposition, recovery, re-distribution and sales. It is, however, important to stress that these processes could be combined as well as sequence of these business processes may differ from chain to chain (Krikke et al., 2004).

##### **2.1.4.1 Product Acquisition**

Acquisition is the process of retrieving (including physical collection) the products, parts, or material from the market (Krikke et al., 2004). According to Guide and van Wassenhove (2002), acquisition is a key process in increasing profitability of reverse chain. Thus, the timing, the quality and the quantity of products should be managed properly (Krikke et al., 2004).

There are three sources of backward flows:

- from the forward SC (e.g. damaged or defective products) where products are ‘pushed’ upstream through the same stream as they flowed downstream;
- from the established reverse supply chain in which, for example due to applied policies (e.g. leasing or credit for replacement purchasing), the products are ‘pulled’ upstream; and
- from the waste stream which is highly complex (Prahinski & Kocabasoglu, 2006).

Gattorna (2003) noted that central collection centres, for collecting and sorting returns, are very effective. The number of collection points is important. On the one hand, the higher the number of collection points the higher customer service level. On the other hand, a high number of collection facilities may extremely increase reverse logistics costs. Supply chain members (e.g. manufacturer or distributor) or third party can organ-



ize and control the collection process. For example, Subaru in the US has outsourced the entire process of the returns collection to Roadway Express (Gattorna, 2003).

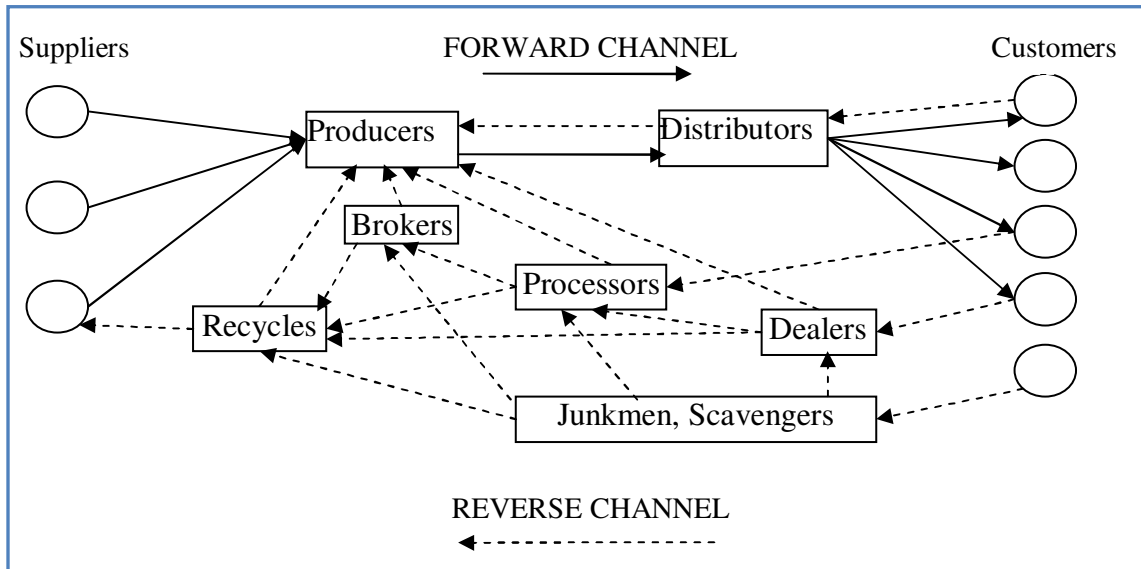


Figure 2.2 Possible channel participants on the reverse supply chain (Prahinski & Kocabasoglu, 2006 p. 521).

Prahinski & Kocabasoglu (2006) have found that other chain participants, such as brokers, processors, dealers, junkmen and scavengers, are usually involved in the reverse supply chain (figure 2.2). According to Krikke et al. (2004) in order to increase the performance of the collection process, high level of cooperation and coordination between parties is necessary.

#### 2.1.4.2 Reverse Logistics

The process involves the moving returned goods to the location of recovery or disposal directly, or through testing, inspection and sorting facilities (Guide & van Wassenhove, 2002; Krikke et al., 2004). The main reverse logistics' activities are transportation, warehousing and inventory management.

According to Tibben-Lembke and Rodgers (2002) reverse logistics is a critical issue for many firms and accounts for four to ten per cent of the total logistics costs. Thus, the development of the reverse logistics systems and the effective management of reverse logistics activities provide possibility to reduce cost, increase revenues, and generate additional profitability (Poist, 2000)

According to Blackburn et al. (2004) due to different characteristics of returns and different requirements for different types of returns (lead-time, costs), the reverse supply chain usually consists of several reverse logistics flows with different attributes.

Wu and Cheng (2006) stated that there is a fundamental difference in goals and requirements between forward and reverse logistics. According to Fleischmann et al. (1997) when compared to forward logistics' flows the backward flows usually go through the different streams. Furthermore, different types and characteristics of returns complicate operational aspects of reverse logistics (Guide et al., 2003). Tibben-Lembke and Rodgers (2002) identified key differences between forward and reverse logistics that are shown in table 2.2.

## Frame of Reference

Table 2.1 Differences in forward and reverse logistics (Tibben-Lembke & Rodgers, 2002, p. 4)

Forward logistics	Reverse logistics
Product quality uniform	Product quality not uniform
Dispositions option clear	Disposition options unclear
Routing of products unambiguous	Routing of products ambiguous
Cost involved easily understood	Cost involved not easily understood
Standardized channel	Exception driven
Product packaging uniform	Product packaging often damaged
Product pricing uniform	Product pricing not uniform
Inventory management consistent	Inventory management inconsistent
Product life cycle manageable	Product life cycle less manageable
Financial management issues clear	Financial management issues unclear
Negotiations between parties straightforward	Negotiation less straightforward
Customer easily identifiable to market	Customers less easily identifiable to market
Forecasting relatively straight forward	Forecasting more difficult
One-to-many transportation	Many-to-one transportation
Process visibility more transparent	Process visibility less transparent

Since reverse flows are usually initiated by customers, the reverse logistics activities are much more reactive. High level of uncertainty makes it difficult to plan, forecast and allocate capacity and resources to handle and control reverse flows – ‘...*future planning and forecasting for reverse logistics are made difficult because individual customers ultimately initiate reverse logistics activities.*’ (Tibben-Lembke & Rodgers, 2002, p. 275) However, since the volume for different types of returns varies depending on life cycle of the products (e.g. at the introduction phase the percentage of returns for the particular type of product is higher), the level of uncertainty can be reduced by integrating this data into the planning stage of reverse logistics activities (Sahyouni et al., 2007). Moreover, Tibben-Lembke and Rodgers (2002) have found out that variations in the volume of reverse flows are influenced by variations in the volume of forward flows (e.g. increased sales, will increase volume of returns), thus reverse logistics can benefit when such information (sales schedule, promotion plans, etc.) is available.

Fleischmann et al. (1997) noted that one of the most important differences between forward and reverse logistics is that the reverse flow moves from many origins to one destination. This attribute is even more complicated by factors such as the different physical characteristics of returns or the non-standardized or often damaged packaging (Tibben-Lembke & Rodgers, 2002). According to Fleischmann et al. (1997) due to these factors, it is difficult to combine forward and reverse transportation, even if such combining would lead to a significant financial saving.

Guide et al. (2003) have recently found that in order to save the cost of logistics and speed up reverse flows many firms tend to outsource their reverse logistics activities or the entire process to a specialists. Poist (2000) stated that since reverse logistics often requires high level of flexibility and customization the standardized services offered by third-party logistics providers could not always be appropriate. In turn, Krumwiede and Sheu (2002) stated that there has been a growing number of 3PL providers that offer customized services and senior managers of these firms emphasize business opportunities in the reverse logistics.

### 2.1.4.3 Inspection and Disposition

The process involves activities such as inspection, testing, sorting, and grading returned products (Blackburn et al., 2004). The process is usually labour intensive and time consuming (Guide & van Wassenhove, 2002). However, it is essential in order to identify quality and composition of the returned products, choose suitable recovery alternative and identify appropriate route in the reverse chain (Poist, 2000; Krikke et al., 2004).

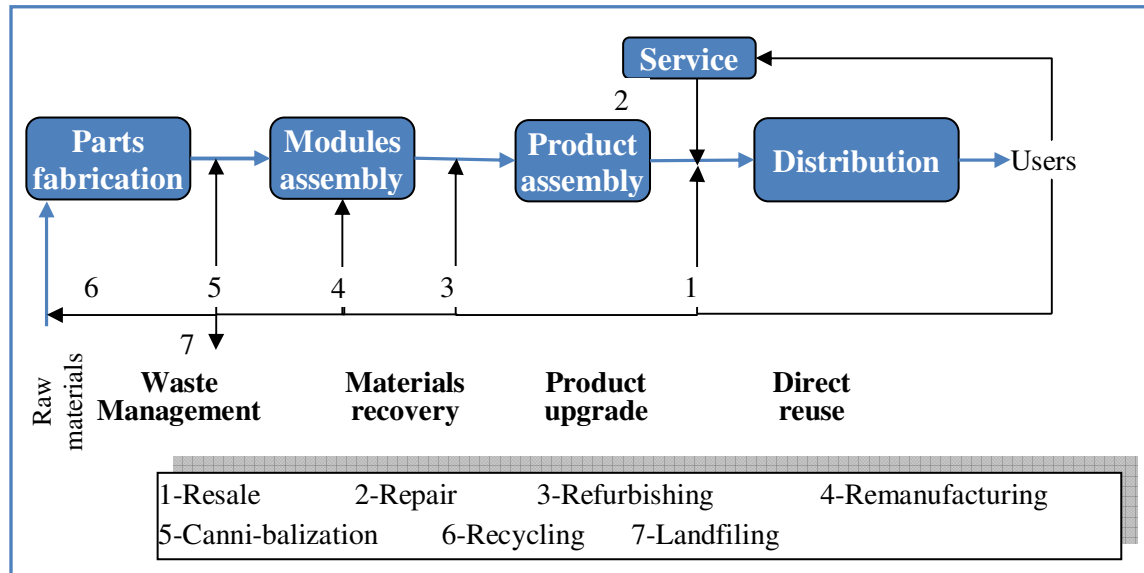


Figure 2.3 Disposition alternatives on the reverse supply chain (Prahinski & Kocabasoglu, 2006 p. 522).

Prahinski and Kocabasoglu (2006) identified four disposition options – direct reuse, product upgrade, material recovery and waste (figure 2.3). ‘Disposition should maximize the value of reclaimed goods or dispose of the goods in the most cost-effective way’ (Gattorna, 2003, p. 274). According to Guide and van Wassenhove (2002) a selection of disposition alternatives should be made based on product characteristics such as quality and product configuration. Besides, essential factors such as market demand (Krikke et al., 2004); and contractual relationships between reverse supply chains partners (Tibben-Lembke & Rodgers, 2002) should be considered when choosing between alternatives of disposition.

In order to reduce the reverse logistics costs and speed up the recovery process, the disposition decisions in reverse chain should be done as early as possible (Blackburn et al., 2004). According to Gattorna (2003); Tibben-Lembke and Rodgers (2002) firms can considerably facilitate reverse flows by implementing quality standards and utilizing information technologies (sensors, bar coding, etc.) to standardize and automate the testing process.

### 2.1.4.4 Recovery

The recovery process refers to product recovery – returning products, parts or material to original condition (cleaning, repair refurbishing, remanufacturing), extracting valuable components, and managing waste (Blackburn et al., 2004; Krikke et al., 2004). Table 2.3 presents conceptual levels of six recovery options listed in order of required degree of teardown with applicability to sell recovered product in original, similar or alternative markets.

Table 2.2 Outline of recovery options (Krikke et al., 2004, p. 25)

Options	Operations	Resulting Output	Applied in
<b>Direct reuse</b>	Check on damage and clean	As is, e.g. for refill	Original or similar markets
<b>Repair</b>	Restore product to working order, some component repaired or replaced	Original product	Original or similar markets
<b>Refurbishing</b>	Inspect and upgrade critical modules, some modules repaired or replaced by upgrades	Original product in upgraded version	Original or similar markets
<b>Remanufacturing</b>	Manufacture new products partly from old components	New product	Original or similar markets
<b>Cannibalization</b>	Selective retrieval of components	Some parts and modules reused, other scrapped	Both original and alternative markets
<b>Scrap</b>	Sort, recycle, and dispose of	Materials and residual waste	Alternative markets

According to Thierry, Salomon, van Nunen and van Wassenhove (1995) profitability of recovery activities depends on the ability to minimize the environmental impact of return, legislation, and ability to utilize recovery as a marketing instrument. However, Guide and van Wassenhove (2002) noted that due to the high degree of uncertainty in terms of quality and timing of returns, the recovery process is quite unpredictable. Thus, to reduce variability and costs it is extremely important to make appropriate decisions (e.g. differentiation, standardization) during the testing and sorting phases (ibid).

#### 2.1.4.5 Re-Distribution and Sales

The process refers to a process similar to distribution and sales in forward supply chain (Krikke et al., 2004). However, it might be difficult to find markets for recovered goods, consequently marketing efforts and investments in customers' education might be needed (Guide & van Wassenhove, 2002). Furthermore, in cases when goods should be sold in non-original markets, it might be needed to set up the separate channels (Krikke et al., 2004). According to Thierry et al. (1995) recovered products, parts or components can be sold by:

- the company itself;
- other companies (supply chain partners);
- companies outside the supply chain.

Business opportunities often occur in the markets where customers cannot afford the new products but can buy used or refurbished versions at lower prices (Guide & van Wassenhove, 2002). However, according to Gattorna (2003) to avoid 'cannibalization' it is necessary to define clearly the channel strategy since returned goods channels can steal customers away from primary goods.

#### 2.1.5 Reverse Supply Chain Design

To be able to capture additional value from returns processes it is necessary to design and control reverse supply chain carefully. Several researchers have focused on issues of reverse supply chain design. Skjott-Larsen, Schary, Mikkola and Kotzab (2007) de-

financed advantages and disadvantages of both centralized and decentralized reverse supply chains, and evaluated the role of centralized/decentralized control of processes within the reverse chain. Rogers and Tibben-Lembke (1999) stressed the importance of centralized return centres as design strategy to achieve economy of scale. Blackburn et al. (2004) stated that time value of returned products should be considered as the main criteria for the design of reverse supply chain.

Below, two reverse supply chain design models are presented – centralized and decentralized (figures 2.4 and 2.5). However, according to Skjott-Larsen et al. (2007) in practice, there may be a variety of configurations between these two extremes.

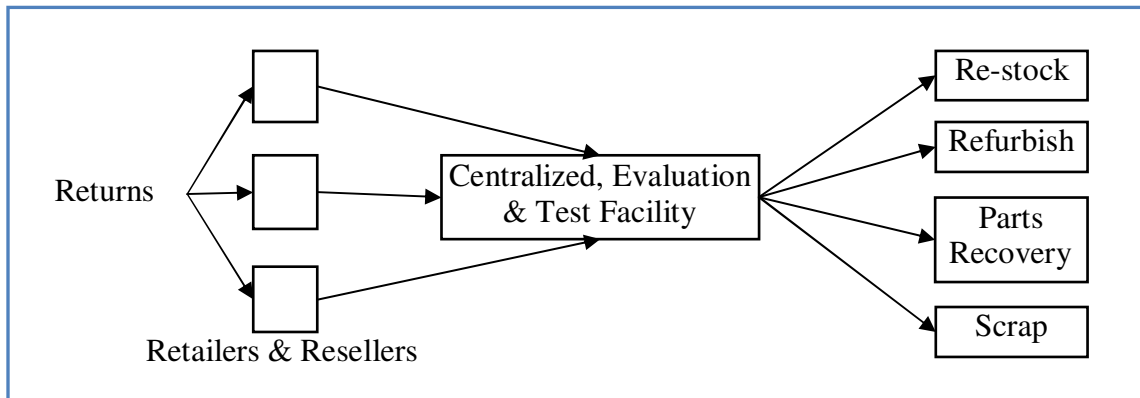


Figure 2.4 Centralized reverse supply chain (Blackburn et al., 2004, p. 13).

*Centralized reverse supply chain.* A reverse supply chain model with centralized evaluation and testing facilities (figure 2.4) is designed to minimize the processing cost (Blackburn et al., 2004). In a centralized system the retailers send returned products to one or several centralized return centres (CRC) where, products are evaluated and tested, and based on the result of testing the appropriate disposition alternative is selected (Rogers & Tibben-Lembke, 1999). According to Skjott-Larsen et al. (2007) in a centralized reverse supply chain model, usually one organization (one of the supply chain partner or dedicated logistics providers) usually take control and responsibility for physical processing of product returns.

Rogers and Tibben-Lembke (1999) identified the following features of centralized model that lead to cost minimization:

- Higher space and equipment utilization – allows to reduce the space and to utilize better equipment dedicated to returns’ handling;
- Labour costs – minimization of labour force for return processing, increase revenues due to employment of skilled specialists (e.g. for the testing process);
- Transportation costs – minimization of transportation costs through the consolidation;
- Standardization – quality, visibility and standardized operations allow to reduce the errors (e.g. incorrectly chosen disposition alternative).

According to Blackburn et al. (2004) since all types of returns are transported and then sorted at centralized facilities, minimization of the processing cost in centralized reverse supply chain model is achieved at the expense of long delays in returns processing. That means that for return types whose marginal time value is high the centralized reverse supply chain configuration may be inappropriate (ibid).

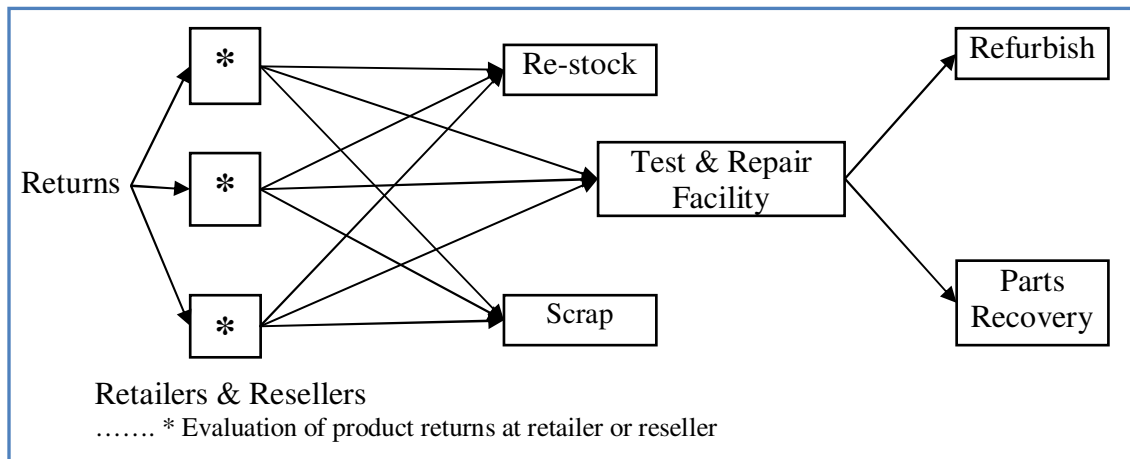


Figure 2.5 Decentralized reverse supply chain (Blackburn et al., 2004, p. 16).

*Decentralized reverse supply chain.* A decentralized model represents configuration (figure 2.5) where the first evaluation is performed at retailer’s site (Skjott-Larsen et al., 2007); or dedicated facilities (Blackburn et al., 2004). This model creates a possibility to differentiate among different types of product returns at the early reverse chain phase (Blackburn et al., 2004), then send these returns to one of the most appropriate reverse flows for the chosen disposition alternative (Krikke et al., 2004). According to Blackburn et al. (2004) the decentralized model allows to minimize time delays which is extremely important for returns with high time marginal value. For instance, some returns may even not need to be repaired (e.g. returned new- box have never been opened) and can be re-sold directly. Blackburn et al. (2004) stated that early product differentiation, in the reverse flow, could be defined as the *preponement* (see chapter 2.3.3).

However, since the returns’ evaluation is a time consuming process and may require skilled employees, the evaluation and differentiation of returns at retailers’ site increases labour costs (Skjott-Larsen et al., 2007). Furthermore, the lack of control of evaluation process may decrease the quality and cause errors (ibid). Moreover, decentralized reverse supply chain model increases transportation costs, and reduce space utilization ratio (Blackburn et al., 2004).

In summary, the main difference between centralized and decentralized reverse supply chain configurations is the positioning of the evaluation facilities. Centralized reverse supply chain configuration increases cost efficiency, in turn, decentralized facilitates increase response due to minimization of time delays (Blackburn et al., 2004). However, in practice, design of the reverse supply chain represent trade-off between various factors such as: marginal time value of returns (Blackburn et al., 2004); resources needed (Rogers & Tibben-Lembke, 1999); control and transportation costs between various links (Skjott-Larsen et al., 2007); characteristics of returns, economies of scale in reverse supply chain processes (Skjott-Larsen et al., 2007; Rogers & Tibben-Lembke, 1999); and variations in disposition alternatives (Prahinski & Kocabasoglu, 2006).

### 2.1.6 Reverse Supply Chain Challenges

According to Rogers and Tibben-Lembke (1999) companies in order to increase their competitiveness and capture additional value of product returns, must have a strategic vision of managing reverse flows. However, reverse flows encounter specific challenges that differ from those of forward flows (Skjott-Larsen et al., 2007). In the literature of

the reverse supply chain, researchers pointed out the number of challenges that influence reverse flows management and affect reverse supply chain strategy. These challenges are:

- *Lack of formal operating procedures.* Products are retrieved from the market and they may be unpacked and may not contain product identification such as bar-coding or labeling. This creates difficulties in formalization of information systems and standardizing procedures. Lack of formal operating procedures increase time waste and requires additional resources (Skjott-Larsen et al., 2007; Pochampally et al., 2009).
- *Differences in quality, quantity and timing.* Large variations in value, quality, quantity and timing of returns create difficulties to make precocious forecasting and planning of requirements and resources needed for product return processing through the reverse chains (Blackburn et al., 2004; Guide et al., 2003; Fleischmann et al., 1997).
- *Decreasing market value due to time delays.* Late returns differentiation (e.g. in centralized return centers) can save cost and resources, however, due to time delays, decrease market value which is especially important for returns with high marginal time value. Thus, the differentiation, in the reverse chain, should be done as early as possible. However, taking into consideration complexity of characteristics of product returns, resources needed and coordination issues between parties, it might be difficult to implement early differentiation (Blackburn et al., 2004; Skjott-Larsen et al., 2007).
- *Retailer-Manufacturer conflict.* According to Rogers and Tibben-Lembke (1999) differences in the objectives between retailers and manufacturers may cause inefficiencies that lengthen the processing time. Conflicts may often rise because of disagreements on value and condition of returned items and timeliness of response (ibid).
- *Lack of local competence.* According to Skjott-Larsen et al. (2007), such reverse supply chain processes as the inspection, testing and the evaluation require high level of competence. Lack of local competence (e.g. lack of competence at retailer's store) in these processes may decrease the speed of reverse flows and increase errors (e.g. by choosing appropriate disposition alternative) (ibid).
- *Lack of performance measurement.* According to Pochampally et al. (2009), the performance measurement techniques used in a forward supply chain cannot be applied to the reverse supply chain due to the differences in various aspects. Furthermore, Skjott-Larsen et al. (2007) have found out that companies rarely measure their returns processes' efficiency in a systematic way. However, in order to be able to increase the reverse supply chain performance it is important to set up performance measures such as - *'time from customer's complain to replacement of new product/repaired defect product at the customer premise <....>, quantity and quality of returns, causes of return, cost involved in returns'* (Skjott-Larsen et al., 2007, p. 296).

According to Rogers and Tibben-Lembke (1999); Skjott-Larsen et al. (2007); Guide et al. (2003); Pochampally et al. (2009), companies that realize their reverse supply chain as a strategic part of their business mission and develop their reverse supply chain policies and practices strategically, are able to overcome challenges mentioned above, and to achieve long-term competitiveness.



## 2.2 Supply Chain Strategy

The idea of today's business is that supply chains but not companies compete (Christopher & Towill, 2001). To get a right product, at the right place, at the right time to the consumer is a key not only to success but also to survival. However, to reach it, a company needs a plan or strategy. According to Coyle et al. (2003), strategy is defined as:

*'A course of action, a scheme, or a principal idea through which an organization or individual hopes to accomplish a specific objective or goal. In other words, a strategy is designed to determine how someone is going to achieve something that has been identified as being important to future success.'* (Coyle et al., 2003, p. 698)

A supply chain strategy determines - *'the nature of procurement of raw materials, transportation of materials to and from the company, manufacture of the product or operation to provide the service, and distribution of the product to the customer, along with any follow-up service and a specification of whether these processes will be performed in-house or outsourced.'* (Chopra & Meindl, 2007, p. 23)

Even the supply chain strategy requires a lot of attention, there is no single strategy that is always right (Chopra & Meindl, 2007), and *'one size does not fit all'* (Christopher, Peck & Towill, 2006, p. 277) to support a wide range of products.

### 2.2.1 Strategic Fit

When selecting a supply chain strategy it is necessary to understand the company's competitive strategy. A company's competitive strategy defines *'the set of customer needs that it seeks to satisfy through its products and services'* (Chopra & Meindl, 2007, p. 22). The analysis of a relationship of company's competitive strategy and the supply chain strategy should be started with the value chain. The value chain begins with the development of the new product; marketing and sales generate demand; operations do transforming to create a product; distribution takes the product to a customer or vice versus; service responds to customer requests (ibid). Finance, accounting, information technology, and human resources are the supporting facets for the value chain.

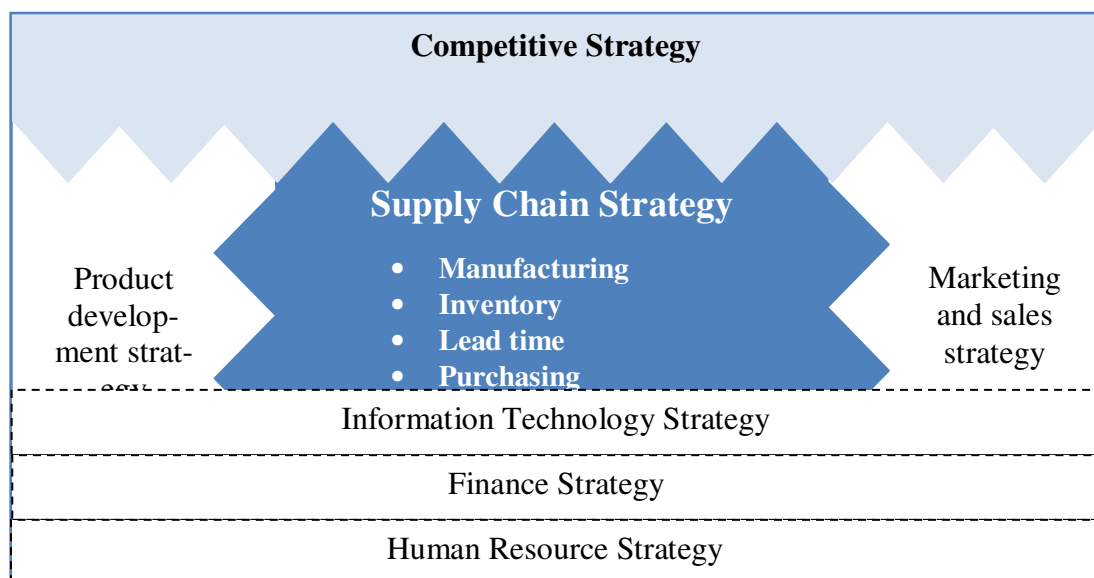


Figure 2.6 Fit between competitive and functional strategies (Chopra & Meindl, 2007, p. 34).



When executing a company’s competitive strategy, all these functions play a role and a strategy for each of them is in a need. Even more, the competitive strategy and all functional strategies must fit together to lead to success of company’s value chain. Figure 2.6 shows the fit between competitive and functional strategies. Supply chain strategy, similar to other functional strategies, should be aligned with the company’s overall strategic direction or competitive strategy and guide the company’s approach to the supply chain management (Sebastiao & Golicic, 2008).

**2.2.2 Classification of Supply Chain Strategies**

It is necessary to match the supply chain strategies with the specific product characteristics and the market conditions (Fisher, 1997; Cristopher & Towill, 2002; Lee, 2002). Fisher (1997) was the first who has emphasized the match between the supply chain strategy and product’s demand. He has divided products mainly into two categories: either primarily functional, or primarily innovative. Functional products satisfy the basic needs and have a stable, predictable demand and long life cycles, however they invite competition and it leads to low profit margins. In order to avoid low profit margins, companies introduce innovations into their products, but an innovation makes a demand of a product unpredictable, the life cycle of a product becomes shorter. Both types of products require different types of strategies for the supply chain, which performs two different functions: a physical and market mediation. The physical function covers the manufacturing of a product from raw materials, transportation, and warehousing. The market mediation is a way to ensure that a product in a market matches those that the customer wants. Both functions have their own costs, but for the functional products, it is easier to balance the market mediation because of a predictable, stable demand; for the innovative products it is difficult to foresee the demand and it can lead to the excess or shortages in the market. It is a reason why innovative products should act responsive-ly to a demand (Fisher, 1997). As a result, the functional products require physically efficient process with a primary purpose to supply predictable demand efficiently at the lowest possible cost. Innovative products need a market-responsive supply chain with an aim to respond quickly to unpredictable demand, in order to minimize stock-outs, forced markdowns, and obsolete inventory. Figure 2.7 shows ‘matches’ and ‘mis-matches’ between two types of products and two types of strategies.

<b>Efficient supply chain</b>	<b>Match</b>	<b>Mismatch</b>
<b>Responsive supply chain</b>	<b>Mismatch</b>	<b>Match</b>
	<b>Functional products</b>	<b>Innovative products</b>

Figure 2.7 Fisher’s matrix for supply chain strategy selection (Fisher, 1997).

Lee (2002) added a supply uncertainty to Fisher’s strategy matrix. He focused not only on demand uncertainties, but also on supply uncertainties. Lee argued that ‘stable’ supply is available when manufacturing process is mature and supply base is well established; an ‘evolving’ supply process is where the manufacturing process is under early development and rapidly changing. Supply and demand uncertainties are the main areas to consider when selecting a strategy. Lee has created a matrix for matched strategies where low demand and low supply uncertainties require efficient supply chain; high demand and high supply uncertainties match with the agile supply chain; low demand

uncertainty and high supply uncertainty is a match with the risk-hedging supply chain; high demand uncertainty and low supply uncertainty requires a responsive supply chain.

Christopher and Towill (2002) have focused on products, demand and lead time when selecting a supply chain strategy. They have suggested the lean and the agile concepts for the supply chain, as well defined differences between them and conditions for suitability.

Later, Christopher et al. (2006) have introduced taxonomy for selecting global supply chain strategy (figure 2.8). The key dimensions of this taxonomy are replenishment lead- time and predictability/variability of demand. On the horizontal axis, there are the demand characteristics in terms of ‘predictability’. On the vertical axis, there is a reflection of a replenishment lead time for the same product.

<b>Supply Characteristics</b>	<i>Long Lead Time</i>	<b>LEAN</b> Plan and execute	<b>LEAGILE</b> Postponement
	<i>Short Lead Time</i>	<b>LEAN</b> Continuous Replenishment	<b>AGILE</b> Quick response
		<i>Predictable</i>	<i>Unpredictable</i>
<b>Demand characteristics</b>			

Figure 2.8 How demand/supply characteristics determine pipeline selection strategy (Christopher et al., 2006).

The whole matrix suggests four generic supply chain strategies. When demand is predictable – lean strategy is applicable. For short lead time, continuous replenishment is required. In this case vendor managed inventory could be implemented. If lead time is long and demand predictable – ‘lean’ strategy when make and source are done ahead of demand in the most efficient way. For unpredictable demand and short lead time, the agile solutions could be implemented based upon rapid response. If demand is unpredictable and replenishment time is long the leagile strategy is most suitable. Leagile is a hybrid of the lean and the agile concepts. The postponement concept is a solution, when strategic inventory in some generic form is carried and later assembled/ configured/ distributed upon actual demand.

### 2.2.3 Market Winners and Market Qualifiers

Hill (1997) has earlier developed the concept of ‘order qualifiers’ and ‘order winners’ for determining the manufacturing strategy. ‘Order qualifiers’ consider the baseline for entering into a competitive arena. ‘Order winners’ consider specific requirements for actually winning an order. The definition of both terms should lead to a specific strategy.

Christopher and Towill (2000) borrowed these ideas to develop wider supply chain oriented concepts of ‘market qualifiers’ and ‘market winners’. It was argued that to be truly competitive not only the appropriate manufacturing strategy but the supply chain strategy is required as well.

<b>Agile Supply</b>	<ul style="list-style-type: none"> <li>• <b>Quality</b></li> <li>• <b>Price</b></li> <li>• <b>Lead time</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Service Level</b></li> </ul>
<b>Lean Supply</b>	<ul style="list-style-type: none"> <li>• <b>Quality</b></li> <li>• <b>Lead Time</b></li> <li>• <b>Service Level</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Price</b></li> </ul>
<b>Market Qualifiers</b>		<b>Market Winners</b>

Figure 2.9 Market winners-market qualifiers for agile versus lean. (Mason-Jones et al., 2000).

The attributes of the lean and the agile supply chain are shown in the figure 2.9, where quality, lead time and service level is market qualifiers for the lean supply chain, and price is the market winner, then the market winner for the agile supply is the service level. Furthermore, this framework suggests that the company needs to operate with the leanest agile system or the most responsive lean system, because the cost is a market winner for the lean supply chain; however, cost is a market qualifier for the agile supply chain (Christopher & Towill, 2002).

### 2.3 The Lean and the Agile Concepts in the Reverse Supply Chain

Several strategies were discussed above, however, ‘lean’, ‘agile’, and ‘leagile’ concepts are seen by authors as the best usable. In this paragraph, all three concepts will be covered widely, focusing on their ‘thinking’, applicability to the supply chain, adaptation to the reverse supply chain, and barriers and conditions of implementation.

#### 2.3.1 Lean

*Definition.* The concept of ‘lean enterprise’ was developed by Womack and Jones (1996). The focus of the lean approach has been the elimination of waste or *muda*. The origins of lean thinking could be traced to the Toyota Production System with its focus on the efficient use of resources through the level scheduling (Ohno, 1988). Naylor, Naim and Berry (1999, p. 108) provided a definition for leanness which means - ‘developing a value stream to eliminate all waste including time and to enable a level scheduling’. Ohno (1988) has developed a list of seven basic forms of muda: 1) defects in production; 2) overproduction; 3) inventories; 4) unnecessary processing; 5) unnecessary movement of people; 6) unnecessary transport of goods; 7) waiting by employees. Womack and Jones (1996) added the muda of goods and services that fail to meet the needs of customers.

While comparing with the mass production, lean companies keep less inventory, fewer defects incur while providing greater variety in products (Goldsby, Griffis & Roath, 2006). Lean philosophy depends on the elimination of wastes and the efficiency with the purpose of minimizing the cost. According to Huang, Uppal & Shi (2002) lean production terminology could be pursued in terms of reduced lead time, efficiency, flexibility, cost cutting and level scheduling.

*Lean supply chain.* Christopher (2000) mentions that lean is suitable in the high volume, low variety and predictable environments. The driving force for the product supply

chain is therefore cost reduction (Mason-Jones et al., 2000). However, the cost reduction is done through waste elimination. Lean supply chains reduce all types of waste, errors, unnecessary assets, and cycle times by continuously pursuing the perfection and operational efficiencies within the supply chain network (Morash, 2001). The logistics related waste can raise the cost but not the value; it could be extra processing, unnecessary warehousing, extra handling, waiting, etc. Four principles are involved in achieving the perfection: specifying the value, identifying the value stream, making the value flow, pull scheduling (Harrison & van Hoek, 2007).

Value is specified from the customer's perspective and primary value activities are transformation of raw materials into finished goods, distribution, marketing and service; secondary activities are design, manufacturing and distribution processes needed for the primary activities. Identification of the value stream refers to a principle of the identification of the whole sequence of processes along the supply chain network. Delays, inventory, defects minimization, and downtime support the flow of value (ibid). Lean thinking shares the philosophy of a time-based strategy JIT (just-in-time). JIT supply chains focus on time-definite deliveries. It allows reducing the buffer inventory and safety stocks. JIT could involve more frequent deliveries of smaller shipments that can increase the inventory and cycle stocks, though it could also lower in-transit inventory and cycle stocks (Morash, 2001).

Christopher et al. (2006) divided the lean concept applicability into two parts in accordance with the lead-time. For a short lead-time, continuous replenishment is appropriate. It means that companies could reengineer their supply chains through real-time information sharing, enabled by technology (such as EDI) and the Internet. There are a lot of possible tactics to ensure continuous replenishment, such as collaborative planning, forecasting, and replenishment (CPFR), vendor-managed inventory (VMI), continuous replenishment programs (CRP), and efficient consumer response (ECR) (Yao & Dresner, 2008). These programs enable buyers and suppliers to share the inventory status information based on real data information. Vendor managed inventory is used for manufacturers' and retailers' collaboration, where manufacturer is responsible for the inventory replenishment at retailer's location to agreed level. However, the information technology is a prerequisite. Shared information includes point-of-sale, demand, and inventory information among firms in a supply chain (ibid).

Predictable demand and long lead time are conditions for choosing a plan and execute strategy (Christopher et al., 2006). In this case, there is an opportunity to make or source ahead of demand in the efficient way. By using the accurate demand forecasts and the ERP (Enterprise Resource Planning) system, the MPS (Master Production Scheduling) and the MRP (Material Production Scheduling) could be run to create the production and purchasing plans that meet the demand while minimum working capital (Herrin, 2010). By the coordination of these plans through S&OP process, the operations across the business could be aligned to deliver continuous revenue growth and cost reduction.

*The lean concept application in reverse supply chain.* The main idea of 'lean' is cost reduction through eliminating the waste in activities that do not add the value for the customer. The main thing to take in consideration is the value of the returned product. Blackburn et al. (2004) have presented the idea of the marginal time value considering product returns. It says that returns could be either time-sensitive or time-insensitive (figure 2.10).

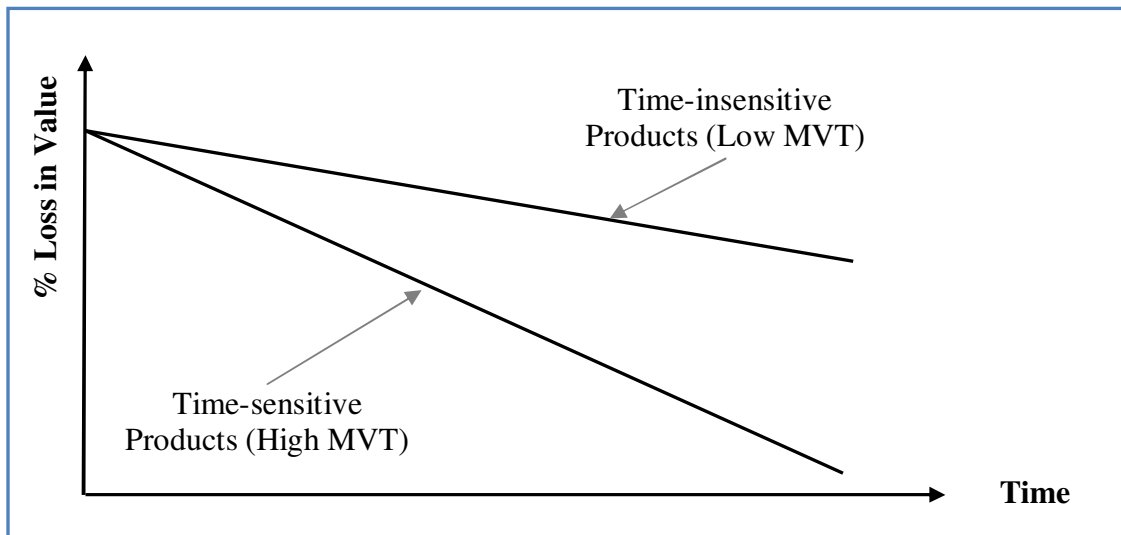


Figure 2.10 Differences in marginal value of time for returns (Blackburn et al., 2004, p. 12).

The returned product must be downgraded to a lower-valued product- a product must be remanufactured, salvaged for parts, or scrapped; but the value of a product decreases with time as it moves through the pipeline to its ultimate disposition (Blackburn et al., 2004). As a result, the company should analyze the nature of a product and realize its marginal time value. Returns with low marginal time value should be treated in a cost efficient way, and returns with a high marginal value should be treated in a responsive way. For the first group of returns (low MVT) lean supply chain is suitable because extra time and cost on speed do not add so much value for the manufacturer or raw materials supplier. It means that the company could centralize the evaluation activity (ibid) and it brings several advantages such as saved costs for one evaluation center compared with several, possible transport consolidation of returns, etc. More information about centralized and decentralized evaluation and test facility is covered in chapter 2.1.5.

*Lean implementation: conditions and barriers.* Lean supply chain arrangements require high level of information sharing, rapid performance with suppliers and minimal transaction costs (Mollenkopf, Stolze, Tate & Ueltschy, 2009). Thus, information technology and process integration is a necessity for a lean supply chain. Moreover, the algorithmic forecasting mechanism is used (Christopher & Towill, 2000), and thus the information technology for planning and forecasting is needed.

The main barrier could be summarized by the appearance of difficulties concerning the implementation and the maintenance of lean practices because of supply chain's increase in complexity and length (Mollenkopf et al., 2009).

### 2.3.2 Agile

*Definition.* Contrarily to the lean concept, the agility is required for the volatile demand, high variety of customer requirements. A key characteristic of an agile organization is flexibility (Christopher & Towill, 2001). The origins of agility as a business concept lie in the manufacturing systems. Initially it was established for rapid changeovers in manufacturing systems to enable greater responsiveness for changes in the product mix or the volume. Later it became a broader business concept. Naylor (1999, p.108) defined it as: '*agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile marketplace*'. The agility employs a 'wait-and-see' ap-

proach to demand, instead of relying on speculations: what, how much, and where might be demanded (Goldsby et al., 2006).

*Agile supply chain.* According to Harrison and van Hoek (2007, p. 204) - ‘the agile supply chain is customer responsive, by it we mean that the supply chain is capable of reading and responding to end-customer demand’. The focus of the agile supply chain is customer and markets, thus the key performance indicators are capabilities and customer satisfaction (Harrison & van Hoek, 2007). It is an approach to organize logistics capabilities around the individual end-customer demand. The requirements for an agile supply chain are a relentless focus on drivers of the customer value in all the processes; developing capabilities for responsiveness and flexibility in advance, and using those capabilities to align supply chain operations in a dynamic manner (ibid). A supply chain should possess a number of distinguishing characteristics in order to be agile (Christopher, 2000; Christopher & Towill, 2000). They are shown in the figure 2.11.

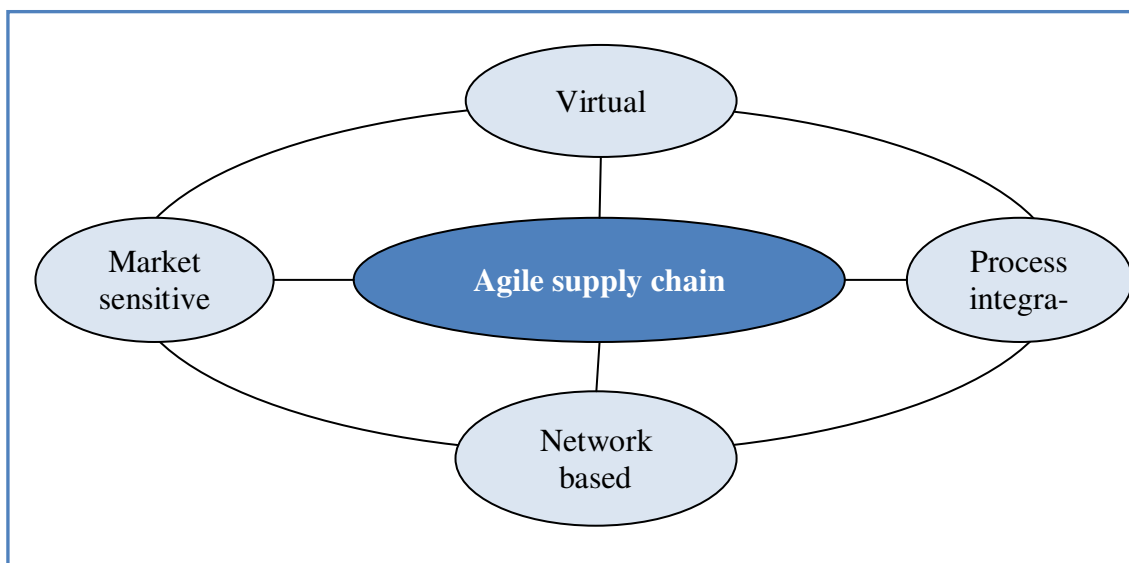


Figure 2.11 The agile supply chain (Christopher, 2000, p. 40).

First, the agile supply chain is market sensitive. It means that the supply chain is capable of evaluating and responding to actual demand. Most of the organizations have little direct feed from the market of data on real customer requirements, and they have make a forecast based on past sales or shipments. However, the efficient consumer response (ECR) and the use of information technology to capture data on demand directly from point of sale (or point of use) are transforming the ability to respond directly to the market demand (Christopher, 2000).

Second, the use of IT systems to share data between buyers and suppliers is creating a virtual supply chain (Christopher, 2000). Electronic data interchange (EDI) and Internet have enabled participants in the supply chain to act upon the same data, as real demand (Christopher & Towill, 2000).

Third, shared information between supply chain partners can only be fully enabled through the process integration. It means that collaborative operating between buyers and suppliers, cooperative product development, common systems, and shared information are needed (Christopher, 2000). This form of cooperation becomes more and more dominant because companies focus on their core competencies and outsource all other

activities. Along the process integration, comes joint strategy determination, buyer-supplier teams, visibility of information, or even, open-book accounting (ibid).

Forth, the last ingredient of agility is a network, where partners are linked together. There is a growing recognition that individual businesses no longer compete alone, but rather supply chains. Now the era of the 'network competition' has started. The organizations that can better structure and manage their relationships with partners are more responsive to the market demand (Christopher, 2000).

*The agile concept application in reverse supply chain.* Agility and customer responsiveness in the reverse supply chain are very important in two cases: for seeking the customer satisfaction and for the returns with a high marginal time value.

Effective return management program increases the satisfaction of a customer instantly. The buyer will be happy and more likely to do business again when a company does a good job handling a return (Smith, 2005). Long –term relationships are linked to high-quality reverse logistics programs. According to Autry, Daugherty and Ellinger (2001) firms must recognize the importance of the effective reverse supply chain in order to keep the relations with customers and not to harm the organization's reputation. To keep a customer happy the responsiveness in the reverse supply chain is needed, especially when taking into consideration time spent on reacting to claims, reparation and service level.

The marginal time value of a product was discussed above. If lean principles are applicable for the returns with low marginal time value, the agile concept is suitable for high marginal time value returns. The speed becomes an important criterion for products that are losing their value in the reverse supply chain. In this case, decentralized evaluation centers are most suitable to make a decision on the destination of returned product as soon as possible (Blackburn et al., 2004).

*Agility implementation: conditions and barriers.* There are different facilitators for achieving responsiveness or agility. The most important thing is that companies have not yet recognized the importance of close relationships with their key suppliers (Christopher, 2000). Firstly, in order to achieve closer relationships, companies should identify a limited number of 'strategic' suppliers with whom they can work together and link all the systems and processes.

Another prerequisite is a high level of shared information for a clear visibility of the demand. The information technology system should enable the ability to catch the real demand far down the chain and share the information with partners. The third prerequisite is a high level of 'connectivity' between the company and its strategic suppliers. It refers to creation of development teams that are cross-functional and are intended to interface with the equivalent customer's management team within the supplying organization (ibid).

The biggest barrier to agility is the complexity that increases as companies grow and extend their marketing reach (Christopher, 2000). Complexity is caused by the way in which organization structures and management processes are designed. It would need to reengineer business processes and eliminate many non-value adding activities that are inherited in traditional functionally based business (ibid).



### 2.3.3 Leagile

*Definition.* Even though the lean and the agile approaches are often discussed as opposing paradigms, they share the common goal: to meet customer demands at the lowest possible cost (Goldsby et al., 2006). As a result, lean and agile approaches can complement each other and bring the ‘leagile’ concept. This solution ‘utilizes lean principles when designing supply chains for predictable standard products and agile principles for unpredictable or ‘special’ products’. (Christopher et al., 2006, p. 281).

*Leagile supply chain.* Christopher et al. (2006) argue that it is not really a question whether lean or agile approach should be applied in the supply chain, but rather the selection and integration of suitable aspects of these paradigms. Hybrid supply chain strategies recognize that there will be some products with stable and predictable demand and some with unstable and unpredictable demand (Christopher, 2000). The combination of lean and agile strategies has three different approaches: the de-coupling point, the Pareto curve, and the separation of ‘base’ and ‘surge’ demands (Christopher & Towill, 2001).

*The de-coupling point approach* or the postponement strategy idea is based on holding the inventory in some generic or modular form and completing to the final assembly or configuration when the order from the customer is received (Christopher & Towill, 2001). The lean methods could be applied up to the de-coupling point and the agile methods beyond it. The de-coupling point also dictates the form in which the inventory is held. If demand penetrates right to the point of manufacture, the inventory is held in form of components or materials. If the demand is visible only at the end of the chain, the inventory could be held in the form of finished materials. The goal of the agile supply chain is to carry the inventory in a generic form and wait for the final assembly or localization (Christopher, 2000). It is a strategy of postponement – delayed configuration- where the main idea lies in designing products using common platforms, components and the final assembly or customization is delayed until the order from a customer is received.

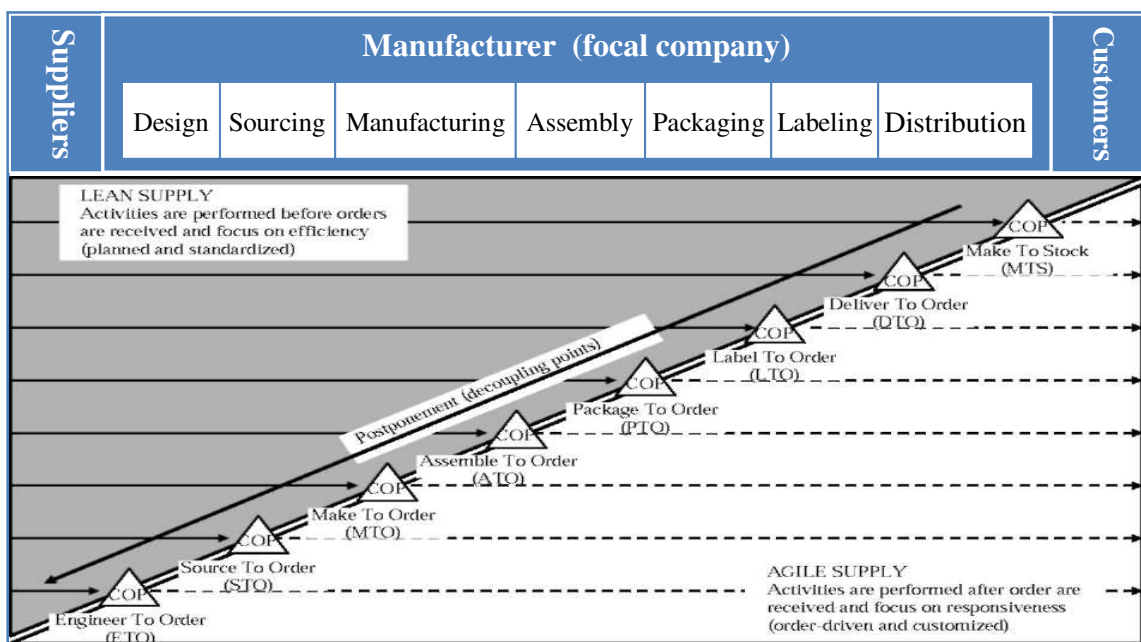


Figure 2.12 Different de-coupling points and postponement strategy (Hilletoft, 2009, p. 22).



The de-coupling point depends on where the differentiation occurs. The companies seek to postpone it to the latest possible point (figure 2.12). It could be assembly (ATO), production (MTO), sourcing (STO), or design (ETO) until after the customer order is received (Hilletoth, 2009). There are several advantages of this strategy (Van Hoek, 1998). First, the inventory is held at the generic level, thus less stock-keeping variants and fewer inventories in general. Second, as the inventory is generic, it increases the flexibility, because the same components, modules and platforms could be transformed in a variety of products. Third, forecasting is easier at the general level than at the level of the finished product. Forth, the ability to customize products locally means that the variety of products is offered at the lower total cost.

*The Pareto curve* approach focuses on the Pareto law: 80 per cent of the total volume will be generated from 20 per cent of the total product line and the way of this 20 per cent management should be different from another 80 per cent. It could be said, that 20 per cent of production is likely to be more predictable and the lean concept could be applied, while the rest 80 per cent is likely to be less predictable and requires the agile approach (Van Hoek, 1998). This strategy referred to as a mixed-model approach in manufacturing environments. It is common for manufacturing facilities to be designed so that some lines are for efficient processing of fast-moving product and others are for small-batch lines with quick, frequent changeovers for slower-moving items (Goldsby, et al., 2006).

*The separation of 'base' and 'surge' demands* strategy is based on separating demand patterns into 'base' and 'surge' elements (Christopher & Towill, 2001). Two different approaches deal with the 'base' and 'surge' demands. First, the base demand can be forecasted on the history sales. Base products should be handled through the lean procedures to achieve economies of scale. Surge demand is handled through more flexible and higher costs processes. Second, the arrangements could be made to deal with both 'base' and 'surge' demands either by separation in space (separate production lines) or in time (using slack periods for producing base stock) (ibid).

*The leagile concept application in the reverse supply chain.* The discussion about the leagility implementation in reverse supply chain firstly focuses on the de-coupling point approach (figure 2.13).

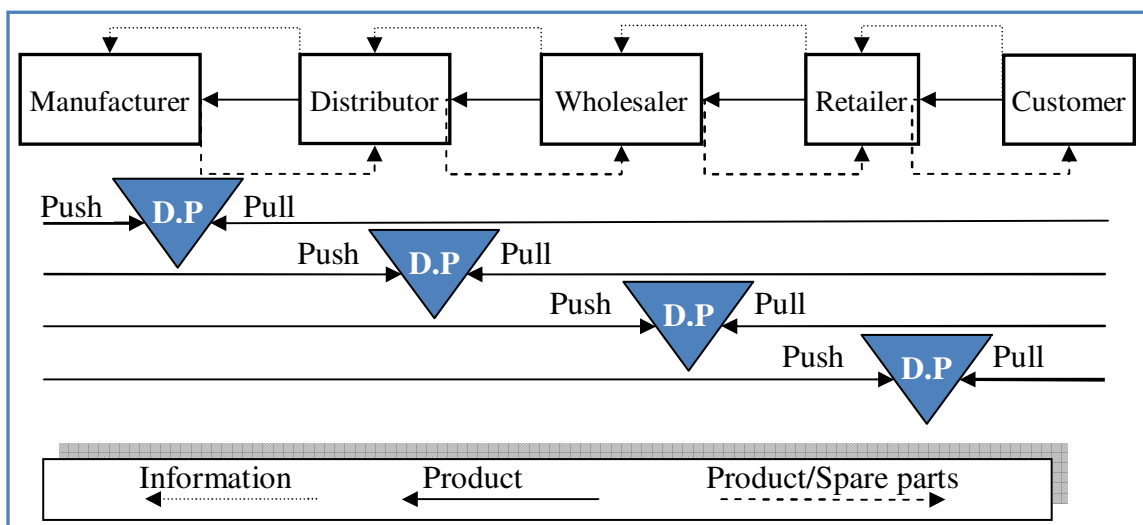


Figure 2.13 Reverse logistics structure and decoupling point (Banomyong et al., 2008, p. 37).

The application of the leagile strategy in a reverse supply chain means that lean will be used at the upstream of the de-coupling point to eliminate wastes in the reverse supply chain processes. The agile will be used at the downstream of the de-coupling point to reduce lead time and deal with a volatile customer demand as quickly as possible (Banomyong et al., 2008). The combination of the benefits of the lean and the agile concepts could help to reduce the overall lead-time and the cost and to increase the customer satisfaction. Figure 2.13 shows various positions of de-coupling points in the reverse supply chain. One of the objectives of reverse supply chain is to provide convenient after sales or repair service to customers. The closer the location of service center is to the customers, the higher flexibility could be retrieved. However, higher costs would be involved in this case. Leagility applies to the costs and the flexibility trade-off. From the manufacturer to the de-coupling point (where the service center is located) the lean concept is implemented, that allows costs saving, and from the de-coupling point to the customer the agile concept is implemented to achieve higher flexibility.

Another important aspect of the strategy in the reverse supply chain is the principle of *preponement*. The postponement is applicable in the forward supply chain; however, it is not so useful in the reverse supply chain. The preponement is based on the idea of doing early product differentiation (Blackburn et al., 2004). Figure 2.14 shows the differences between delayed product differentiation (postponement) and early product differentiation (preponement). Early diagnosis of a product allows maximizing the asset recovery by fast-tracking returns on to their ultimate disposition and minimizing the delay cost. The earlier the decision on product's destination is made (restocking, refurbishing, recovering, or scraping), the easier it is to save the costs on the transportation and recover value. The preponement could dramatically increase the asset recovery for products with a high marginal time value (ibid). Early product differentiation is also associated with the decentralized service centers. The setting up of the service center near customers should help to minimize inconveniences for customers (Banomyong et al., 2008), as well as to do the early return inspection.

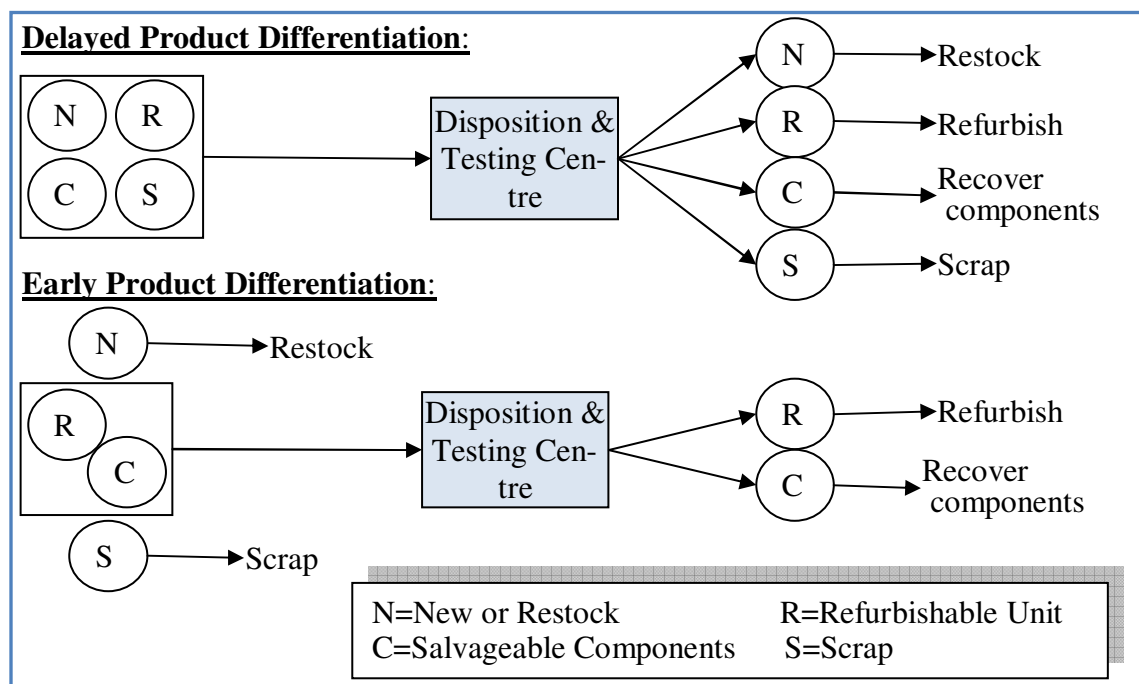


Figure 2.14 Early vs. delayed product differentiation (Blackburn et al., 2004, p. 15).

*Leagility implementation: conditions and barriers.* The appropriate market conditions and the operating environment for the Pareto optimum strategy application are the high level of product variety and the non- proportionate across the range demand (Christopher & Towill, 2001). For the de-coupling point strategy application are possibilities of modular production or intermediate inventory, as well as delayed final configuration or distribution (ibid). For surge/base demand separation strategy are situations where the base level of the demand can be confidentially predicted from the past experience and where local manufacturing and small batch capacity are available (ibid).

There are some barriers of the differentiated strategy utilization. First, it is the requirement of collaboration, because differentiated strategy involves more participants. Second, it requires developing differentiated services based on the solutions differing cost-to-serve. Third, more integrated information systems are required to support decision support tools and to facilitate the visibility of demand and inventory (Hilletoft, 2009).

## **2.4 Supporting Facets for the Strategy**

The strategy for the reverse supply chain is usually a complex plan with many involved actors and their responsibilities, different actions and tactics. In this chapter, the role of the information technology, as information sharing enabler, and importance of outsourcing, as the supporter for the reverse supply chain strategy, will be shortly discussed. Both of them are important for achieving the goals that are intended by the generic strategy.

### **2.4.1 Information Technology**

Information technology (including hardware, software, data and communication technology) is used to ‘*support information gathering, processing, distribution and use*’ (Beynon-Davies, 2002, p. 5).

According to Blumberg (2005) information technologies provide significant opportunities for increasing the performance in reverse supply chain processes. Landers, Cole, Walker and Kirk (2000) have found that real time-based tracking allows to reduce stock levels and to improve picking and routing processes. De Brito (2003) noted that IT has enabled the optimization of vehicle routing and operation scheduling and it leads to a better allocation of resources. Meyer (1999) stated that specialized software dedicated for returns’ handling increases standardization, which leads to the acceleration of the reverse flows within the reverse supply chain and increases the accuracy in choosing an appropriate disposition route.

IT enables the information exchange between facilities, and coordination of activities and processes with the reverse supply chain partners (Li & Olorunniwo, 2008). Moreover, IT enabled information sharing increases flexibility in managing unpredictability in the reverse chain- ‘*Easy access to information helps both manufacturer and retailers resolve returns questions quickly.*’ (Meyer, 1999, p. 29) According to Rogers and Tibben-Lembke (1999); Li and Olorunniwo (2008); Blumberg (2005) the most common information technologies applied in the reverse supply chains are Internet, electronic data interchange (EDI), bar coding, radio frequency identification (RFID), and enterprise resource planning (ERP).

*EDI and internet.* EDI – is a set of electronically based standards for information sharing (Li & Olorunniwo, 2008). Survey, made within the companies involved in the reverse supply chain processes, has shown that even if there is a developed set of 180 transactions dedicated to manage reverse flows the majority of the firms are using only some of the functionality of the EDI (Rogers & Tibben-Lembke, 1999). Furthermore, there is an opinion that EDI transactions in the reverse supply chains will be gradually replaced by the Internet (ibid).

*Bar coding.* Bar codes allow tracking of the product returns in real-time or near real-time manner and increase the accuracy in data entry and data collection (Blumberg, 2005). Bar coding is especially important in managing the routing, inventory and service operations (ibid). However, the use of bar coding in the reverse chains has limitations. Due to the dirt or crowded environments, it is not always possible to scan product returns optically (Blumberg, 2005). Furthermore, product may be returned without (e.g. on packages) or with removed bar codes (Rogers & Tibben-Lembke, 1999).

*RFID* – consists of active or passive tag and radio frequency reader/ emitter sharing (Li & Olorunniwo, 2008). RFID, in RSC, is used for the same purposes as bar coding – to achieve efficient and effective tracking and control returns' flows (Blumberg, 2005). Due to the utilization of the electronic spectrum, RFID is less impacted by dirt and congestions, and scanning can be done faster than using bar codes (ibid). However, RFID is more expensive and can be subject to errors due to the electromagnetic interference (Blumberg, 2005).

*ERP* – is a specialized information system that leads to connect all facets of the reverse supply chain (Li & Olorunniwo, 2008); increase integration and facilitate decision making (de le Fuente, Ros & Cardos, 2008); and allows to achieve high level of coordination of activities within and between organizations (Bernon & Cullen, 2007).

Even if there are a number of advantages for applying IT to facilitate the reverse supply chain processes, in practice, returns' management is a heavily IT-driven process (Li & Olorunniwo, 2008). According to de le Fuente et al. (2008) compared to the forward supply chains, in the reverse chains there is still a lack of implemented IT systems. *'Very few firms have successfully automated the information surrounding the return process'* (Rogers & Tibben-Lembke, 1999, p.44). Difficulties in the IT implementation in the reverse channels are related to many exceptions that occur in the reverse supply chain processes (Rogers & Tibben-Lembke, 1999); and, compared to forward supply chains, lack of financial investments (de le Fuente et al., 2008).

#### **2.4.2 Outsourcing**

According to Linder (2004, p. 55) outsourcing means –*'purchasing ongoing services from an outside company that currently provides, or that most organizations normally provide, for themselves'*. It means that companies purchase services from external companies. It refers to ongoing processes, however, when the responsibilities of the service providers end at the end of a contract. Consequently, outsourcing involves choosing a third party to perform a task, a function, or a process, in order to obtain business-level benefits.

Reasons for outsourcing decision usually apply to the costs reduction and focus on the core competencies (Sislian & Satir, 2000; Kakabadse & Kakabadse, 2005). Even trans-

actional costs for an external supplier allow saving money due to the economies of scale and expertise. The external party is able to provide services cheaper and gain profit because of the experience and economies of scale (Kremic, Tukel & Rom, 2006). The focus on the core competencies improves company's performance in a number of dimensions. Reengineering of business processes could help to achieve significant improvements in critical areas of performance such as cost, quality, speed, and service (Kakabadse & Kakabadse, 2005). Next to that outsourcing also has strategic implications (Sanders, Locke, Moore & Autry, 2007). Outsourcing is becoming a strategic tool to engage highly skilled suppliers. If outsourcing is aligned appropriately with the overall strategies of a firm, it could enhance the revenues by allowing greater focus on the activities that the firm considers to be the most important (ibid).

When considering the reverse supply chain, most of the companies outsource most or all of their reverse supply chain activities (Rogers & Tibben-Lembke, 1998). These companies outsource reverse activities to reduce the administrative work if doing it by themselves. The outsource suppliers become experts in managing reverse supply chain flow and can provide value-added services, as remanufacturing or refurbishing (ibid). Moreover, reverse supply chain is usually not a core competence for a company, thus one of the most important decisions could be outsourcing these activities to a third-party reverse logistics provider (further - 3PRLP) (Serrato, Ryan, & Gaytan, 2007). 3PLs in a closed-loop supply chain could be effective in ensuring sustainability since efficient reverse logistics services enable business with the opportunity to increase their profit margins, to differentiate their services from those of the competitors, to attract new clients to these services, and to raise their status in the global supply chain network (Efendigil, Önüt, & Kongar, 2008).

However, outsourcing the reverse supply chain activities is more suitable when there is greater uncertainty about how many units may be returned. High variability in returns decreases the economic possibilities of maintaining the firm's own reverse logistics facilities because the required capacity will be changing constantly. The responsiveness can be achieved by 3PRLP involvement, which is an expert in these activities, and can take advantage of the economies of scale to convert reverse logistics functions into a profit-creating activity. However, for industries with low return variability and longer product life cycles it is easier to develop their own facilities for the return flow, even if the reverse logistics may not be part of their core activities (Efendigil et al., 2008).

## 2.5 Summary of the Frame of Reference

The theoretical framework started with presenting the definitions and the scope of the reverse supply chain and reverse supply chain management. Several authors (e.g. Dowlatshahi, 2000; Prahinski & Kocabasoglu, 2005) agreed upon a lack of clearly defined and commonly accepted the term of RSC and RSCM. The authors of this thesis applied the definition of RSC developed by Guide and van Wassenhove (2002) and applied by other authors, e.g. Blackburn et al. (2004); Krikke et al. (2003) where the RSC is seen as series of activities dedicated to get back the products from the customer and to recover their value, reuse or dispose them. Consecutively, the RSCM is an effective and efficient management of these activities (Prahinski & Kocabasoglu, 2005).

The authors, based on past studies related to the reverse supply chain (e.g. Prahinski & Kocabasoglu, 2006; Pochampally et al., 2009; Rogers & Tibben-Lembke, 1999; Meyer,

1999), have collected and described driving forces that increase interests in the RSC and influence its strategy, design, and management. The main driving forces are shortening the products' life cycles, changes in buyer's behavior, increasing demand for improving the customer service level, green forces and business opportunities in the secondary markets.

Later, the classification and characteristics of the returns were presented. Returns can be classified into End-of-Life, End-of-use, Commercial returns and Re-usable items. Commercial returns usually have a high economic value or business opportunities. They refer to both the B2B and the B2C products and parts, and include wrong deliveries, damaged, outdated or unsold goods, warranty, service returns, wrong deliveries and returns due to the changed customers' preferences. In order to increase the competitiveness, generate additional revenues and decrease the processing cost, it is necessary to organize the reverse supply chain processes strategically. (Sahyouni et al., 2007; De Brito, 2003; Prahinski & Kocabasoglu, 2006; Rogers & Tibben-Lembke, 1999). Furthermore, such returns' characteristics as composition, deterioration and usage pattern may influence the strategy, design, and organizing of the reverse flows and processes within the RSC (de Brito, 2003).

Further, five business processes of the reverse supply chain (acquisition, reverse logistics, inspection and disposition, recovery, redistribution and sales) were reviewed. As acquisition is the first step in the reverse chain, such factors as the number of collection points, timing and quality, infuse speed and cost of processing returns in further processes (Guide & van Wassenhove, 2002; Gattorna, 2003). Cost, speed and flexibility – these requirements for the reverse logistics differ depending on the particular reverse flow, type of the product returns and product characteristics (Blackburn et al., 2004). Planning and forecasting of the reverse logistics activities is complicated due to the high level of uncertainty, low visibility and many nodes of origin (Fleischmann et al, 1997; Wu & Cheng, 2006). Testing and inspection is a labor intensive and time consuming process; however it is essential to chose the most appropriate route of disposition (Poist, 2000; Krikke et al., 2004). The earlier the differentiation for different returned goods is done the more possibilities there are to speed up the reverse flows for returns with a high marginal time value and to reduce logistics cost for returns with a low marginal time value (Blackburn et al., 2004). Recovery is used to capture the value for the returned products and may be influenced by the environmental legislation, economic factors and marketing forces (Thierry et al., 1995; Guide & van Wassenhove, 2002). Redistribution and sales of recovered products are influenced by the business opportunities in a particular market (Krikke et al., 2004); and might require the setting up of separate channels (Thierry et al., 1995).

Reverse supply chain design impacts on cost, quality and time of processing product returns. Based on studies of Rogers and Tibben-Lembke (1999); Skjott-Larsen et al. (2007); Blackburn et al. (2004); Krikke et al. (2004), centralized and decentralized RSC models were discussed. The centralized RSC is designed to move flows of returns at a low cost. Decentralized – due to the minimization of time delays, increase the speed of response. In practice, there is a variety of configurations between these two extremes.

Further, the frame of reference focuses on the supply chain strategy. The strategic fit between the supply chain strategy and the company's competitive strategy is very important (Chopra & Meindl, 2007), as the alignment of strategies lead to a competitive ad-

vantage and value creation. Fisher (1997), Lee (2002), Christopher and Towill (2002) made the biggest inputs in the academic researches about the strategy for supply chain. Fisher (1997) has proposed a matrix for innovative and functional products, where different type of products requires different supply chain strategy (efficiency or responsiveness). Lee (2002) has added the supply uncertainties next to demand uncertainties to Fisher's matrix. The authors of this thesis focused on the taxonomy for the supply chain strategies introduced by Christopher and al. (2006). The matrix of different configurations of demand and supply characteristics suggests the most applicable concept for the supply chain strategy from lean, agile and leagile. However, the company has to operate with the leanest agile system or the most responsive lean system according to matrix of 'market winners' and 'market qualifiers' (Christopher & Towill, 2000).

The key characteristic of lean concept is the cost (through waste) reduction (Mason-Jones et al., 2000). In the forward supply chain, the lean concept is suitable when a demand of products is predictable and through continuous replenishment or planning programs companies can seek for cost efficiency (Christopher, 2000; Morash, 2001; Christopher et al., 2006). However, it could be more complicated when focusing on the reverse supply chain, here, lean is mostly applicable for the returns with a low marginal time value (where returns are insensitive to the time spent in a pipeline from the end customer to the secondary raw materials supplier) and the reverse flow could be dealt with in cost efficient way (Blackburn et al., 2004).

Agility represents the responsiveness and the speed upon customer's request. In the forward supply chain, it is mostly suitable for the innovative products, or products with the uncertain demand and short lead time (Christopher et al., 2006). The agile reverse supply chain is applicable for returns with a high marginal time value (Blackburn et al., 2004) or could be matched to the high company's priorities for the customer satisfaction (Smith, 2005). Fast customer's claim management and responsiveness could significantly improve the brand image and keep the customer.

Leagile, a mix of the lean and the agile concepts, could be applied for a long lead time and the uncertain demand (Christopher et al., 2006). There are three ways to divide the products into two parts and then apply different concepts: Pareto optimum, de-coupling point, and 'base' and 'surge' demand. For the supply chain strategy that is mostly used is the de-coupling point or postponement strategy that the idea is to postpone the product differentiation. The point where the differentiation is done is called the de-coupling point and up to that point lean strategy is suitable, after the de-coupling point – agile (Hilletofth, 2009). For the reverse supply chain, the strategy of the preponement is introduced (Blackburn et al., 2004). Contrary to the postponement, early product differentiation could bring several benefits such as saved transportation costs and gained value for the product recovery on time (especially for the high marginal time value returns).

Two supporters for a strategy - information technology and outsourcing were discussed. IT enables the information exchange between the facilities, and coordinates the activities and the processes with the reverse supply chain partners (Li & Olorunniwo, 2008). Outsourcing could be seen as a strategic tool for ensuring the effective and sustainable reverse supply chain management and in this way increasing profit margins, differentiate services, enhancing the revenues by focusing on the core activities (Efendigil et al., 2008).

### 3 Methodology

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*The chapter will start by presenting the research philosophy and research approaches applied for this study. Furthermore, the research strategy, the data gathering methods and data analysis procedures used to conduct this research will be described. The chapter will end by discussing the validity, reliability and criticism of chosen method.*

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#### 3.1 Research Philosophy

Both the philosophy and the research have the aim to improve our knowledge of the world. The philosophy is more concerned on knowing what kind of things exist in the world and what is right to know them, while the research is concerned with their knowable properties (Williams & May, 2000). However, the research is impossible without the philosophy because the outcomes would be very different as they have emerged from the different starting points, and the philosophy is impossible without the social research because questions asked by philosophers should be supported by debates in research (Williams & May, 2000). According to Saunders, Lewis and Thornhill (2007) there are three different philosophical views: epistemological - philosophy of the knowledge and the nature of that knowledge; ontological - philosophy of the reality and the nature of it; and axiological that studies the judgments of values. In this research, the most relevant view is the epistemological one and it has three branches: positivism, realism, and interpretivism.

*Positivism* is a philosophical position that holds that only observable and measurable reality can provide the authentic knowledge (Salmon, Earman, Glymour, Lennox, Machamer, McGuire, Norton, Salmon & Schaffner, 1999). From the positivist point of view, the way to obtain and develop the knowledge lies in describing the phenomena that is experienced and can be verified (Saunders, Lewis & Thornhill, 2003). These imply that highly structured and quantitative research methods are appropriate (ibid).

*Realism* is based on the idea that the reality exists independent of human thoughts and beliefs (Saunders et al., 2003). The principles of the realist explanations lie on - '*the outcome of an action follows from mechanisms acting in particular contexts*' (Robson, 2002, p. 30). It leads to a way of doing experiments; however, in social research it is far more complicated. For realists there are social objects that could be studied scientifically, but the methods must fit the subject matter (Robson, 2002).

In this thesis *interpretivism* as epistemological position was applied. Interpretivism assumes that the reality is not objectively determined, besides the world is very complex and each phenomenon is often unique (Kelliher, 2005). From the interpretivist point of view, in order to understand and discover reality, it is necessary to explore '*subjective meanings motivating people's actions*' (Saunders et al., 2003, p. 84). This allows understanding perceptions, motives, and values that humans have about their actions (Kelliher, 2005). Since the reality of the business world is complex, dynamic and the set of circumstances in each particular firm are unique, the generalization for interpretivist is less valuable, and thus qualitative and less structured research methods are appropriate (Saunders et al., 2003). Since this research is concerned about analysing the managerial side of a company while focusing on the reverse supply chain, there is a necessity to understand the motives and the actions of a company. Even more, all gathered information should be processed by realising hidden objectives and correctly interpreted. Such is the main reason why interpretivist point of view is the most suitable for this thesis.



### 3.2 Deductive and Inductive Approaches

Depending on the reasoning that is used to support or justify the conclusions, the research can be classified as either deductive or inductive (Hugh, 2003). Deduction and induction reasoning (figure 3.1) have opposite directions – ‘*Deduction reasons from the mind to the world, whereas induction reasons from the world to the mind.*’ (Hugh, 2003, p. 160) Deductive reasoning moves from broader to more specific (Saunders et al., 2003); and conclusions follow logically from known facts (Sekaran, 2000). In turn, inductive reasoning starts from the observation of the specific phenomena and moves to a broader generalization and theories, and the conclusions are made based on observed facts (Sekaran, 2000). The main criteria for choosing the approach that should be applied are the starting point and the aim of the study, and whether study addressed to develop or test the theory (Hyde, 2000).

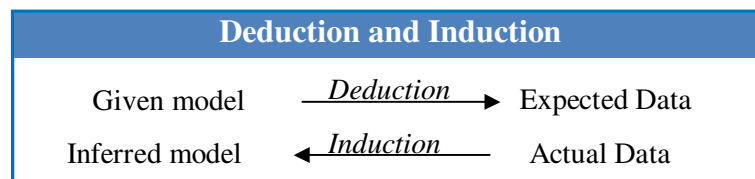


Figure 3.1 The opposite reasoning directions of deduction and induction (Hugh, 2003, p. 160).

The starting point of the deductive approach is based on well established theories and a researcher seeks to test if the theory can be applied to specific instances (Hyde, 2000). Based on the theoretical framework a researcher develops a hypothesis which, then, depending on the result of the observation can be either confirmed or rejected (Skinner, 2008). In the deductive research the quantitative data, highly structured methods are usually used (Saunders et al., 2003). On the one hand, that makes the deductive research process well controlled, yet on the other hand, a researcher become ‘*independent of what is being researched*’ which creates limitations for the alternative explanations of phenomena (Saunders et al., 2003, p. 89).

This thesis is written based on inductive logic. The starting point of the inductive research is a specific observation which leads to the formulation of the research questions and then, based on the data analysis, to the development of already the established theories or creation of the new ones (Hyde, 2000). The inductive research is issue-oriented (Skinner, 2008) A researcher seeks to gain a deep understanding of the nature and the context of a particular phenomena or event and becomes ‘*part of the research process*’ (Saunders et al., 2003, p. 89). To be able to uncover different views on the phenomena a small sample and qualitative data with various data collection methods are appropriate (ibid). Such flexible research design allows to make changes of research emphasis which increase the possibility for the alternative explanations and facilitate the research progress (Hyde, 2000).

The study process of this thesis started with the collection of the facts and the development of the ideas about the reverse supply chains and their strategies. The literature’s study has shown that the study area is relatively new and is not explored enough to formulate hypotheses. Instead, deep analysis about the issues and the problems regarding the choice and implementation of the reverse supply chain strategy was needed. Thus, in this study, authors’ intention was not to test if the existing theory can be applied in a particular situation, but to develop the theory by adding new perspectives and new knowledge gained from real business situations.

### 3.3 Exploratory, Correlational, Explanatory and Descriptive Studies

From the point of view of the purpose of a study, the research can be classified as exploratory, correlational, explanatory or descriptive (Kumar, 1999; Sekaran, 2000; Saunders et al., 2003). However, such classification is theoretical, which means that in practice these categories can be combined within the same research (Kumar, 1999).

- *Exploratory studies* are appropriate if a researcher seeks to explore the new, unknown or not enough explored areas (Sekaran, 2000). Since, the information about the situation or the phenomena is limited, to be able to get new insights, the researcher wants to investigate what is happening (Saunders et al., 2003). Furthermore, exploratory studies are based on the flexible research design, thus a researcher can change the direction of the study (ibid).
- *Correlational studies* are appropriate when a researcher attempts to find out if there is a relationship between particular variables of the phenomena or the situation – ‘*The main emphasis in a correlational research study is to discover or establish the existence of a relationship/ association/ interdependence between two or more aspects of a situation*’ (Kumar, 1999, p. 9).
- *Explanatory studies*, in contrast to correlational studies, are appropriate when a researcher seeks to explain the nature of the relationship – ‘how’ and ‘why’ there is a relationship between two or more variables (Kumar, 1999). This means that the explanatory research can help to explain ‘why’ or ‘how’ something is happening.
- *Descriptive studies* are appropriate when a researcher attempts to describe a situation, a phenomenon or a problem accurately (Kumar, 1999). Descriptive studies are well structured, formalized and have established rules and procedures (Ghauri & Gronhaug, 2005); and the research questions or the hypotheses are stated clearly (Saunders et al., 2003).

In this thesis, the exploratory and some of the elements of the explanatory approaches are used. Since, the situation about applicability of the lean and the agile concepts in the strategy of the reverse supply chain has not been clearly defined by the previous researchers, in order to be able to answer research questions, both the understanding of ‘what’ and the qualitative explanation ‘why’ is happening were necessary. This also implies that research design should be flexible enough to make changes during the study (i.e. continuous developing of the study based on gradually obtained information).

### 3.4 Time Horizon

Regarding the time perspective studies can be classified as either longitudinal or cross-sectional (Saunders et al., 2003). Longitudinal studies – collecting information on phenomenon or situation at two or more points in time (Sekaran, 2000) Longitudinal studies allow evaluating the pattern of change during the time (Kumar, 1999) However, it can be very time-consuming (Saunders et al., 2003). Cross-sectional studies are used when the purpose requires to explore the overall picture on particular phenomenon, problem or situation (Kumar, 1999). The main disadvantage of the cross-sectional studies is that they cannot evaluate the change (Saunders et al., 2003). According to Kumar (1999) cross-sectional studies usually rely on the quantitative methods. However,

Saunders et al. (2003) argues that the cross-sectional studies are also commonly used in the case study strategy based on the interviews.

This thesis, regarding the time perspective, is cross-sectional. There were two reasons to choose this perspective. Firstly, in order to fulfil the purpose and to answer research questions, it was not necessary to study the situation in more than one point of time. Secondly, even if the business world is extremely dynamic, the strategy (in this thesis – the strategy for the reverse supply chain) is more stable and it often takes years rather than months to implement strategic change, and thus the application of the longitudinal perspective, due to the time limit, was not reasonable.

### 3.5 Qualitative and Quantitative Methods

Saunders et al. (2007) have stated that based on the type of information sought during the research process the research could be classified either as quantitative or qualitative. According to Kumar (1999) the problem and the purpose of the study is the main criteria for choosing the appropriate method. The chosen method requires different techniques and processes to measure the variables and to analyze the information (Blaxter, Hughes & Tight, 2001). According to Maxwell (2005) both quantitative and qualitative methods have different strengths, logic, and are addressed to achieve different study goals. The main differences between quantitative and qualitative approaches are presented below (table 3.1). However, according to Saunders et al. (2003) qualitative and quantitative researches are not mutually exclusive – in some studies, to fulfil the purpose, both methods can or must be used within the same research.

Table 3.1 Differences between qualitative and quantitative research (Blaxter et al., 2001, p. 65)

Qualitative paradigms	Quantitative paradigms
• Concerned with understanding behaviour from actors' own frames of references	• Seek the facts/causes of social phenomena
• Naturalistic and uncontrolled observation	• Obtrusive and controlled
• Subjective	• Objective
• Close to the data: the 'insider' perspective	• Removed from the data: the 'outsider' perspective
• Grounded, discovery-oriented, exploratory, expansionist, descriptive, inductive	• Ungrounded, verification-oriented, reductionist, hypothetico-deductive
• Process-oriented	• Outcome-oriented
• Valid: real, rich, deep data	• Reliable: hard and replicable data
• Ungeneralizable	• Generalizable
• Holistic	• Particularistic
• Assume a dynamic reality	• Assume a stable reality

According to Punch (2000) the main concept of the quantitative research is based on the gathering and analysis of the information about the phenomena in numerical means. The quantitative method is appropriate if a researcher seeks to '*quantify the variations in a phenomenon, situation, problem or issue.*' (Kumar, 1999, p.10). The strength of the quantitative research lies in the possibility to generalize the sample's result to the whole population (Creswell, 2002).

The qualitative research approach is used in this thesis. According to Punch (2000), the qualitative research can be defined as the research where study is made and a conclusion

can be generated based on the qualitative data. The qualitative data represents the meanings expressed through words – ‘...is concerned with collecting and analyzing information in as many forms, chiefly non-numeric, as possible’ (Blaxter et al., 2001, p.64). The strength of the qualitative research lies in its deep focus on the particular situation, the ability to understand the meaning of such situation for a participant, and to understand the contexts of the participant’s actions within such situations (Maxwell, 2005). ‘It tends to focus on exploring, in as much detail as possible, smaller numbers of instances or examples which are seen as being interesting or illuminating, and aims to achieve ‘depth’ rather than ‘breadth’ (Blaxter et al., 2001, p. 64). The qualitative research is flexible and adaptable; however, the results are subjective and often cannot be applied to the whole population (Gillham, 2001).

The qualitative research approach is suitable for this thesis because it provides an opportunity to understand a point of view, the attitudes and perceptions of the interviewed participants regarding the wide range of issues related to the choice and the implementation of the strategy for the reverse supply chain. Furthermore, since the purpose is to explore and explain the nature of the phenomenon, rich qualitative data, that could facilitate the understanding of the links between various different variables, is necessary. Besides, since the business environment is highly complex and each reverse supply chain is unique, to illuminate and understand the meaning of what is happening requires both the research flexibility and the ability to take a look from the ‘insider’ perspective.

### 3.6 Literature review

Blaxter et al. (2001) have stated that each research project should start by reviewing the existing literature (books, journals, etc). A literature review is defined as – ‘a systematic, explicit, and reproducible method for identifying, evaluating, and interpreting the existing body of recorded work produced by researchers, scholars, and practitioners’ (Fink, 1998, p. 3). According to Kumar (1999), by reviewing the literature, researchers can clarify the research problem, improve the methodology and increase the understanding about the research area. There is no correct structure for the literature review, it should however start with a more general area which later should be narrowed down to the specific research objectives (Saunders et al., 2003). In order to save the time Kumar (1999) suggested use indices of journals, abstracts of articles and citation indices.

The literature review for the thesis was started by looking for relevant information in various electronic databases such as ABI/Inform, Business Source Premier, Elsevier Science Direct, etc. and Google Scholar search engine. Certain keywords were used: ‘reverse logistics’, ‘reverse supply chain’, ‘supply chain strategy’, ‘strategy for reverse supply chain’, ‘lean’, ‘agile’, ‘leagile’. Hundreds of found articles were viewed by first reading the abstract, later looking at the introduction, and if relevant information was found continuing to a whole article. The most important strategy was to make very short notes on the main idea of the article. Later it has helped a lot when formulating the main research problem. Simultaneously to that, the search SCM books at Jönköping University library and lecture conspectus were reviewed. When a useful article or a book was found, the authors were looking for a reference list to expand the knowledge on a topic, gather more important information, and be acquainted with more publications of the relevant authors. However, only a few articles were focusing on the RSC, and it has led to a challenge while narrowing the topic because of the limited previous researches and the time limit for the thesis.

### 3.7 Research Strategy

Saunders et al. (2003) stated that depending on the objectives of the study different research strategies should be applied (e.g. survey, experiment, case study, grounded theory, action research). Yin (2003) pointed three conditions that are important for the strategy selection: the proposed research questions, the extent of researchers' control over behavioural actions, and the necessity of the focus on the contemporary events (Figure 3.2). Each strategy has its own advantages and disadvantages, and different ways to collect and analyze the data (Saunders et al., 2003).

Table 3.2 Relevant situations for different strategies (Yin, 2003, p. 5)

Strategy	Form of Research Question	Requires Control of Behavioural Events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case study	How, why?	No	Yes

In this thesis, a case study as a research strategy is chosen. According to Saunders et al. (2003) case study is an empirical analysis of a contemporary situation, event or phenomenon using a wide range sources of evidence. Blaxter et al. (2001) noted that the case study data collected based on peoples' experience allows showing the complexity of the reality and exploring the alternative meanings. Creswell (1997) stated that case study is appropriate as the strategy if the objectives of the study require an in-depth analysis; and according to Yin (2003) it is suitable when research objectives require answering the questions 'how' and 'why'. Furthermore, a case study allows analyzing a phenomenon in the previously uncovered areas (Stake, 1995).

According to Yin (2003) case study research can be conducted either through single-case or multiple-case studies. In this thesis, a multiple-case study as a research strategy is applied. According to Yin (2003) conclusions drawn from two or more cases are more powerful than from a single case study. The advantage of multiple-case studies is that from different cases collected and analyzed data allows not only to compare the results but also to provide possibilities to the analytical generalization (Blaxter et al., 2001). In contrast to a single case study, the conclusions drawn based on multiple-cases research strategy are more 'powerful' and comprehensive (Yin, 2003).

Since the purpose and the research questions require a deep understanding of the particular business situations, complexity of the issues and problems within the previously not researched area, from the point of view of the authors of this thesis, a case research strategy in this study is the most appropriate. Furthermore, since implementing the lean and the agile concepts in the reverse supply chain depend on the set of circumstances that may vary in different companies (even in the same industry), to be able to fulfil the research's goals and draw comprehensive conclusions, the analysis based on a few case studies is needed. Thus, the authors have decided to apply the multiple-case research strategy.

### 3.8 Cases and Respondents Selection

The guidelines for the case selection differ when selecting a single case or multiple cases. The reasons for choosing multiple cases in this research are mentioned above. According to Blaxter et al. (2001) it is necessary to carefully select the cases within multiple-case study. *'Every case should serve a specific purpose within the overall scope of inquiry'* (Yin, 2003, p. 47). There are two approaches when selecting multiple cases. The first is a literal replication when the cases with similar settings are chosen and similar results are expected to be achieved. The second – a theoretical replication when the cases have different settings and are selected to predict contrasting results (Shakir, 2002). The replication logic provides suggestions for a determined number of cases. Yin (2003) suggests the initial satisfactory number of cases: 3 to 4 cases for a literal replication, and 6 to 8 for a theoretical replication. However, for the theoretical replication the number of the cases is considered satisfactory when *'rival theories are grossly different'* and the number of cases need to be increased when *'rivals have subtle difference'* (Shakir, 2002, p. 195).

In this research, the authors have decided to use the literal replication while selecting the cases because of a more suitable approach for the research purpose and the time limit if considering a theoretical replication. As a result, all the selected case companies (Fläkt Woods, Swegon, Systemair, and Rettig ICC) are the leading manufacturers in the indoor climate industry in Europe; all the companies are brand-owners and sell their products globally; the head offices and/or the main production facilities of all of the firms are located in Sweden. Since there are just a few players in particular industries, it was not possible to select the identical cases in terms of the number of employees and turnover. Thus, in 2009 the number of employees in these companies varied from approximately 1000 to 3500, and the generated turnover varied from 220M€ to 670M€.

The second step, after the selection of the cases, required to choose the respondents within each single case. According to Kumar (1999) the non-random/probability sampling is appropriate in qualitative researches. Saunders et al. (2003) also suggested to apply the non-probability sampling technique when the research objectives do not require generalization. The non-random/probability sampling implies that a sample is not chosen randomly, i.e. a sample can be chosen based on a particular set of the required characteristics (ibid). Kumar (1999) identified four non-random/probability sampling designs - quota sampling; accidental sampling; judgement (purpose) sampling; and snowballing sampling.

In this research in order to choose the respondents within each single case, two sampling designs - judgemental (purposive) and snowballing were applied. Judgemental (purposive) sampling design is based on the idea that a researcher chooses the respondents depending on their ability to provide the information necessary to achieve the research goals (Kumar, 1999). Snowball sampling design is based on a network idea. When it is difficult to obtain contacts in a particular organization, Saunders et al. (2003) suggested making contact with a few people, they then should be asked to identify other individuals in a firm, the new persons becoming a part of a sample. Initially, the authors of this thesis contacted the senior managers and logistics managers in the selected organizations. The contact information was obtained from the firms' websites. The authors have sent an email containing personal information, information regarding the research area, motivation to conduct interviews in a particular company, and a simplified (shortened)

interview guide. In total nine highly motivated emails were sent and four people from different companies agreed to participate in the study.

### 3.9 Data Collection

To be able to meet the research objectives each researcher should carefully consider the data collection process (Blaxter et al., 2001). Depending on its origin, data collected during the research process can be classified either as secondary or primary (Kumar, 1999). Secondary – data that have already been collected by someone for another purpose, primary – the ‘new’ data collected for a particular research (Saunders et al., 2003). To fulfil the purpose of this thesis both secondary and primary data were used.

#### 3.9.1 Secondary Data

Since obtaining the primary data is difficult and time consuming, using the secondary data might be a good alternative to facilitate the research process; furthermore, usage of the secondary data leads to significant financial savings (Blaxter et al., 2001). According to Saunders et al. (2003) secondary data can be quantitative as well as qualitative, and the secondary data may also lead to unforeseen discoveries. Ghauri and Gronhaug (2005) stated that secondary data, on the one hand, can be seen as a ‘comparison tool’ to understand and interpret the primary sources. On the other hand, there is no possibility to control the quality of the data, and the data collected for other purposes cannot match the needs of a specific research, or defections and aggregations do not fit into the research context. Saunders et al. (2003, p. 190) have classified the secondary data into:

- *Documentary* including written (e.g. organizations’ web sites) and non written (e.g. taped interviews) material;
- *Multiple source* (e.g. government publications, journals, industry specific reports);
- *Survey*: censuses, continuous and regular, and ad hoc surveys (e.g. government, organizations’, academics’ surveys).

In this thesis the following types of secondary data were used:

- *Documentary*: articles, journals, doctorate and master thesis, organizations’ records, annual reports, brochures, power-point presentations.
- *Multiple sources*: industry specific reports, publication and analysis available from such websites as Reverse Logistics Association, Reverse Logistics Executive Council Reverse Logistics Magazine, etc.

Due to the enormous amount of the data available, the data was carefully filtered and then, suitability to the research area was precisely evaluated.

#### 3.9.2 Primary Data

Kumar (1999); Saunders et al. (2003); Ghauri and Gronhaug (2005) have stated that there are several methods for the primary data collection, i.e. observation, questionnaires and interviewing. The purpose of the study, research questions, available resources and researcher’s skills – the main criteria for choosing the most appropriate data gathering method (Kumar, 1999). In this thesis, primary data are gathered through the interviews conducted by the authors. Interviews are the most often applied method for the information gathering from people (Kumar, 1999; Sekaran, 2000). Interviews help

to obtain reliable and valid data on the issues of interest (Saunders et al., 2003). Interviews are the most important source of the information in the case studies (Yin, 2003); and are commonly used for obtaining qualitative data (Ghauri & Gronhaug, 2005). Authors of this thesis have made a decision to conduct interviews based on the strengths of this data collection method for the chosen research approach and the research strategy. Interviews, by focusing on the issues relevant to the study purpose and the research questions, allowed to obtain the specific data necessary for the analysis and conclusion.

Depending on the degree of formality and structure interviews can be classified into structured, unstructured (in-depth) and semi-structured interviews (Saunders et al, 2003; Bailey, 2007; Denzin & Linkoln, 2003; Kumar, 1999; Sekaran, 2000). Structured interviews use questionnaires (Saunders et al., 2003); built in specific order of predetermined questions (Sekaran, 2000); all respondents are asked the same set of questions in the same manner (Denzin & Linkoln, 2003). Structured interviews can be favourable when the research problem is well-known (Saunders et al., 2003); a researcher can control the data gathering process (Kumar, 1999); especially useful when a researcher seeks to compare the data collected from different groups (Bailey, 2007). On the other hand, structured interviews lack the flexibility and social interaction (Sekaran, 2000). In contrast to the structured interviews, unstructured interviews are informal (Saunders et al., 2003); similar to conversation (Bailey, 2007); do not have predetermined list of questions (Saunders et al., 2003), and different interviewees can be asked a different number of questions in different sequence (Sekaran, 2000). Unstructured interviews are addressed to in-depth explore factors of the phenomenon, event or situation (Sekaran, 2003); and can provide insight data about participants' behaviours, perceptions and beliefs to particular phenomenon (Saunders et al., 2003). However, unstructured interviews are very time-consuming (Bailey, 2007); the data often the lack of reliability and it is hard to generalize (Sekaran, 2000).

In this thesis, a semi-structured type of interviewing was used. Bailey (2007) noted that a researcher, who has adopted an interpretative research philosophy, prefers, to apply semi-structured or unstructured interviews. According to Saunders et al. (2003) semi-structured interviews are commonly used for the exploratory and explanatory studies and are very appropriate for collecting the qualitative data. Semi-structured interviews both include some level of flexibility and in structured guidelines (Bailey, 2007). List, order and number of questions can vary from respondent to respondent (Saunders et al., 2003). When a researcher has found new interesting aspects related to the phenomenon, semi-structured type of the interview due to its flexibility, provides a possibility to formulate some questions spontaneously (Kumar, 1999). A possibility to raise new questions is especially useful in the situations where little is known about the research area (Saunders et al., 2003).

In this thesis, each single case within a multiple-case study is unique and consists of different sets of circumstances. Furthermore, the purpose and research questions required to explore not only 'what' is happening in the relatively unknown area but also to explain qualitative relationship between the different situations. To do that, deep focus on each single situation, and understanding of the meaning from the participants' point of view was necessary. This means, the interviews had to be adaptable and flexible enough. Thus, the semi-structured interview as a primary data gathering method was chosen. The authors have formulated an interview guide with a set of specific questions regarding the study area. However, it is important to note that the questions were cus-



tomized and adopted for a particular company and for a particular interviewee. An example of the interview guide is presented in appendix 1. Furthermore, during the interview additional questions, to clarify situation or discover new aspects of problems or the phenomenon, were asked.

According to Sounders et al. (2003) qualitative interviews can be conducted one to one-to-many (focus groups interviews) or one-to-one (face-to-face or telephone interviews). Telephone interviews can be advantageous when interviewees, for example due to tight working schedule, cannot be contacted face-to-face (Seidman, 1998). Telephone interviews can significantly reduce the cost and increase the speed of the research; however, personal face-to-face interviews allow establishing the commitment and the trust, which is especially important in the case of dealing with sensitive interview questions (ibid). Sounders et al. (2003) suggested that telephone interviews should be conducted when trust and commitment have already been established.

Primary data for the empirical part of this thesis was collected by conducting 13 interviews during April 2009 (Appendix 2). Ten interviews were conducted face-to-face while the other three were telephone interviews. To be able to conduct face-to-face interviews, the authors visited companies' headquarters and/or main production facilities located in Jönköping, Skinnskatteberg, Kvänum and Järpås. The telephone interviewing method, was chosen because interviewee were placed outside Sweden and/or had tight working schedule and were not able to make an appointment. Interviewees' ability to provide relevant information as well as the ability to devote time influenced the length of the interviews. Thus, interview's length has varied from 25 min to 2 h 15min. All the interviews were recorded.

### 3.10 Data Analysis

One of the last parts of the research project is the analysis of the gathered information (Kumar, 1999). Data collection and data analysis are interrelated processes (Saunders et al, 2003). To be able to draw valuable conclusions a researcher should analyse empirical data systematically (Blaxter et al., 2001). Choosing the appropriate strategy and procedures for the data's analysis allow achieving study objectives (Kumar, 1999). However, according to Yin (2003), there are no clearly defined strategies and procedures and the analysis of the data in multiple-cases is a difficult process.

There are many different strategies dedicated for inductively based qualitative data analysis, such as narrative analysis, grounded theory, data display and analysis, analytic induction (Saunders et al., 2003). However, according to Bailey (2007) most of the strategies share some similar set of analytic process that requires to break the down, to study data components, and interpret its meaning. According to Saunders et al. (2003) this process involves the following activities:

- categorization – the data classification in meaningful categories by using the terms from existing theory, from data or used by participants;
- 'unitizing' data – attaching 'bits' to the data relevant to the defined categories, this activity leads to the data reduction and increased manageability; and
- recognising relationships - developing categories (e.g. merging or subdividing) and searching for the relationships or patterns in a set of data.

In this thesis, all interviews were transcribed for data analysis. Appropriate categories were identified by reading transcripts. The terms used in theoretical framework were the source for categories. The structure for the allocation of categories followed the structure used in the interview guide. Appropriate labels with authors' comments were written in the right-hand margins. To separate the text related to each label the brackets alongside the text in the right-hand margin were used.

To analyze the empirical findings *data display and analysis strategy* was chosen. According to Miles and Huberman (1994) this approach includes three steps - data reduction, data display, and drawing conclusions (cited in Saunders et al., 2003). After the categorization, labelled units of data were cut out in order to allocate them to appropriate categories. This step led to the reduction of amount of data (since not all data were relevant to categories) and increased the focus and manageability of the rearranged data. In order to be able to identify patterns and relationship between the units the data displaying approach (the network technique) was applied. Visually displayed network consisted of boxes with labels and key points of data. Lines linked the boxes according to the identified relationships and dependences between units. Applied method helped to indicate variables that were important to draw conclusions.

Bailey (2007) noted that computer technologies could facilitate the analysis of qualitative data significantly. In this thesis, the computer programs such as MS Word and MS Visio were used. MS Word was mainly used for context analysis, editing, making notes, categorization and rearranging of data units. MS Visio was used for the visual displaying of the data and finding relationship and patterns between the labelled data units.

### **3.11 Validity and Reliability**

Validity refers to the quality of the research and should be addressed in every stage of a study (Kumar, 1999). Validity implies whether the research approaches, methods and techniques actually measure what they have to measure (Blaxter et al., 2001). However, Stenbacka (2001) argue that the concept of validity for qualitative studies should be re-defined. In qualitative research, where the main purpose lies in the understanding a social phenomenon, validity can be achieved through non-forcing interviewing with well-targeted interviewees - *'This means that the understanding of the phenomenon is valid if the informant is the part of the problem area and if he/she is given the opportunity to speak freely according to his/her own knowledge structures.'* (Stenbacka, 2001, p. 552)

In the research methodology, many forms of validity are discussed, e.g. face and content validity, concurrent and predictive validity (Kumar, 1999). Yin (2003) notices that three forms of validity are especially important for the multiple-case research strategy: construct validity - establishment of the appropriate instruments of measuring; internal validity - assuring that causal relation between the variables is correctly established; external validity - establishing the possibility to generalize data. Saunders et al. (2003) stated that research must always ensure the validity of the study. In order to be able to achieve the construct validity researchers should use multiple sources of evidence and build up evidences' chain, in turn, external validity in multiple-case studies can be achieved through the replication logic during the research design phase which increase the analytical generalization (Yin, 2003).

To ensure the validity the authors of this thesis have used multiple sources of evidence i.e. not only data gathered during the semi-structured interviews but also corporate, in-

dustry and academics documents and journals related to the research area (reverse supply chain as well as the lean, the agile and the leagile concepts). Furthermore, to ensure the validity, targeted participants were interviewed (see appendix 2).

The concept of reliability refers to the accuracy and the consistency – ‘*The basic reliability issue concerns a measurement method’s ability to produce the same research result over and over again.*’ (Stenbacka, 2001, p. 552). According to Kumar (1999) there are several factors that affect reliability in the qualitative research i.e.:

- *The wording of questions* – wording may affect the interpretation of question;
- *The physical setting* – physical settings may affect responses;
- *The mood of interviewee* – the answers may be affected by mood of interviewee;
- *The nature of interaction* – the responses may be affected by the interaction between the interviewer and the respondent;
- *The regression effect on an instrument* – the attitudes of the interviewee on the issue may affect the answers.

Since the factors mentioned above can change during the time, it is impossible to have research tools that can provide 100 percent reliability (Kumar, 1999). According to Robson (2002) the main threats to reliability are interviewer and interviewee’s biases: interviewer’s bias – interviewer’s behaviour that affects the interviewee’s answers; interviewee’s bias – unwillingness of the interviewee to provide the requested information, e.g. sensitive information (cited in Saunders, 2003). The aim of reliability is to decrease the study biases (Yin, 2003).

In this study, in order to reduce the impact of the mood of interviewees and misinterpretation, more than one person in each company were interviewed. To avoid the interviewee’s bias companies that were willing to participate and disclose the information were chosen. To avoid the interviewer’s bias, the authors were behaving neutrally and were not interrupting the interviewees. Non-verbal behaviour was avoided as well. It is important to note that different position within company, different scope of delegated responsibilities, and different level of experience of the respondents could have had a direct impact on the questions’ interpretation. To reduce the level of misunderstandings and misinterpretations the compiled materials were sent to respondents for correction.

### **3.12 Method Evaluation**

From the authors’ point of view, to achieve the purpose of the study it was reasonable to choose the qualitative research approach, to apply the multiple-case study research strategy, and to conduct the semi-structured interviews. However, there are some weaknesses in the chosen method as well as possible alternative ways to conduct the study.

Firstly, the chosen qualitative research approach does not provide possibility to apply the result to the whole population. The lack of ability to achieve theoretical generalization makes the study less valuable for the academia and the practitioners. Secondly, the chosen method is highly associated with the problem of biases. Even though the authors have made efforts to decrease the biases, the chosen method does not allow guaranteeing a very high reliability. Finally, the authors are sure, that in order to reach deep understanding of the phenomenon it would be appropriate to use more sources of evidence. For instance, observation to evaluate how the sorting and testing process in the RSC is done could increase quality of the study significantly.

## 4 Empirical Study

*The chapter will present the empirical material collected from the interviews at four companies. For each company the empirical findings will be presented under the sub-chapters: general company information, products and returns, reverse supply chain processes, reverse supply chain strategy, driving forces and barriers.*

### 4.1 Introduction

In this thesis, the empirical study is based on the material of thirteen interviews conducted at four targeted companies operating in the indoor climate industry (the list of the participants can be found in the appendix 2), and data collected from companies' websites, PowerPoint presentations, and annual reports.

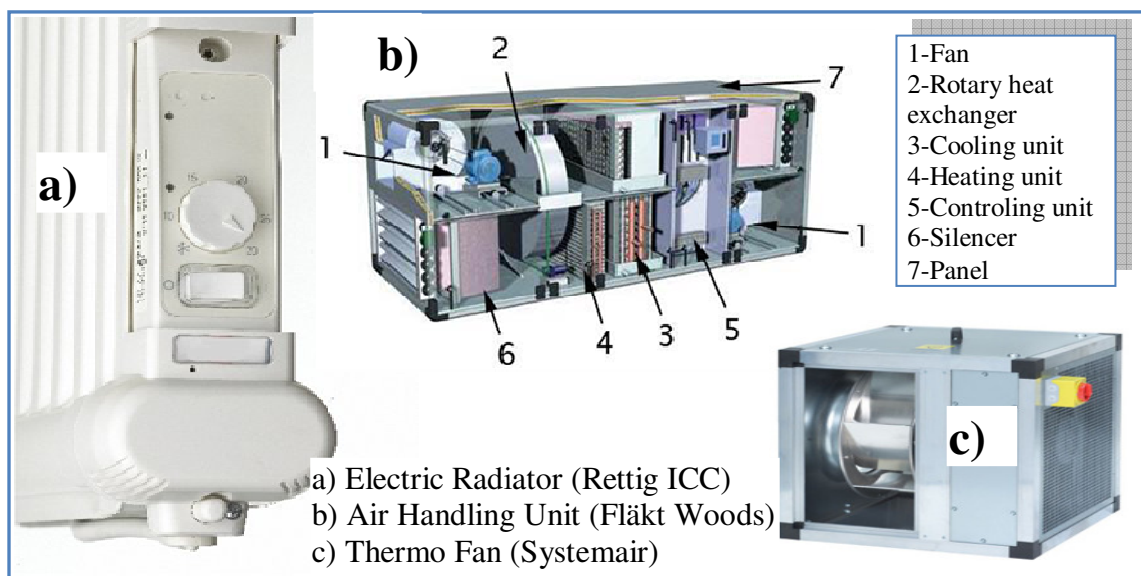


Figure 4.1 Product examples (Rettig ICC, 2010; Fläkt Woods, 2010; Systemair, 2010).

The companies Fläkt Woods, Systemair, Swegon and Rettig ICC supply a wide range of products and provide extensive series of solutions for the air climate industry. Detailed information is provided under the sub-chapters 'General Company Information' and 'Products and Return'. However, the empirical study focuses on the reverse supply chain processes and the strategy for products that are produced in particular plants located in Jönköping (Fläkt Woods), Skinnskatteberg (Systemair), Kvänum (Swegon), and Järpås (Rettig ICC). The examples of products are presented in Figure 4.1. All products have a long life cycle; however, strategic reverse supply chain decisions are complicated by the complexity of the components that have different life cycle.

### 4.2 Fläkt Woods

Fläkt Woods is an important global provider of the energy-efficient air solutions. Fläkt Woods focuses on the markets of air climate for building and air movement for infrastructure and industry. For buildings, the company offers air climate products and solutions that supply clean and fresh air in an energy-efficient way. For infrastructure and industry, Fläkt Woods offers services and products (such as fans for cooling systems) that increase the efficiency, the performance and reduce the environment impact of the equipment and processes (Fläkt Woods, 2010).

### 4.2.1 General Company Information

Fläkt Woods is an entity of two companies - Fläkt and Woods. Fläkt was established by Sven Söderberg and Robert Sundström in 1918. Originally, the company was called Svenska Fläktfabriken Söderberg & Co and the first production site was located in Jönköping (Sweden). Woods was established by Maurice Woods in Colchester (UK) in 1909. The company started by producing single-phase motors. In the beginning of 2000s Fläkt was well known as an expert in the air handling and the air climate industry, Woods, in turn, became a leader in producing axial fans. In the year 2002, both companies formed the Fläkt Woods Group (Fläkt Woods, 2010).

Nowadays, Fläkt Woods group is a leader in the ventilation and treatment of the air systems – in the top 3 air climate players in Europe and in the top 3 air movement players worldwide. The group has employed 3500 employees that work in 26 factories in 20 countries around the world. Through the well-developed network of representatives (agents), Fläkt Woods group supplies its systems to offices, hospitals, schools, etc. in 95 countries. In 2008, annual turnover was 670 M€ (Fläkt Woods, 2010).

Fläkt Woods group has defined its vision as – *‘to be a leading global provider of high quality air solutions that are used by people at work or at home, by industry and in infrastructure applications’* (Fläkt Woods, 2010). To accomplish the vision and increase the competitiveness Fläkt Woods have been continuously developing its extensive research and product development resources, and expertise to provide high quality products and solutions that reduce the operating cost and save the environment. The value creation and the customer satisfaction have been achieved through long experience with unique clients’ reference lists, application expertise that allows understanding the specific customers’ requirements, technology and innovations, and high quality of products and processes (Fläkt Woods, 2010).

Quality, environment, and corporate responsibility are important concerns of the company. Fläkt Woods is certificated according to ISO 9001:2000, ISO 1400:2004 and created the document of corporate responsibility that focus on seven key areas – overall governance and ethics, environment, customers and suppliers, employees, communities, investors, and other stakeholders (Fläkt Woods, 2010).

### 4.2.2 Products and Returns

Fläkt Woods has an extensive product portfolio including air handling units, fans, controls, chilled beams, energy recovery units (Fläkt Woods, 2010). Plant in Jönköping (Sweden) focuses on manufacturing of the Air Handling Units (AHUs). There are different kinds of Air handling units – eQ units (including eQ1 and eQ2), EU units (including EU, EU Express and Marine EUMM units), ABR and VEKA, and Hygienic Air Handling units (Fläkt Woods, 2010). AHU typically consist of such parts as fan, rotary heat exchanger, cooling and heating units, silencer, and panel.

Returns are not very common in Fläkt Woods, because: *‘our production lives as long as the building’* (L. Hed, personal communication, 2010-04-06). Yet, even if the whole product is never returned, parts of the air handling unit break and they must be changed. Thus, regarding the returns, parts of the products are being returned to the company. However, the claims are under 1% of the turnover due to the warranty issues from the supplier, design or manufacturing of Fläkt Woods.

### 4.2.3 Reverse Supply Chain Processes

The scheme of the main processes in RSC in the company is shown in the figure 4.2.

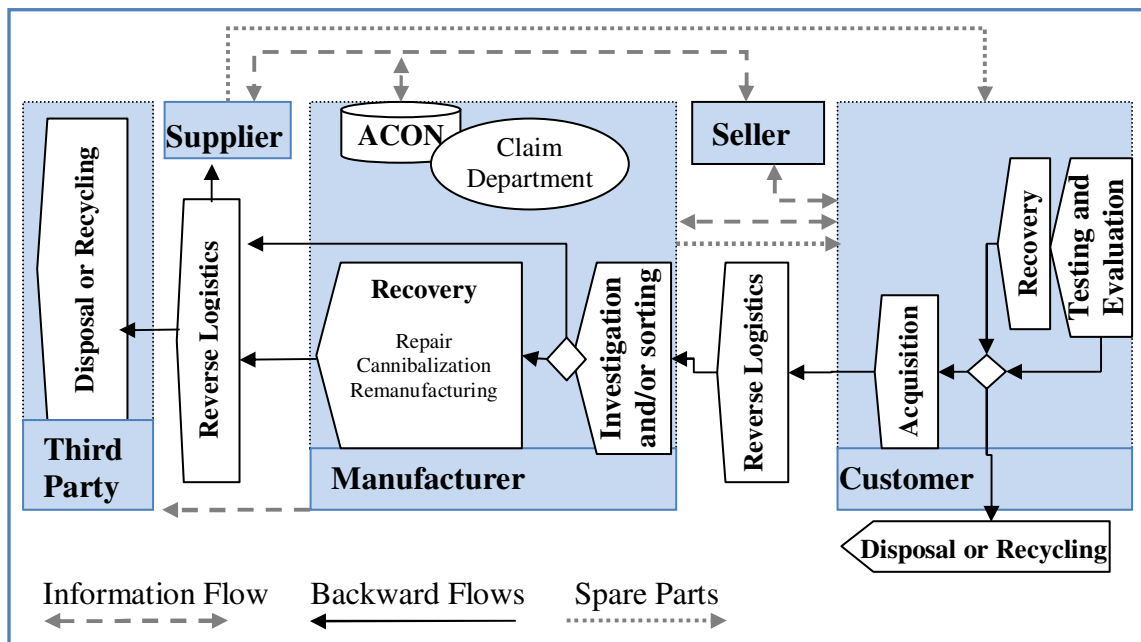


Figure 4.2 The processes of the reverse supply chain in Fläkt Woods.

*Product acquisition.* The process starts with an information flow from customer to claim management: the customer claims the damage of a product to his sales agent. The agent fills the claim form in the web-based ACON system and the claim management department gets it at the same time. The claim department notifies the sales agent (through ACON) or customer directly that the claim has been taken into consideration. After the primary testing of a problem at the site, the new spare part is shipped to the customer as soon as possible and the broken part is taken back for the secondary testing and inspection. ‘We have on stock most of the spare parts’, but if not ‘we can send our technician to fix it on site or we can send one of the contracted company’s technician’ (L. Hed, personal communication, 2010-04-06).

*Testing and inspection.* In this case, there are two stages for testing and inspection, in each step after the testing of the differentiation of the product is made (early sorting). The first differentiation includes testing and evaluation that is done at the site of the customer in order to identify the problem. The next step depends on the outcomes of this testing. If the cause of the inflicted damage is not new and has already been analyzed by the manufacturer based on other customers’ cases, the broken part is left in the customer’s custody for proper utilization. If the cause of the problem has not been met before, the broken part is shipped back to the factory for a second testing and inspection (K. Lilja, personal communication, 2010-04-07). The secondary differentiation includes investigation and sorting which takes place in the manufacturing unit. If the cause of the problem is found in the supplier’s material, the broken part is sent to the supplier. If a damage occurred in the part manufactured by the company, all departments (quality, R&D, technical sales support, etc.) do the deep examination of a problem and for the possible future improvements. This teamwork could also be done even if the main cause was found in supplier’s equipments. After the identification of the cause, the part of a product is sent to recovery stage (K. Lilja, personal communication, 2010-04-07).

*Reverse logistics.* The transportation activities are mainly outsourced to companies such as UPS, TNT (express logistics) and DSV (road transportation for larger quantities). Express courier is used for shipping a new spare part to change the broken one, or for shipping the broken part back to the factory to fix it and forward it to the customer. Lower costs of transportation are when e.g. DSV is used, however in reverse logistics it is used only for the broken parts when the new one has been already transported and changed, but the damaged part is needed for the further examination (L. Hed, personal communication, 2010-04-06).

*Recovery.* When the cause of a problem is found, the product goes to the recovery stage. Depending on the decision of sorting, the product (usually a particular part of it) could be repaired, remanufactured, cannibalized, or recycled, and the scrap left after any of these processes disposed. Fläkt Woods makes reparation, remanufacturing or cannibalization at the same production unit and uses the recovered parts for the future production manufacturing depending on the age of the material. However, *'99 % of the air handling unit could be recycled, <...> we take what we can take and use, the rest we send out'* (K. Lilja, personal communication, 2010-04-07). The residuals are sorted and later transferred for the recycling companies: still valuable parts such as metal are sold; parts that are dangerous for the environment remain and garbage are collected by the environmental organizations that the company has contracts with. *'We collect paper, galvanized parts, other types of metal, etc. in containers, and once per month the recycling companies comes to take full containers'* (K. Lilja, personal communication, 2010-04-07).

*Re-distribution and sales.* Fläkt Woods does not resell its products because they make to order and the product is configured for the individual use, especially the air-handling units that are too large and too complicated for the secondary use. Moreover, the company believes that re-distribution and re-sales could negatively affect their brand image (K. Lilja, personal communication, 2010-04-07; L. Hed, personal communication, 2010-04-06).

#### 4.2.4 Reverse Supply Chain Strategy

Figure 4.3 provides a scheme of processes in the reverse supply chain in Fläkt Woods where each process focuses either on the speed and responsiveness or on the cost and efficiency. The blue narrow on left shows the trade-off of the cost and the speed for a process showed on the right. These priorities formulate a strategy for the reverse supply chain. However, there are different cases of returns and they are approached differently (C1-C4).

The processes in the reverse supply chain have already been analyzed, thus only the elaboration on the time and the costs will be done. When the customer notifies the seller about the problem and the claim is sent to the manufacturer, the claim department has 12 hours for the first response to the query. The goal of the company is to manage all claims in one week. At the moment Fläkt Woods manages 95 percent of the claims in one week (K. Lilja, personal communication, 2010-04-07); it includes primary testing of a problem (when engineers are sent to the site) and a shipment of a new part by an express courier. *'Sometimes I can ask a taxi driver to take that part and go to Stockholm from Jönköping, because the priority one is to keep the customer satisfied'* (K. Lilja, personal communication, 2010-04-07).

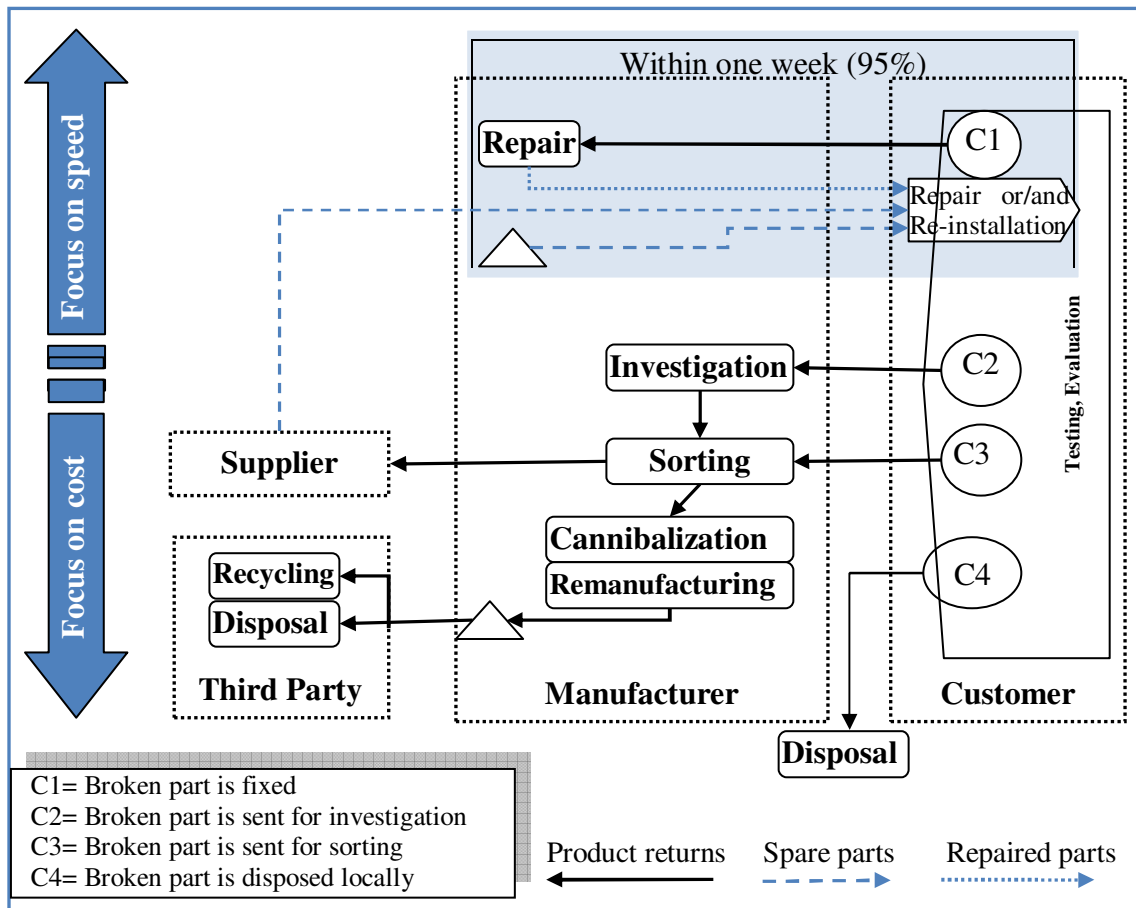


Figure 4.3 Focus on the speed and responsiveness vs. the cost and efficiency in Fläkt Woods’s RSC.

However the case 1(C1) would be when a new part is not available on the stock and the lead time from supplier is longer than the time of the reparation of the old one. Thus, the company focuses on the speed to ship the old part back to the manufacturing unit, fix it, and send back to the customer by express. Another solution is to send engineers to the site to fix the problem. In this case, the priorities are the speed and the customer satisfaction. Moreover, there are particular parts of the air handling unit that require a lot of attention in case of the possible damage. These are the fans and the rotating heater changer. *‘If any of these parts are broken, all efforts are needed to fix the problem as soon as possible, because the temperature in office could be too low or too high, or no air will pass through the air handling unit, and it will cause a lot of problems especially in hospitals, kinder gardens, schools, or old people houses’* (K. Lilja, personal communication, 2010-04-07).

When the new part is installed for a customer, there are three options to handle the old part. The second case (C2) is when the problem of damage is new and has not yet been met by Fläkt Woods. *‘Sometimes it doesn’t matter how much it costs, we need to get it back, because the fault interests us’* (K. Lilja, personal communication, 2010-04-07). Then the company ships the broken part for the further investigation in order to find a cause and be prepared for the possible future similar cases in the future, especially when there are more same parts installed for other clients. In this situation, it is sought to find the equilibrium of the cost and the speed because the speed is important though the costs could not be too high as well. After the investigation, the broken part goes to the recovery stage, where the cost becomes the priority.



The third case (C3) is when the problem was met before and the old part of a product has a higher value than the transportation costs. Thus, the broken part is shipped back to the factory and the sorting is done, where the part could be sent to the supplier (if it was originally received from a supplier) or goes to any of the recovery processes. In this flow, the costs are taken into the consideration.

The fourth situation (C4) occurs when the company knows the problem of the broken part from other cases and the part of the product is less valuable than the transportation costs. *'We don't ask Australia to send it back, because the scrap could worth 1000 SEK and the freight 5000 SEK, then we say 'keep it''* (K. Lilja, personal communication, 2010-04-07). In addition to that, it is applied to after warranty service. As a result, the old part is left in the customer's custody and responsibility for the proper disposal. However, the company provides the instruction for a proper utilization. *'We made instructions how to recycle air handling units and that they consist of: that kind of metal, rubber, paper, etc'* (K. Lilja, personal communication, 2010-04-07).

To sum up, Fläkt Woods uses different strategic approaches that depend on the a damaged product. It could be described as the preponement strategy, where the early differentiation is done and the decision of the product destiny determines the strategy: agile, lean or the trade-off of them. However, the customer satisfaction and the environment are the most important criteria for the company, and thus the costs could only be saved only in the cases where it does not have an impact on keeping the customer satisfied.

### 4.2.5 Driving Forces and Barriers

All interviewed managers believe that senior managers of Fläkt Woods pay a lot of attention to the environment and the quality. There are discussions with senior managers about meeting the requirements of quality and environmental issues once per month (K. Lilja, personal communication, 2010-04-07). The claim management and the reverse supply chain fell into these requirements. The company is strict about the customer's satisfaction as well. The time of dealing with the claims is being reduced every year. Fläkt Woods believes that a quick response and a solution to the customer's problem increase the value of the brand image and give it a competitive advantage. These are the main driving forces for the reverse supply chain.

Considering the current problems in the reverse supply chain, there is a need to improve the information sharing and communication ways with their suppliers, because it often happens, that due to the lack of personnel or too complicated current system, they are late to send broken parts of a product to supplier. *'It is necessary to find a simpler way to alert supplier of a problem'* (K. Lilja, personal communication, 2010-04-07). For the future considerations, it is necessary to *'get down the handling time of claims; send the new material quicker'* (L. Hed, personal conversation 2010-04-06).

## 4.3 Systemair

Systemair is a leading provider of the efficient, environmental friendly and user-friendly ventilation products. Systemair, under the brand names Systemair, Frico, VEAB and Fantech, supplies high quality products for removing, transporting, heating or improving air in the buildings. The central aim of the company is to develop and produce the products that are simple to install, maintain and use (Systemair, 2010).

### 4.3.1 General Company Information

Systemair was established by Gerald Engström in 1974. Originally, the company was called L.H.G. Kanalfläkt AB. The production started with the manufacturing of the circular dust fans in Skinnskatteberg (Sweden). In the 1970s and 1980s, by establishing and acquiring the sales companies, Systemair, entered the markets of Finland, Denmark and Norway. Furthermore, in 1981, Systemair has started exporting its products to the United States. By acquisition of Frico International in 1992, Systemair became much larger and expanded its product range with the fan heaters and air curtains. Moreover, Systemair has acquired the Environment Air (Canada) in 1995, the SCIE Systemair (sales agent in France) in 1997, and the Europair (a developer and seller of the air terminal devices and iris damper in Sweden) in 1999. In the late 1990s, the company has changed the distribution strategy towards using the wholly owned subsidiaries instead of external sales firms. In the 2000s - by acquiring sales companies in such countries as Estonia, Netherlands and Portugal, by establishing new sales companies in Hong Kong, Hungary, Ireland, Romania, etc., and by acquiring such producers as VEAB Heat Tech (Sweden), Marvent (Slovenia), Gelu (German) - Systemair has demonstrated a significant growth in the production capacity, distribution capabilities, sales and profitability (Systemair, 2010).

Today, Systemair is a leading ventilation company with 12 manufacturing plants located in 11 countries (Sweden, Denmark, Norway, Germany, Lithuania, Slovenia, Slovakia, Spain, Malaysia, USA and Canada) and 2 central warehouses (Systemair, 2010). To reach the customers, and to be able to obtain the information about the market demands and trends directly, the company has established about 50 own sales companies and representation offices in North America, Europe, Asia and Africa. Systemair has approximately 2000 employees. During 2008/2009 financial year, the company generated a turnover of 280M€ (Systemair, 2010).

Systemair's business concept is based on three core values, particularly:

- quality – producing high-quality standardized products;
- availability – delivering right away from stock (production to stock);
- delivery liability – delivering on time (centralized production and logistics processes as well as the local are integrated through ERP system) (Systemair, 2010).

The concept of the sustainable development is one of the key elements of the Systemair's strategy. *'Sustainability for us means responsibility and quality – in our business activities, environmental efforts, and care for personnel and in our civil life'* (Systemair, 2010). The company not only develops and produces the energy-efficient goods, but also ensure that all products are environmental-friendly and recyclable. Moreover, the Systemair's code of conduct affects the evaluation and the selection of the suppliers. Furthermore, the company coordinates and manages its logistics flows in a manner to achieve not only the cost savings through higher capacity utilization, but also to reduce the environmental impact (Systemair, 2010).

### 4.3.2 Products and Returns

Systemair's product portfolio consists of six product groups - fans and accessories (e.g. dust fans, roof and box fans); ventilation units (e.g. compact air handling units, supply air handling units); air terminal devices (e.g. supply and exhaust diffusers); air curtains

and fan heaters (e.g. dust heaters and dehumidifiers); smoke and heat ventilation (e.g. axial and centrifugal fans that are used in high temperature environments); and other ventilation products (Systemair, 2010).

The headquarter, one of two main warehouses and the largest manufacturing plant are located in Skinnskatteberg (Sweden). Moreover, an addition plant that was acquired in 2002 is located in Skinnskatteberg. Further, in this research regarding Systemair the reverse supply chain for products that are manufactured in Skinnskatteberg’s plants will be analyzed only. These two production facilities focus on the manufacturing of wide range of fans, and the assembling of the smaller air handling units and the compact units (Systemair, 2010).

The rate of the claims is very small in Systemair (under 1 %); however, they do happen usually because of the wrong price and the installation problems (T. Veittikoski, personal communication, 2010-04-22). If some damaged occurred, particular broken parts are changed, and the old ones are returned to the local subsidiary. Most of the problems happen with the electronic parts, e.g. the controller , that are produced by the suppliers.

### 4.3.3 Reverse supply chain processes

The scheme of the main processes in RSC in the company is shown in the figure 4.4.

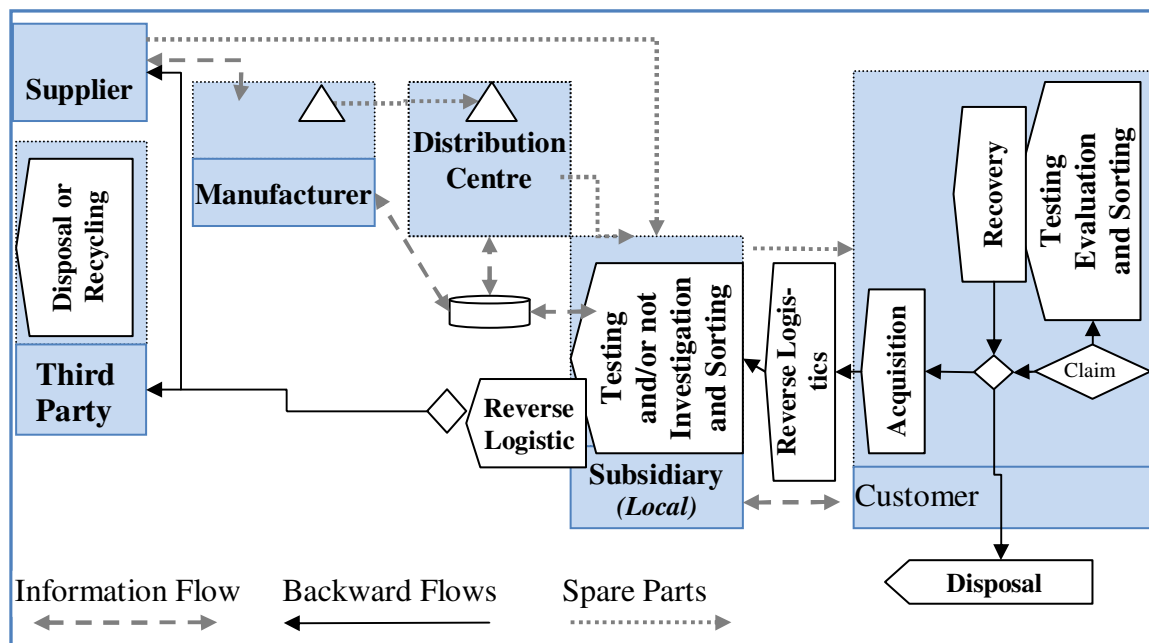


Figure 4.4 The processes of the reverse supply chain in Systemair.

When the customer has a complaint, he contacts his sales agent or local subsidiary of the Systemair. Most of the problems are handled by the local subsidiary. The engineers from the external service provider are sent for the primary problem testing and a new part of the product together with the invoice is sent to the customer. The new spare part is sent from the distribution centre, where some stock is kept, to the local subsidiary, which provides the part to the customer. If the customer suspects that the problem occurred because of the company’s fault, he sends the broken part to the local subsidiary. After testing there, the company makes a decision about the payment for a new part (T. Veittikoski and R. Hedlund, personal communication, 2010-04-22). If the distance from

the customer is too big and the delivery of the broken part would be too expensive, the disposal takes place at the customer's site.

*Testing and inspection.* The primary testing is done at the customer's site in case the reparation could be done locally. Systemair has contracts with the external service providers and an independent expert analyzes and fixes the problem if possible. *'When there is a problem, it is better to send a neutral person, who makes tests and decides together with a contact in the company upon solution'* (T. Veittikoski, personal communication, 2010-04-22). Later, the broken part is usually sent to the local subsidiaries for the deeper testing and inspection. If the fault is in the supplier's product, it is sent to the supplier. If the problem occurred because of the Systemair's mistake in the production, the product is going to be scrapped: sorted and then sent to the recycling companies (T. Veittikoski, personal communication, 2010-04-22).

*Reverse logistics.* Systemair outsources transportation activities to several companies. The contracts are usually made with the best transportation providers in terms of the coverage of a specific geographic region and costs. However, transportation backwards is used quite seldom, because the customer transports the goods to the local subsidiary, and the broken part is usually scrapped there, because *'transportation back to factory is completely wrong if you are looking into environment and it is only costs of transportation'* (T. Veittikoski, personal communication, 2010-04-22). In case of a fault of the supplier of Systemair, the broken part is sent to him. Anyhow, it is important to have the best provider when a new spare part has to be sent very fast (T. Veittikoski, personal communication, 2010-04-22).

*Recovery.* The broken part of a product is scrapped locally most of the times. It means that the product does not come back to the factory for the reparation or the cannibalization. The product is usually disassembled and sorted at the local subsidiary, and then the recycling companies take all the residuals and transport for recycling processes. (T. Veittikoski, personal communication, 2010-04-22).

*Re-distribution and sales.* Re-distribution and re-sales in the secondary markets are not common in Systemair, because *'it is difficult to take responsibility of re-installed production, and it could negatively impact on a brand'* (T. Veittikoski, personal communication, 2010-04-22).

#### **4.3.4 Reverse Supply Chain Strategy**

Figure 4.5 provides a scheme of the processes in the reverse supply chain in Systemair where each process focuses either on the speed and responsiveness or on the cost and efficiency. The blue narrow on the left shows the trade-off between the cost and the speed for each process on the right. These priorities formulate a strategy for the reverse supply chain.

When the problem appears, the customer talks with his sales agent and the claim is transferred to Systemair. *'The claim is seen as a normal order and the goal is to handle the order at the same day'* (T. Veittikoski, personal communication, 2010-04-22). It means that the company reacts responsively to the claims: *'when we can not solve the problem immediately, it is necessary to tell when we will come back'* (T. Veittikoski, personal communication, 2010-04-22). Usually the new part is shipped from the stock to the customer as soon as possible, later after the investigation the cause of a problem

will be discovered and the party, who made a mistake, will cover the costs (R. Hedlund, personal communication, 2010-04-22).

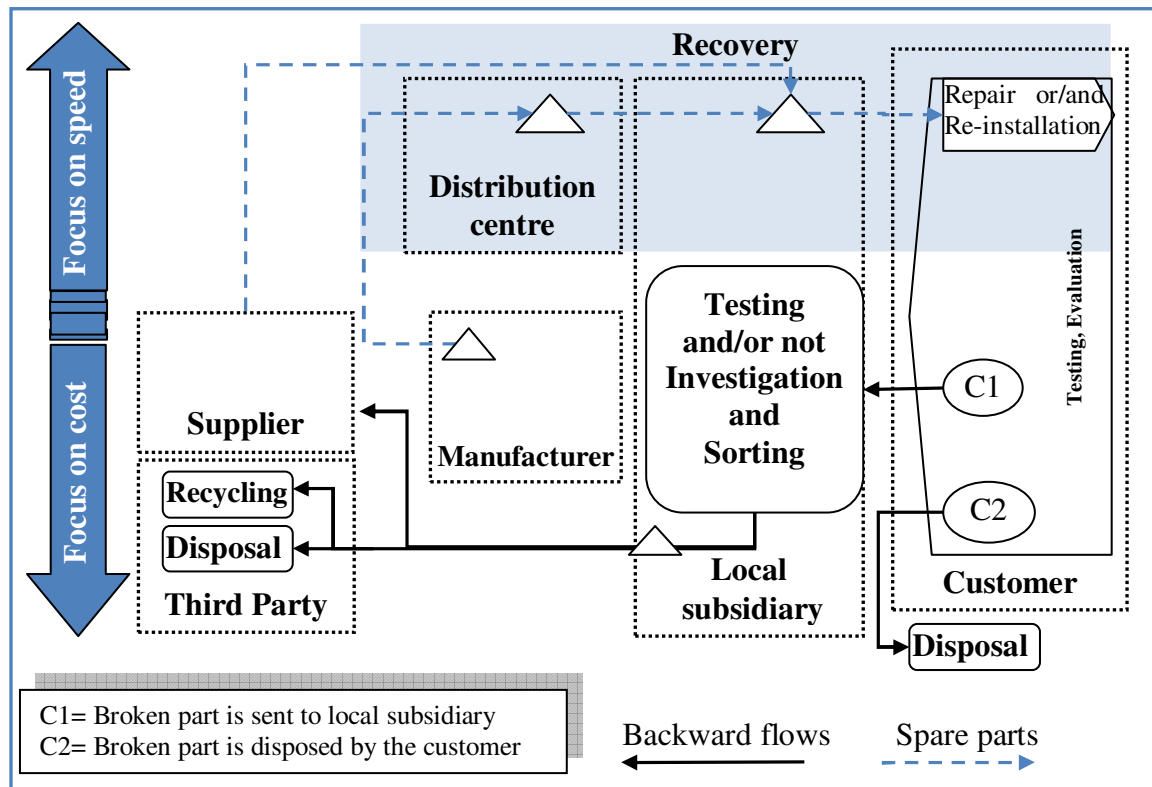


Figure 4.5 Focus on the speed and responsiveness vs. the cost and efficiency in Systemair's RSC.

When considering the broken part, the company focuses on the costs. The broken part is scrapped locally at the local subsidiary, because the transportation back to a factory is seen as a waste of the costs on the transportation and environmentally unfriendly (Case 1). Systemair trusts their subsidiaries and partners with a proper disposal of production residuals (T. Veittikoski, personal communication, 2010-04-22). If the problem happened because of a failure in the supplier's production, the product is sent back to the supplier for further investigation and the supplier will cover the transportation costs. Other possibility is to fix the problem on site. In this case, the engineers from the service company are sent as soon as possible so that the broken part could be disposed at the customer's site (Case 2).

As the returned products are not common in the company, only very seldom the engineers of Systemair or quality managers fly to a country or send back the product for further investigation if the suspicion about the production or construction problem, which could be important for discovering the possible future claims, appears (R. Hedlund, personal communication, 2010-04-22). The analysis of the main problems is conducted by taking the quarter reports from the subsidiaries and looking at the reasons of the claims that come from the customers. 'We analyze the problems and if the problem is not common for all production line' (R. Hedlund, personal communication, 2010-04-22).

To sum up, Systemair is trying to be as responsive regarding claims as possible. It means that being agile close to the customer is a very important strategy to reach the customer's satisfaction. While taking the further flow backwards of the damaged goods the company focuses on the effects to the environment and the costs

#### 4.3.5 Driving Forces and Barriers

The protection of the environment is the priority number one for Systemair. It means that the company is concerned about the green supply chain: purchasing, transportation, manufacturing, distribution and reverse logistics. The company does not believe in the transportation of the broken parts back to a factory when it can be scrapped locally. Systemair has contracts with the recycling companies for the proper disposal of all residuals (T. Veittikoski, personal communication, 2010-04-22). Systemair is certificated for ISO 9001 and ISO 14001. It shows that the quality and the eco-management is part of the strategy. The requirement for high quality is also a driving force for the RSC as an effective claim management helps the future improvements. In addition to that, it is important to keep the customer satisfied, as it is a key to a good relationship with a customer. *'In reverse supply chain the customer looks how fast we are'* (T. Veittikoski, personal communication, 2010-04-22), thus it is important to solve the problems fast.

*'It has to be constantly reminded to the senior managers in every company to pay more attention to the claim management and the reverse supply chain'* (T. Veittikoski, personal communication, 2010-04-22). However, now due to the low rate of returns, neither of the respondents sees many problems. The main challenge according is to keep a high service level and provide all the necessary trainings for the external service providers. When all the service is outsourced, it is difficult to ensure the sufficient level of quality.

The other problem happens when *'we are interested in a problem of the claim from a long distance, but because of high expenses on freight, we do not take it back for the testing'* (R. Hedlund, personal communication, 2010-04-22). It leads to a dilemma whether to choose the extra testing and inspection or to save the costs.

### 4.4 Swegon

Swegon is a leading provider of safe, environmentally –friendly products and economic solutions for the superior indoor climate with fresh air and pleasant temperature. Continuing development of the products and services allows providing the best solution from both the technical and the economic standpoint for all kinds of building. Knowledge and experience combined with the well-developed network of representatives led to achieving a substantial market share in most European countries (Swegon, 2010).

#### 4.4.1 General Company Information

The History of Swegon has its roots in two firms – Farex and Stifab. Farex was established in 1932, Stifab - in 1974. In 1995, both companies merged and became Stifab Farex. 10 years later, Stifab Farex – manufacturer of components, merged with PM-Luth – expert in air the treatment equipment, and became Swegon AB (Swegon, 2010).

Today, Swegon manufactures products in four factories – three are located in Sweden (factories in Kvänum, Arvika and Tomelilla) and one in Finland (factory in Kaarina). Through the sales companies and distributors, mostly in Europe but also in other countries (e.g. United States, United Arab Emirates), Swegon supplies a wide range of products that provide complete solutions for a superior indoor climate with a better operating economy, and provide the repair and maintenance services. The company has approximately 1000 employees. During the last year, Swegon generated turnover of 220M€ (Swegon, 2010).

Innovation, quality and the environment are the key elements of the Swegon's strategic vision. 'We maintain a position at the leading edge of development, and our success in innovation has set the standard for future generations' (Swegon, 2008, p. 6). The company is certificated according to ISO 9001:2000 and ISO 1400:2004. In three plants, Swegon has established high-technology laboratories where the research and development projects are taking place to ensure the continuous improvement of the products (Swegon, 2010).

#### 4.4.2 Products and Returns

Swegon's product portfolio consists of approximately 100 products within the different products groups including air diffusers, air handling units, fans, flow control, home ventilation and waterborne climate systems. The headquarters, testing centre, and the largest of four factories of Swegon are located in Kvänum (Sweden). Further, regarding Swegon in this research the reverse supply chain for products that are manufactured in Kvänum's plants will be analyzed only. The factory in Kvänum has approximately 350 employees and focuses on the manufacturing of 'Gold' and 'Compact' series of air handling units. The 'Gold' series combines such features as the highest quality and low operating costs, while the 'Compact' series offers the advanced technology of 'Gold' series with a high level of flexibility regarding the installation in smaller premises (Swegon, 2010).

There is a very low percentage (under 1%) of returns in Swegon. Most of them are the broken parts of the air handling units. The problem usually happens with the control systems for the air handling units that are produced by the suppliers.

#### 4.4.3 Reverse Supply Chain Processes

The scheme of the main processes in RSC in company Swegon is shown in figure 4.6.

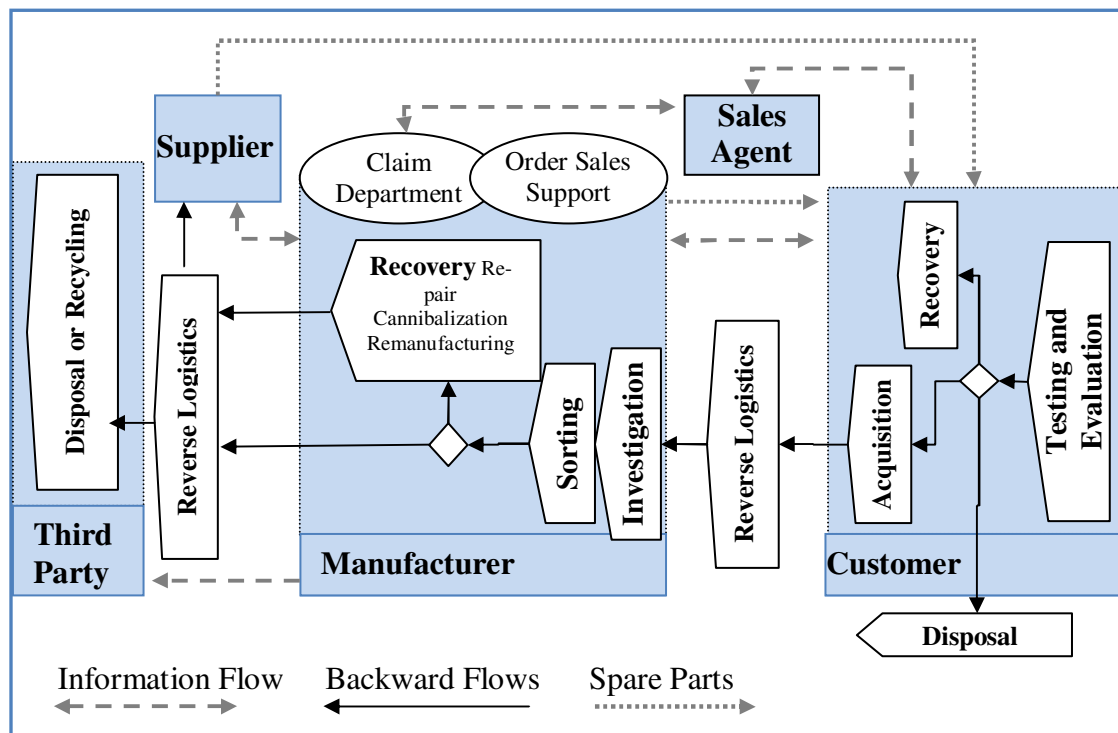


Figure 4.6 The processes of the reverse supply chain in Swegon.

*Product acquisition.* The rate of the returns is low in Swegon, however, when the customer has claims, he contacts his sales agent (all of them are part of Swegon company; there are no external distributors for Swegon production). Later, the new part is usually shipped to the customer and the broken part is sent back to the factory for further investigation, after the primary testing at the customer's site by the engineers (T. Bohlin, personal communication, 2010-04-23). The Claim department manages the claim and they take back the product, but they also work with the Order Sales Support department, which sends the new part as a new order (A. Algotsson, personal communication, 2010-04-23).

*Testing and inspection.* The primary testing is done at the customer's site in case the repair could be done on site. In Sweden Swegon sends its own engineers for fixing the technical problems. Contrarily in Europe, the company has contracts with external service providers and local engineers test and/or fix the problem. *'It is better to have engineers, who can talk local language'* (B. Sjunnesson, personal communication, 2010-04-23). Some of the broken products are disposed there if the transportation costs are too high to send it back to the factory. However, most of them are sent back and the main testing and inspection takes place at the production unit when the broken part is received back. Later, *'testing results fall into two categories: supplier's fault and our fault'* (T. Bohlin, personal communication, 2010-04-23). Products manufactured by the suppliers are sent back to them. Others after the problem investigation go to the recovery stage.

*Reverse logistics.* Swegon has contracts with external companies for transportation, approximately two contracts per country (T. Bohlin, personal communication, 2010-04-23). Express couriers are used for the fast deliveries (such as a new spare part for a customer) and for small quantities of broken parts, because it is cheaper compared with the 'road' transportation (A. Algotsson, personal communication, 2010-04-23). If the broken part is produced by the supplier, it is later transported to the supplier; however the supplier has to pay for the transportation.

*Recovery.* After the problem identification the sorting is done. The parts of the product could be repaired, cannibalized, or recycled. The fixed part is sent back to the stock of spare parts. If it is impossible to repair completely, some elements could be recovered and the rest scrapped (cannibalization). All the unusable details are sorted at the factory and recycling companies take them every week. The company is encouraged to do the sorting not only because of the environmental concerns but also because of the extra payment from the recycling companies (A. Algotsson, personal communication, 2010-04-23).

*Re-distribution and sales.* Re-distribution and re-sales in the secondary markets are not common in Swegon due to the low rate of returns, and possibly negative impact on their brand image (T. Bohlin, personal communication, 2010-04-23).

#### **4.4.4 Reverse Supply Chain Strategy**

Figure 4.7 provides a scheme of processes in the RSC in Swegon where each process focuses either on the speed and responsiveness or on the cost and efficiency. The blue narrow on left shows the trade-off between the cost and speed for each process on the right. These priorities formulate a strategy for the reverse supply chain. However, there are different cases of returns and they are approached differently (C1-C3).



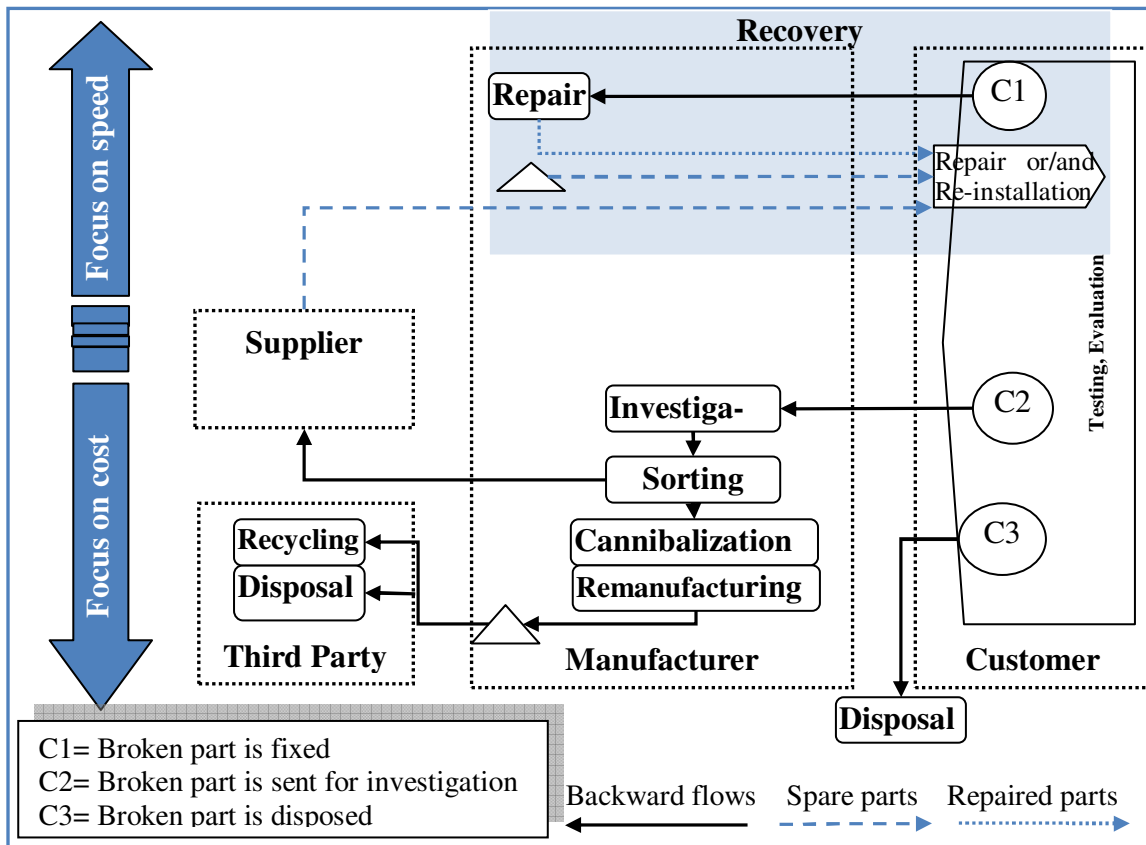


Figure 4.7 Focus on the speed and responsiveness vs. the cost and efficiency in Swegon's RSC.

After the received claim from the customer, Swegon has 24 hours for the first reply (T. Bohlin, personal communication, 2010-04-23). As soon as possible, the company sends engineers for the primary problem identification and ships a new part. The new part is processed as a simple order by the Order Sales Support department (A. Algotsson, personal communication, 2010-04-23). Usually the spare part is available in stock, if not it has to be ordered from the supplier. In the last case, the shipment to the customer will take longer because of the extra delivery time from the supplier. Seldom, the part is fixed at the factory and sent back to the customer. This solution and reparation on the site are shown in the figure 4.7 as the first case (C1). This case could be described as highly responsive and the main focus goes on the speed and the fast solution.

Case 2 (C2) is the usual solution for the claim when the new part is shipped to the customer and the old broken part is taken back to the factory for further investigation. The company prefers to take back the broken part. Then if the problem appears to be in the supplier's product, it is sent for the supplier to exam. The product produced by Swegon is investigated at the factory. After the examination, this part of a product could be repaired, cannibalized or scraped. The company is highly responsive regarding the shipment of a new part and fixing the problem for customer. Moreover, the broken product is usually sent back for further investigation, regardless if transportation costs could increase the recaptured value. However, it could be seen as an important process for the future improvements (B. Sjunnesson, personal communication, 2010-04-23).

Case 3 (C3) happens quite seldom but when it does the broken part is disposed at the customer's site. In this case, the transportation costs highly exceed the value of recaptured value or value of the problem investigation. In addition to that, in this case engi-

neers could analyse the problem as much as possible so that it could be decided if this is a cheaper way than transporting the product back (A. Algotsson, personal communication, 2010-04-23).

In summary, Swegon uses different approaches for the product returns. Closer to customer the reaction of the company is more responsive. Swegon seeks to deal with the problem as soon as possible. The agility is applied until the moment than product is received back to factory. Later, up to the recovery stage costs are taken into consideration.

#### **4.4.5 Driving Forces and Barriers**

The customer satisfaction is very important for the company. As a result, a high responsiveness to the claims is needed and could be seen as one of the driving forces for the effective reverse supply chain. Another important aspect is the environmental concerns. Swegon is certificated for ISO 14001 (as well ISO 9001 for quality). Thus, recycling is a very important aspect, because the company has to take care after the environment due to the legislation. *'Also, it is very good for sales because of the brand image'* (A. Algotsson, personal communication, 2010-04-23).

None of the respondents sees the problems in the current reverse supply chain. However, the improvement could be done by a system that connects all products and occurred problems (T. Bohlin, personal communication, 2010-04-23). It could allow observing the problem in the system and generalization of the damages could be done. It could facilitate the tracking of defects in the particular production line or parts from the supplier.

### **4.5 Rettig ICC**

Rettig ICC (Indoor Climate Comfort) - a subsidiary of the Finnish Rettig Group Ltd - is one of the top players in the fields of hydronic and electrical heating and indoor climate regulations. Rettig ICC under two brand umbrellas (one - includes Vogel& Noot, Myson and Finimétal; the other - consists of Purmo Radson brands and include Thermopanel and LVI) supplies radiators, under floor heating, valves and controls mostly to the Northern, Western, Central and Eastern European markets, and increasingly to the markets in North America and Asia (Rettig ICC, 2010).

#### **4.5.1 General Company Information**

Rettig ICC is a family run company that has more than 200 years of the business tradition. Rettig was established by Steffen Cerillius Rettig in the 1770s in Ringkjöping. The company started its business in the tobacco industry, and later, diversified its activities to other industries including shipping, wine, spirits, juices and confectionary (Rettig ICC, 2010).

In 1970, by acquiring the factory Oy Purmo Tuote – Purmo Produkt Ab in Jakobstad, Rettig started its business in the radiator industry. In 1976, to ensure high quality standards, the company invested in a completely new plant in Jakobstad. After the acquisition of the factories Lämpölinja Oy in Kokemäki in 1983 and the Kymi-Strömberg in Heinola in 1986, Rettig became a dominant radiator manufacturer in the Nordic market. Later, the company strengthened its position in Europe after the acquisition of the West German factory Dia-Norm, its Irish associated company Dia-Norm Teoranta in Bunbeg, and the Swedish radiator manufacturer Fellingsbro Verkstäder AB in 1989. In 2000, af-

ter the acquisition of the radiator business of Blue Circle, Rettig Group became a leading manufacturer of the radiators in Europe, and expanded its product range with bathroom, decorative, and oil-filled electrical radiators. Additionally, Delta GmbH in 2001 and Vogel & Noot Wärmetechnik AG in 2002 were acquired (Rettig ICC, 2010).

Today, Rettig ICC has 15 plants in located 11 countries and supplies its products to the customers in over 50 countries around the world. The main customers are sanitary and heating wholesalers. Rettig ICC has approximately 3000 employees. In 2009, the company generated a turnover of 507M€. It is important to note that while the global recession demand was falling in most of the markets, Rettig ICC, due to such change initiatives as the strict cost control and re-allocation of production, was still able to increase its market share in the key regions, e.g. Germany and United Kingdom (Rettig ICC, 2010).

#### **4.5.2 Products and Returns**

Rettig ICC produces a wide range of products, including steel panels, convectors, decorative, electric and bathroom radiators, and under floor heating systems (both hot water and electric. Manufacturing plant in Järpås, Sweden has 130 employees and produces oil-filled electric radiators and electric towel dryers. The Rettig Järpås site is certificated according to ISO 9001:2000 as well as ISO 1400:2004. The finished radiators are shipped to the Nordic markets, France and via Rettig two brand umbrellas to other European countries (Rettig ICC, 2010).

Talking about all Rettig ICC Group in general, returns from customers are not very common; however they can happen due to several reasons: inflicted damage, unsold production or overstock from the distributors, wrong order from the end customer, etc. *'Returns of a product when damage occurred could be divided into two groups: returns which failed after the installation and returns which failed before leaving the distributor'* (J. Stocks, personal communication, 2010-04-19).

For the returns that failed after the installation, there is a need for testing to find out the cause of a problem. If a problem is big, it requires specific attention and it is handled individually. The assessment of an independent expert might be needed. If a problem is not big, and there are already trust and good relationship with a customer already, the company sends the engineers to handle the problem at the site. The returns that failed before leaving the distributor are sent back to factory for testing and inspection (J. Stocks, personal communication, 2010-04-19).

However, to understand all the reverse supply chain processes deeper, the Swedish market was selected and the main focus was on the production unit in Järpås. Most of the claims (about 90 % of all the claims) happen because of the problems of electronic thermostats. It could be explained by a shorter life cycle of these electronic parts – a warranty service for them is 2 years, and for the panel of the radiator – 10 years. However, 20% or even more returned thermostats do not have any problem. The customer usually does not know how to use the thermostat and believes that something is broken (J. Forsell, personal communication, 2010-04-30). The company deals with the B2B and B2C returns. Returns from the customer are based on the damage, problems, returns from distributors happen due to the unsold production, changes in production, etc. (A. Ehn, personal communication, 2010-04-30).

### 4.5.3 Reverse Supply Chain Processes

The processes of reverse supply chain in Rettig ICC are shown below in the figure 4.8.

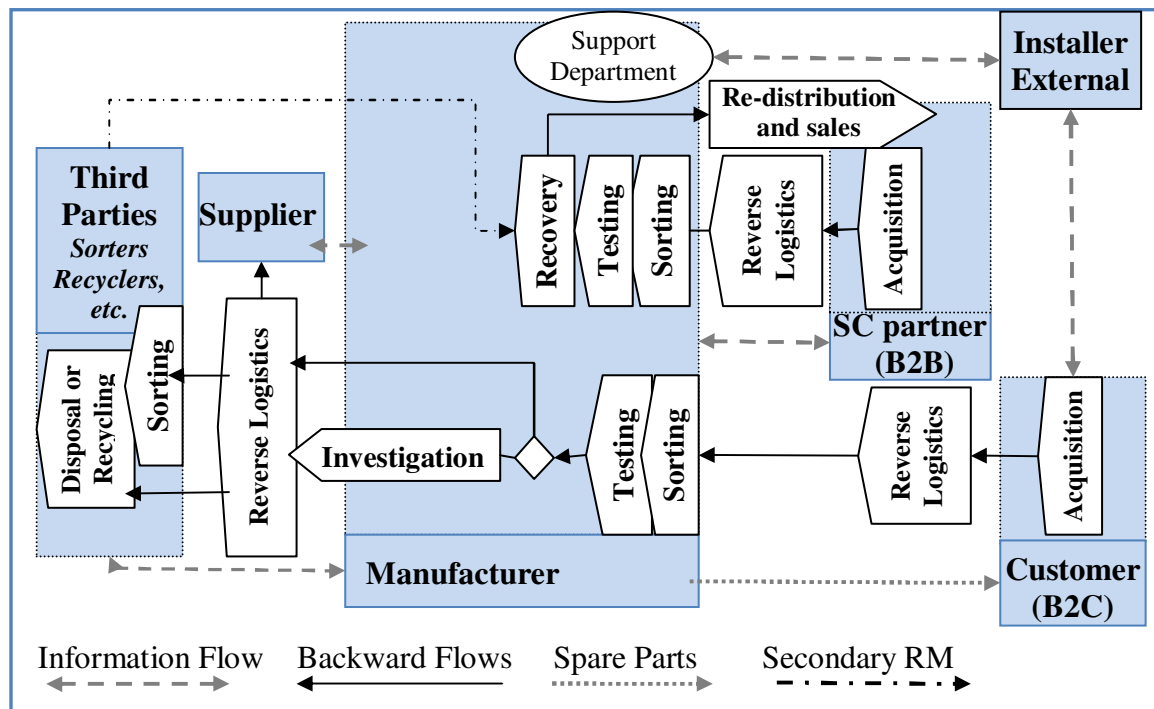


Figure 4.8 The processes of the reverse supply chain in Rettig ICC.

*Product acquisition.* When any problem appears, the customer contacts his installer and the installer sends the claim to the Support Department of the front office in Rettig. When the problem is in the electronic thermostat, the new one is sent on the same day by post, together with an extra box and an address of Rettig on it, to a customer. The customer gets a new part, and he should send the broken one back to the factory. If a problem is the panel of the radiator, other transportation is organized to deliver the new radiator, and later to take the old one back. However, in most of the cases, the responsibility to send a broken part back fell on the customer, even the transportation costs are paid by the company (A. Ehn, personal communication, 2010-04-30).

If business customers want to return the production, it comes on the mutual agreement. *'It can be both ways: we initiate returns because of future changes in production or the distributor initiates it due to unsold production'* (J. Hedberg, personal communication, 2010-04-30). Anyway, any type of returns are negotiated in advance.

*Reverse logistics.* Rettig has contracts with transportation companies; however, for the small parts transportation by post is used. In Sweden it is quite convenient, as the product is sent one day and received on the next day already. If damage occurred in the panel of the radiator, the couriers are needed to send a new part. The same courier is not used for the backwards flow. When there is a need to send broken parts to the suppliers, the consolidation is usually done (A. Ehn, personal communication, 2010-04-30).

*Testing and inspection.* Primary sorting is done in the factory when the broken part is received from the customer. Deep investigation is done to realize the problem, but if the problem is not new and has already been investigated before, the broken parts are sent to the external company for further sorting and disassembling. The company works

closely with the supplier for the investigation of the problems, if Rettig is not able to find the cause, the broken part (usually electronic thermostats) are sent to the supplier for further investigation (A. Ehn, personal communication, 2010-04-30). The sorting of the products from the business customers requires a lot of time, because *'the radiators can be mixed on pallets, can be packaging damages, or other damages, etc.'* (A. Ehn, personal communication, 2010-04-30). All products need to be tested and re-worked.

*Recovery.* There are different stages of recovery, depending on the nature of the returns. If a broken part (such as thermostat) is sent from customer, and the problem is new for the company, during the investigation the part is disassembled and after the identification of the cause, is sorted. If the problem of the damage is not new, all the electronic thermostats are collected and sent to an external company, which does the sorting. All the valuable parts are taken back for the future production manufacturing (cannibalization). The residual scrap is taken by the recycling companies. Talking about the B2B returns, after the testing, most of the products are reused, upgraded and sent back to a warehouse (J. Forsell, personal communication, 2010-04-30).

*Re-distribution and sales.* Re-distribution and re-sales in the secondary markets are not used in Rettig. All recovered products (especially from the B2B returns) are generally sold in the same distribution channel. (A. Ehn, personal communication, 2010-04-30).

#### 4.5.4 Reverse Supply Chain Strategy

Figure 4.9 provides a scheme of processes in the reverse supply chain in Rettig, where each process focuses either on the speed and responsiveness or on the cost and efficiency. The blue narrow on the left shows the trade-off between the cost and speed for each process on the right. These priorities formulate a strategy for the reverse supply chain. However, there are different types of returns: C1- from the business customers, and C2 – from the end customer.

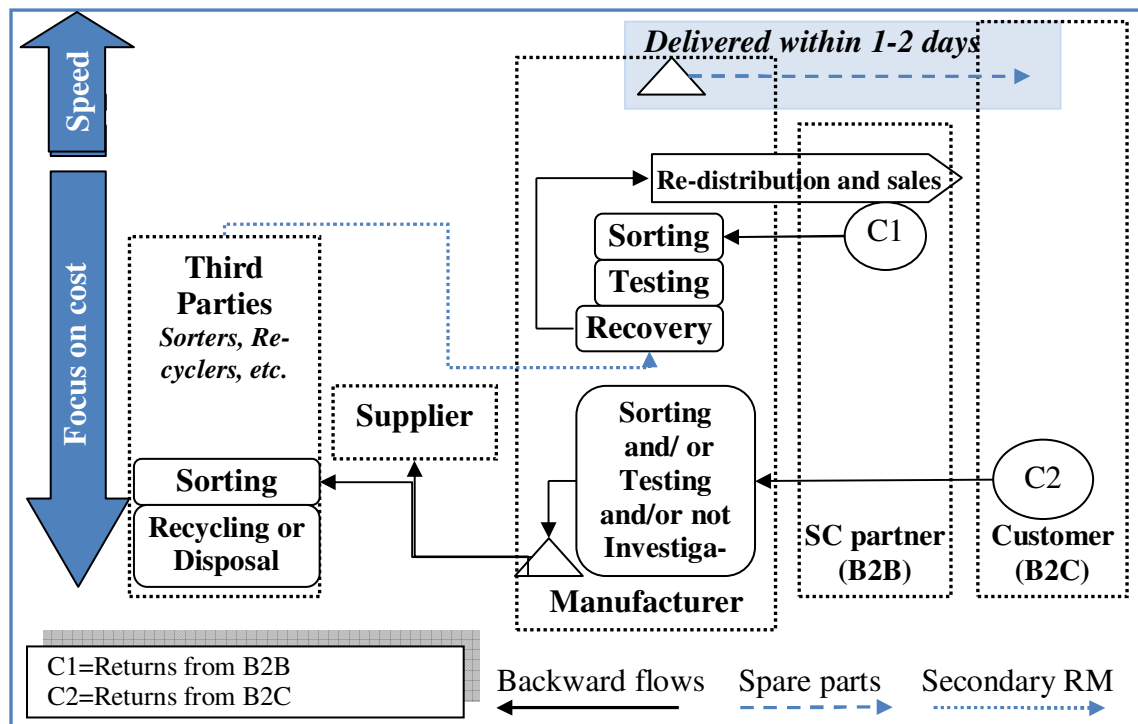


Figure 4.9 Focus on the speed and responsiveness vs. the cost and efficiency in Rettig ICC's RSC.

Rettig Sweden focuses on the speed and responsiveness when handling the end customer claims. The new part is usually sent on the same day when the claim was received. By being fast, customer satisfaction is achieved. All the backwards processes are more lean than agile. It is the end-customer's responsibility to send back the broken part, even the box is given and transportation costs are paid by Rettig. When receiving returned products from the business partners, the company does the consolidation and save the costs on transportation (A. Ehn, personal communication, 2010-04-30).

Another way to cut the costs was to outsource the disassembling of returns (especially electronic thermostats). All thermostats are divided into two groups after primary sorting: when the problem is new and when the problem has already been encountered before. The latter are consolidated and sent to an external company for disassembling in order to cut the costs and get the expertise, especially for handling the hazardous waste. Later, valuable parts (secondary raw materials) are received back for re-using them (J. Forsell, personal communication, 2010-04-30). After the investigation, the parts of a product are sorted at the factory and later taken by the recycling companies.

Returns from the business partners are sorted, each item is tested, and the process to recover the product is done. Mostly, the returns need to be re-packed, the some of them must be upgraded (some materials are changed), and after the recovery process the products are sent to the warehouses and sold through the same distribution channel (A. Ehn, personal communication, 2010-04-30).

In summary, the company is very responsive and agile with the end customer, regarding the claims, and as soon as possible provides a new part. In the rest of the processes in the reverse supply chain, Rettig is focusing on the elimination of costs and waste, thus could be described as lean.

### **4.5.5 Driving Forces and Barriers**

The main driving force for the reverse supply chain is the customer satisfaction in Rettig. The surveys about quality, customer support and claim management are sent to the customers. The result could be summarized as *'the customer understands customer support services as a part of the quality, and when he is satisfied, he says that our company has better quality in general than our competitors'* (J. Forsell, personal communication, 2010-04-30). It means that fast and effective reverse supply chain management, especially close to the customer, can create a competitive advantage.

None of the managers sees any problems in the reverse supply chain. However, there always are ways to improve it. It would be a great benefit to have a system, which could recognize or track returns: *'so that we would know what we are getting back'* (J. Forsell, personal communication, 2010-04-30). Even more, it could be used as the claims database, thus it could reduce the time of testing and sorting the returned products.

However, the Rettig ICC group prefers to focus primarily on the forward flow, where a combination of rigorous testing activities, and stringent component sourcing and efficient manufacturing can ensure the higher quality levels and keep return rates low. Nonetheless, there will always be a requirement for after sales claims and warranty issues particularly with electronic components and here the product return processes needs to work well to avoid customer dissatisfaction and to continue to promote loyalty to Rettig's products and its brands (J. Stocks personal communication, 2010-04-19).

## 5 Analysis

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*The chapter will present the analysis of this thesis. The findings from the empirical part are connected to the frame of reference. The structure of this part was selected to answer to the research questions, raised at the beginning of this thesis.*

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### 5.1 The Perception of Reverse Supply Chain Strategy

As the concept of the reverse supply chain is rather new, it is not widely accepted by the business world yet. According to the experience of the previous researchers (Meyer, 1999; Smith, 2005; Savaskan & Wassenhove, 2006), the companies see the reverse part of the supply chain as the additional costs and forget about the possibilities of increasing their competitiveness.

After visiting four companies and interviewing 13 managers, it could be concluded that most of them associate the reverse supply chain with the 'claim management', 'returns', 'warranty service'. If considering the company's focus on costs, the experience of the authors differs. All companies understand that the reverse flow is highly important to keep the customer satisfied. *'The customer feels quality not only in the product itself, but also in reaction and service level regarding claims'* (J. Forsell, personal communication, 2010-04-30). *'If there is no spare part on stock, I prefer to steal a motor from a new client and give it to the old one, of course if I can inform the new client about the delays in his order in advance. However, the speed to make the old customer satisfied is very important'* (K. Lilja, personal communication, 2010-04-07). Customer satisfaction is the priority number one, regardless what the costs are. *'Finance department is never happy about costs, <...>, however I do not want the company to appear in newspapers due to upset customers'* (K. Lilja, personal communication, 2010-04-07). Even so, the consideration of the costs appears in the further stages of the reverse supply chain.

According to Chopra and Meindl (2007), the strategic fit between the company's competitive strategy and the supply chain strategy should be achieved. It means that the supply chain strategy, as well as other functional strategies should be aligned with the company's overall strategic direction. Reverse supply chain is seen as a part of the whole supply chain, and due to the increasing importance requires strategic actions, as well strategic alignment with the general company's strategy. All of the analyzed companies are certificated for quality (ISO 9001) and eco-management (ISO 14001), thus the quality standards and the environmental issues are considered in all actions of the company. Later all companies will be covered one by one to compare the alignment of the company's and the reverse supply chain strategies or to put it in other words 'strategic fit', taking into account the most important goals for both strategies.

The vision of Fläkt Woods is *'to be a leading global provider of high quality air solutions that are used by people at work or at home, by industry and in infrastructure applications'* (Fläkt Woods, 2010). The quality is also very important in the reverse supply chain. First, the quality of the warranty service: the company is highly responsive to the claims from the customers. Second, the quality of the products: the investigation of the cause of the problem regarding the damages is seen as the strategic action for the future improvements. When the problem, which caused the claims from customer, is new, the efforts from all departments (Quality, Technical Sales Support, R&D, etc.) are combined to find the reasons and do not repeat the same mistakes in future product devel-



opment. Many simulations are performed to avoid the problems later. As a result, the company employs the processes of the reverse supply chain for the improvements in quality, and strategic actions matches the goals of the company.

The business concept of Systemair is based on three core values: quality, availability and delivery liability (Systemair, 2010). The key element in the company's strategy is the sustainable development '*Sustainability for us means responsibility and quality – in our business activities, environmental efforts, and care for personnel and in our civil life*' (Systemair, 2010). Acting green is very important for the company. Systemair has requirements to be environmentally friendly for all the partners: suppliers, transportation companies, distributors (T. Veittikoski, personal communication, 2010-04-22). Being environmentally friendly is very important concept in the reverse supply chain too. All the broken parts are usually scrapped (sorted and send to recycling companies) at the local subsidiaries or already at the customer's site, because the company does not believe in the profit of the returned parts back to the factory as it is seen as unfriendly to the environment due to the pollution during the transportation activity. '*Why should we transport to scrap it here? We can scrap it locally and save costs and environment due to elimination of irrelevant transportation*' (T. Veittikoski, personal communication, 2010-04-22). Green reverse supply chain definitely supports the goal for the sustainable development.

The key elements for Swegon's strategic vision are innovation, quality and environment: '*We maintain a position at the leading edge of development, and our success in innovation has set the standard for future generations.*' (Swegon, 2008, p. 6). Regarding the reverse supply chain, Swegon pays a lot attention for the investigation of a problem. Most of the times the company takes back the broken part back for further investigation as it is seen as an important process for the future improvements (B. Sjunnesson, personal communication, 2010-04-23) and of course, for the innovations. Swegon refuses to take the product back and dispose it locally only due to the extremely high costs of transportation (from long distances). Anyway, the actions in the reverse supply chain match the goal of a company to stay innovative and ensure the quality.

Rettig ICC Group engaged in a strategic review of business, which led to the implementation of the structural change process bringing change in three dimensions: product, brand, and organisation (Rettig ICC, 2010). The key objective of the organization part was to maximise the financial performance within the company (ibid). Due to the strict cost control and the re-allocation of production, the company was still able to increase its market share in some regions during the global recession (ibid). The focus on the cost reduction through the waste elimination is seen in the reverse supply chain processes as well. First, regarding the business clients Rettig does the returns' consolidation to eliminate the waste of the irrelevant transportation. Second, the company outsources the disassembling processes to the external company to gain the expertise, and the cost efficiency. Third, the recovery process allows saving the costs by using valuable parts (secondary raw materials), upgrading (changing only some elements in the old production), re-packing (J. Forsell, personal communication, 2010-04-30). As a result, the cost control in the reverse supply chain matches with the company's strategic goals.

In addition to the description provided above, the authors would like to emphasize that all companies focus on quality, environment, innovations, and costs; however, the main key was selected based on the interpretation of the interviews and companies' websites.



However, the result, that all companies aligned their company's strategy and strategy for the reverse supply chain, can be seen as one of the prerequisites to achieve a competitive advantage, which gave a chance to survive and stay profitable even for the companies under inconvenient circumstances due to the economic recession

## 5.2 The Driving Forces for Implementing Strategy

In the chapter above, the authors analyzed the perception of the strategy for the reverse supply chain in four companies. However, there is a need to explore the driving forces for any strategy implementation in the reverse supply chain due to the deeper understanding about the importance of the strategic actions in the reverse flow of the supply chain. Thus, the findings from the empirical study and the frame of reference will be compared regarding the driving forces for the increasing interest in applying the strategy in the reverse supply chain.

*Green forces.* Prahinski and Kocabasoglu (2006); Pochampally et al. (2009) argue that green forces affect the companies to take the appropriate actions regarding the reverse flow of the supply chain. The attitude of the customer and the governmental regulations force the companies to take the environment into consideration. The findings of the empirical study confirm the fact, that the environment is very important for all companies. All companies have the contracts with the recycling companies and perform the sorting at the production units. The legislation also provides particular rules for handling the hazardous waste. It requires additional resources and costs yet the companies see the environment as a very important part of their strategies and a way to create a good brand image: '*Also, it is very good for sales because of the brand image*' (A. Algotsson, personal communication, 2010-04-23).

*Increasing demand for improving customer service level.* Blackburn et al. (2004) and Prahinski and Kocabasoglu (2006) believe that by speeding up the reverse flows and increasing the responsiveness, the customer service can be improved significantly. The speed and responsiveness have a huge impact on the design of the reverse supply chain in all companies. Even more, all companies realize that happy customer is a key to a competitive advantage; as a result they are looking for the improvements in the reverse flow. E.g. Fläkt Woods is reducing the time for the first reply after receiving the claim: '*at first we replied in 24 hours, later we reduced to 12 hours, and I believe that in future we will reduce the time even more*' (K. Lilja, personal communication, 2010-04-07).

*Cost reduction.* Pochampally et al. (2009) argue that one of the driving forces in the reverse supply chain is the extraction of the potential value from the returns by performing reusing, remanufacturing, or recycling. Based on the empirical findings, the authors believe that companies not only try to reduce costs by reusing valuable materials, but also look for the optimal design of the reverse supply chain. E.g. the involvement of third parties in the reverse supply chain helps to achieve the cost efficiency and expertise (J. Forsell, personal communication, 2010-04-30).

*New retail marketing strategies.* Blumberg (2005); de Brito (2003) argue that unsold merchandises increase the requirements to make the stock adjustments. According to Rettig Sweden case, the company gets more and more returns from the business customers due to the marketing campaigns. However, to deal with it allows a close relationship and well-planned reverse flow. '*All returns initiated by our distributor or us*

*come on a notice given in advance, so we can prepare for it'* (J. Hedberg, personal communication, 2010-04-30).

### 5.3 The Criteria for the Lean and the Agile Strategies Selection

Firstly, in order to define the criteria for strategy selection, the nature of the returns must be understood. De Brito (2003); Rogers & Tibben-Lembke (1999) described the characteristics of commercial returns. Commercial returns refer to the B2B and the B2C products. The B2B commercial returns include wrong deliveries, damaged outdated or unsold goods. The main cause for returning them is overstock. The B2C commercial returns are the goods returned from the end customer shortly after having purchased due to the unmet expectations (size, colour, etc), wrong delivery, or warranty, service returns (repairs, spare-parts, etc) (Krikke et al., 2004; de Brito, 2003; Rogers & Tibben-Lembke, 1999). According to Blumberg (2005) the commercial returns can be returned as either parts and subassemblies or the whole unit equipment and products.

In this thesis the authors have analysed the companies from the same industry and producing similar production. All analyzed products are commercial returns, including the B2B and B2C products. The rate of returns is very low –under 1 % from the turnover. Three companies produce air-handling units, which are large and it is hard to disassemble them. It means that to return the whole product is physically too difficult or even impossible. It is the main reason why only the spare parts may be returned. The reason for the returns most of the time is warranty service issues (repairs). The customer does not return the product due to the unmet expectations, because *'It is that the customer needs for a long time'* (T. Veittikoski, personal communication, 2010-04-22). In addition to that, the production is assembled on the specific order that reduces the possibility of unmet expectations. Rettig is producing radiators and returns from the end customer are warranty, and service returns. The customer mostly returns spare parts, such as electronic thermostats. It is rare that the whole radiator is returned, it happens too, however. The B2B returns happen due to the unsold production or the overstock.

One of the criteria for choosing lean or agile strategy is the characteristics of returns. According to de Brito (2003) there are three product characteristics that affect the reverse chain's organizational decisions and impacts on its profitability. These characteristics are: composition, deterioration, and the use pattern. Rogers and Tibben-Lembke (1999) argue that another factor that has an impact on the reverse supply chain is the volume of returns. Krikke et al. (2004); Blackburn et al. (2004) raise up the importance of life cycle as well. Time-sensitive products (high MTV) require the agile reverse supply chain, and the time-insensitive (low MTV) match with the lean reverse supply chain.

All products analyzed in this thesis have a long life cycle and low marginal time value, thus it should require the lean reverse supply chain. However, due to the large size it is impossible to transport the products back them or collect in the centralized return centre. It means that the centralized design of the reverse supply chain for this kind of products is practically impossible and the lean approach is not suitable for all processes. It could be one of the main reasons to implement leagility and use the preponement. The preponement allows early differentiation of the returns and all of them can be treated differently. This kind of solution was met in the analyzed companies.

Another criterion for the strategy selection depends on return reasons, type and origin, and product vs. part returns the economic values, impact of the environmental policies and business opportunities for the commercial returns may vary significantly. These may require the establishing of several reverse flows with contradictory focuses in cost, speed and quality (Krikke et al., 2004; Rogers & Tibben-Lembke, 1999).

The production, analyzed in this thesis, is usually returned by parts and due to the damages, falls under the warranty service. As a result, if the company seeks to keep the customer satisfied, the reaction to claims has to be fast. None of the companies would like to lose the good image due to the poor quality of the warranty service. For this reason companies prefer to send a new spare part for a customer as soon as possible, or fix the problem on site, or very seldom (if it is the fastest way) to fix the spare part and send it back to the customer. As a result, warranty service, contracts, or any other mistakes from the company's side require high responsiveness and agility implementation. However, after the reparation, it could be dealt with the old broken part in a lean way (eliminating the waste, where no additional value is added to a customer).

### 5.4 The Implementation of the Lean and the Agile Concepts

Similarly to the forward supply chain, the application of the lean concept in the reverse supply chain is built up on an idea of elimination of the waste and achieving the economies of scale in transportation and processing of the product returns (Blackburn et al., 2004). In turn, by applying agile concept, companies seek to increase the speed and the responsiveness of their reverse supply chains (ibid). The implementation of the so-called leagile concept - combination of both the lean and the agile paradigms, helps to increase the responsiveness as well as to reduce the cost (Banomyong et al., 2008).

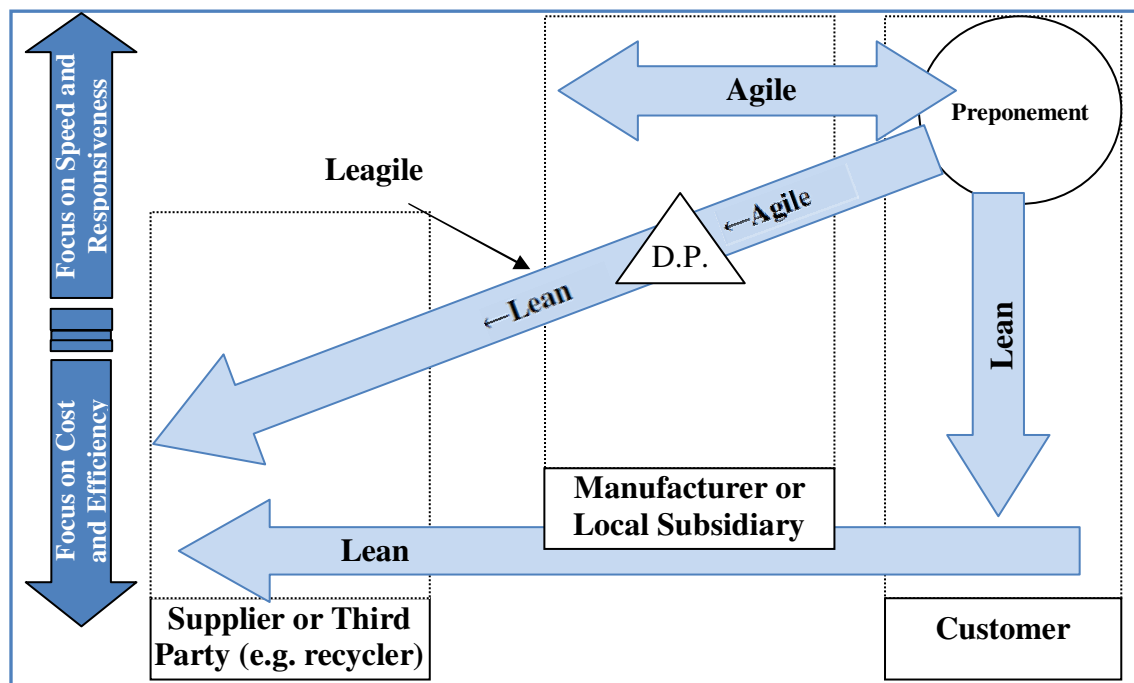


Figure 5.1 The Lean and the Agile concepts in Reverse Supply Chain.

According to Guide and van Wassenhove (2002), five main business processes are involved in the processing of the product returns within the reverse supply chain – product acquisition, reverse logistics, inspection and disposition, recovery, re-distribution

and sales. Allocation and sequence of these processes as well as the strategic RSC design, has a direct impact on the overall costs and the speed of response (Skjott-Larsen et al., 2007; Krikke et al., 2004).

The study of processes in terms of the focus on either speed and responsiveness or cost and efficiency, sequence of these processes, and the reverse supply chain design of each company, has shown that different companies have applied different concepts to their reverse supply strategies (Figure 5.1). Before starting to analyze the implementation of the lean, the agile and the leagile concepts into the reverse supply chains, the authors would like to point out the key findings as well as findings that oppose to existing theory, since they have a direct impact on the implementation of the reverse supply chain strategy. These findings are provided below.

- *Cost-efficiency.* In all cases, in the RSC part from manufacturer (or local subsidiary - Systemair) to supplier, companies tend to eliminate the waste and achieve cost-efficiency. This can be highlighted by the following statement that represents the point of view of all respondents – ‘*there, we always focus on cost <....> the recycler comes when containers are full of sorted material*’, (K. Lilja, personal communication, 2010-04-07). In turn, for the part from the manufacturer to the customer, companies have applied different strategic approaches.
- *Re-distribution and sales.* According to Thierry et al. (1995); Gattorna (2003); Krikke et al. (2004), re-distribution and sales of the recovered products depend on the business opportunities in the same or secondary markets and have an impact on the set of requirements for other business processes. When the returns have a high marginal time value, processes should be organized in the way to increase the speed of responsiveness, in order to maximize profitability (ibid). Three of four companies (Fläkt Woods, Systemair, and Swegon) do not re-distribute or re-sell returned parts or products. There are two reasons for this – first, reselling of used products may negatively affect the brand image – ‘*we never do that, we always sell new and high-quality product <...> otherwise, we would not be able to ensure quality and service level*’ (B. Sjunnesson, personal communication, 2010-04-23). Second reason (Fläkt Woods and Swegon) is related to the forward supply chain strategy – since the production involves high level of customization - most of the products are produced to order. Only Rettig ICC re-distributes and re-sells its products returns (dominantly the B2B returns), however, since marginal time value of the products is low, it does not require speed and responsiveness in the reverse supply chain. Thus, the implementation of the agile or leagile strategies (Fläkt Woods, Systemair, and Swegon) were not affected by the business opportunities related to the re-selling.
- *Investigation process.* In the literature of the reverse supply chain, five business processes were discussed, i.e. product acquisition, reverse logistics, inspection and disposition, recovery, re-distribution and sales (e.g. Guide & van Wassenhove, 2002; Prahinski & Kocabasoglu, 2006; Sahyouni et al., 2007). However, in addition to these processes all companies actively used the process of ‘investigation’. The authors would like to stress that this process was not described in the previous reverse supply chain studies. Investigation differs from the process of inspection and disposition. While the primary task for inspection and disposition is to identify the quality and the appropriate route in the reverse chain (see e.g. Poist, 2000; Krikke et al., 2004), the goal for the investigation process is to

investigate ‘why’ the problem has appeared in order ensure the quality of the products production in the forward supply chain. The representatives of all companies stressed the importance of the investigation in the reverse supply chain strategy – ‘*When we receive the claim, for us it is strategically important to investigate the causes of failing, and who is responsible. <...> It can be our fault and we must make changes in production line, or it can be because of our suppliers’ fault*’ (K. Lilja, personal communication, 2010-04-07); ‘*If the problem is unknown, we have to investigate it*’ (T. Bohlin, personal communication, 2010-04-23). It is also important to note that process of investigation has an impact on speed of processing returns in other reverse supply chain processes, particularly acquisition and reverse logistics.

*Lean* according to Christopher (2000) is appropriate in low variety, high volume, and predictable situations. According to Morash (2001); Mason-Jones et al. (2000) cost reduction can be achieved through eliminating the waste such as unnecessary processing, unnecessary transport of goods, inventories, minimization of errors, etc. Based on the study of Rettig ICC – its priorities, efforts, and practices, it can be stated that the company has used lean strategy in its reverse supply chain. However, in the reverse supply chain literature it is stressed that due to such factors as high unpredictability, low visibility of processes, retailer-manufacturer disagreements, etc., it is difficult to achieve cost-efficiency (see e.g. Pochampally et al., 2009; Skjott-Larsen et al., 2007). Thus, it is important to analyze how has the company implemented the lean concept in its reverse supply chain.

Blackburn et al. (2004) noted that the reverse supply chain with centralized testing and evaluation facilities can eliminate unnecessary waste and reduce costs significantly. Elimination of the waste can be achieved through higher space and equipment utilizations, minimization of labour and transport costs, reduction of errors (Rogers & Tibben-Lembke, 1999). In the case of Rettig ICC, all returned products (both B2C and B2B) are sent to the central facility (plant) for testing and inspection, recovery (figure 5.2 a), and investigation if necessary. Since the volume of returns is low, placing the testing and evaluation, and recovery facilities in the production site led to the minimization of the waste through higher space and equipment utilization. By outsourcing the acquisition and the reverse logistics processes, the company has eliminated the costs related to the establishment of the collection points. Furthermore, the unpredictability in the case of B2C was also reduced since the overall amount of returns received by the manufacturer is usually stable and allows to plan and forecast the quantity of resources needed. In the case of B2B, returns have high volumes. To make plans and forecasting for B2B returns, the company must have contractual agreements with the supply chain partners, these contracts include statements that all issues regarding the product returns (inc. time, delivery etc.) must be negotiated in advance – ‘*Wholesaler cannot just call us as say - ‘tomorrow I will send you 100 radiators back’ - we are always informed in advance.*’ (J. Hedberg, personal communication, 2010-04-30). Defective parts and products that go to suppliers are always sent in a bulk which allows to reduce the transportation cost. Furthermore, waste reduction through better space and equipment utilization, is achieved by outsourcing to specialists part of the sorting activities and entire process of waste management to specialists.

According to Blackburn et al. (2004); Prahinski and Kocabasoglu (2006), one of the main goal of the reverse supply chain is to increase the customer service level. The

question is how could the lean strategy implemented in the reverse supply chain increase the customer service level. How is it possible to keep the customer satisfied and reduce the costs? The company Rettig ICC's solution, in this case, was quite simple. The company reacts extremely quickly when sending a new spare part to the customer. As the result, the customer satisfaction is achieved (a customer can receive the new spare part in 1-2 days), and the waste is eliminated by the applied lean principles in managing the backward flow.

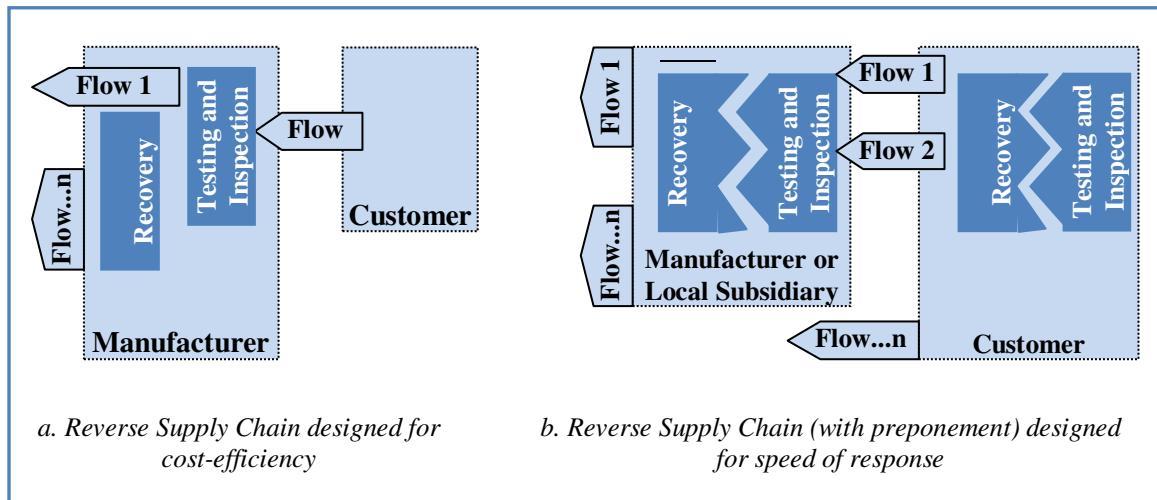


Figure 5.2 Delayed vs. early differentiation (preponement).

*Agile*. The main attribute of the agile supply chain is the flexibility (Christopher & Towill, 2001). The agile strategy is appropriate in highly unpredictable environments for high marginal value time products (Blackburn et al., 2004). By adopting the agile approach, companies can increase the customer service level and generate higher revenues (see e.g. Prahinski & Kocabasoglu, 2006).

In this study, all companies that produce long life cycle products with a low marginal value time, however, three companies, in the part from the customer to the manufacturer, created a highly flexible reverse supply chain. The reasons for that was the intention to achieve high service level and to increase the customer satisfaction. De Brito (2003) noted that such product characteristics as composition, deterioration, and use pattern, might affect the management of the reverse supply chain processes. Respondents in three companies have stressed the importance of product characteristics such as size, complexity and their attribute to be easily disassembled. These characteristics affect the companies' priorities in forming the reverse supply chain strategy.

However, when considering the RSC perspective, it cannot be said that these companies have implemented the agile strategy in their RSC for two reasons. First, the agility concept is applied only to one of the flows (see C1 in figures 4.3 and 4.7). This is a 'special' flow that refers to the service returns when the spare parts cannot be sent to the customer from the stock, and the customer requires to react extremely fast (e.g. school, hospital, etc.). In this situation, companies must act (i.e. take the broken part, delivery it to the manufacturer, fix it, send it back, and install it) extremely fast, and the costs of flow's processing are less important. Second, as it was already mentioned above, the agile concept is implemented only in the RSC section between the customer and the manufacturer. Thus, it can be stated that companies have implemented the leagile strategy instead.

*Leagile*. The successful implementation of the leagile concept in RSC means achieving both responsiveness and cost-efficiency (see e.g. Christopher & Towill, 2001; Bano-myong et al., 2008). Skjott-Larsen et al. (2007) stated that the reverse supply chain's configuration with decentralized testing and inspection facilities could radically increase the speed and the responsiveness of the processing flows of returns. The model suggested the establishment of testing and inspection facilities at the retailers' site (ibid).

Regarding the service returns, the companies of Fläkt Woods, Systemair, and Swegon, have implemented practises that are even more responsive. By sending engineers (from plant, sales office, local subsidiary, or engineers working under contract) to the clients, companies have moved part of the testing and inspection process to the customer's site (figure 5.2b). Furthermore, the engineers can perform part of the process of recovery (repairing) at the customer site. Such configuration led to achieve higher quality and service level. Moreover, higher control allowed reducing the volume of returns entering into the reverse pipeline – *'...very often air handling unit is in good condition, customer just forgot to change a filter.'* (T. Veittikoski, personal communication, 2010-04-22).

Testing and inspection performed at the customer's site creates a possibility to separate returns into different reverse flows at the early RSC stage. Blackburn et al. (2004) defined such early differentiation as the preponement. Preponement allows minimizing time delays for the returns that require quick processing, and achieving cost-efficiency for the return with low marginal value time (ibid). The authors have identified that Fläkt Woods, Systemair, and Swegon differentiated their returns into 2 to 4 backward flows at the customer site (see figures 4.3; 4.5, 4.7). To summarize, it could be stated that there are three types of the reverse flows with different requirements for speed of processing and costs. First – the 'special' flow (described above) is used in urgent situations. Due to a high level of unpredictability, the speed in reverse logistics and recovery processes is achieved at the expense of costs (e.g. involve express deliveries). The second flow involves the returns that need to be investigated, and some product parts or components that can be returned to the forward production (e.g. after cannibalization). From the customer to the manufacturer (or to the local subsidiary – Systemair) agile principles are applied – the speed is the main priority for the reverse logistics and investigation or recovery (e.g. remanufacturing, cannibalization). Later, however, (e.g. after the investigation the product or components are recycled or sent back to the supplier) companies tend to apply the lean concept, i.e. to eliminate the wastes (e.g. through consolidation). Thus, the plant or the local subsidiary plays de-coupling point role. The third flow includes the rest of returns that do not require to be processed quickly. This flow can go to the manufacturer/local subsidiary, supplier, recycling company, etc. Cost-efficiency is the main priority in all parts of the reverse supply chain. If, for instance, the cost for reverse logistics exceeds the value of product, the product will be recycled/ scraped locally. It is important to note that in order to achieve customer satisfaction, in the case of the second and the third flows, the new spare parts are usually sent to customer immediately after receiving the claim.

The outsourcing of the reverse supply chain activities to the specialists has many advantages that were discussed in the previous researches (see. e.g. Poist, 2000; Krumwiede & Sheu, 2002). Even more, according to Efendigil et al., (2008) outsourcing could be seen as a strategic tool to the increase service level and to reduce costs. In the case of Rettig ICC, where the main intention to outsource the reverse supply chain processes and activities referred to the cost elimination. In turn, Fläkt Woods, Systemair, and

Swegon outsource their activities to various service providers to achieve both the speed and the cost-efficiency. Differentiation of flows creates different requirements for returns shipping. Thus, companies outsource the reverse logistics activities to different providers. For example, Systemair has contracts with at least two 3PL in each country, Fläkt Wood use UPS and TNT for express deliveries (flow1 and flow 2) and DSV for flow 3.

Christopher (2000); Christopher and Towill (2000) stressed the importance of information systems for agile and leagile strategies. Information technologies help to integrate and coordinate SC actions between the SC members and even create virtual SC. The important role of information technologies was also confirmed the reverse supply chain literature (see e.g. Li & Olorunniwo, 2008; Blumberg, 2005). Quality managers in all companies noted that the installed ERP systems increase the reverse supply chain's performance significantly. IT facilitates the coordination of the return management activities, and improves the communication process with the customers, sales agents, local subsidiaries etc. For example, Fläkt Woods's ERP system – 'ACON' that is connected to the sales agents allows to view, manage, and measure performance of claim processes, which creates possibilities for the continuous improvement.

## **5.5 The Challenges in Applying the Lean and the Agile Concepts**

Several researchers (Rogers & Tibben-Lembke, 1999; Blackburn et al., 2004; Skjott-Larse et al., 2007) discussed the challenges and the barriers when seeking the effectiveness in the reverse supply chain. The challenges covered in chapter 2.1.6 and others that were found in the empirical study will be attributed to the particular concepts: lean or agile. Even though all challenges could be found in the reverse supply chain processes independently from the strategic selection; the authors of this thesis consider that some of them are bigger obstacles for one strategic concept (e.g. lean) than for the other (e.g. agile). Even more, all challenges discussed here are encountered in any of the analyzed companies and are already attributed to a particular concept. Main challenges in the lean reverse supply chain's processes are the lack of formal operating procedures, the lack of information sharing with the suppliers, and the 'false alarm' returns. The challenges for the agile reverse supply chain are the lack of local competence and the lack of forecasting possibilities.

*The lack of formal operating procedures.* According to Skjott-Larsen et al. (2007); Pochampally et al. (2009) the lack of formal operating procedures are the difficulties to identify the returns, it creates time waste and requires additional resources.

This problem is found in Rettig Sweden, especially when the company gets the returns from the business customers. Most of the returns are mixed on the pallets, have broken packaging, lacks documentation. The system, which recognizes the returns would be a big facilitator, because at the moment the batch of the returned products has to be dealt with and sorted manually (J. Forsell, personal communication, 2010-04-30).

*The lack of information sharing with suppliers.* According to Mollenkopt et al. (2009) the lean supply chain requires high level of information sharing and rapid performance with suppliers and minimal transaction costs.



There is a need to improve the information sharing and the communication with the suppliers' channel. When the company receives the broken part, which is produced by the supplier, the process to notify the supplier is too complicated and usually is not done on time (K. Lilja, personal communication, 2010-04-07). The connection with a supplier by an IT system could definitely help in this case because of the saved time, easier financial procedures regarding the returns, and closer communication regarding the agreements on improvements and changes.

*'False alarm' returns.* Late returns differentiation (as in centralized return centers) saves costs and resources. However, Blackburn et al. (2004) see the disadvantage of this system in a decreasing market value due to time delays. Another disadvantage, seen by the authors of this thesis, is that late return differentiation causes 'false alarm' returns and that leads to the extra costs for transportation, investigation, etc.

Rettig has centralized the inspection center for the returns from customers. However, it was noticed that 20 % or sometimes even more returned electronic thermostats do not have any defects or problems, and they are returned because the customer does not know how to use them properly and believes that the thermostat is broken (J. Forsell, personal communication, 2010-04-30).

*The lack of local competence.* The reverse supply chain processes such as inspection, testing and evaluation require high level of competence (Skjott-Larsen et al., 2007). Lack of the local competence decreases the speed of the reverse flows and increases errors.

Systemair outsources the warranty services to the external local company. However, it is difficult to ensure the sufficient quality of the service and relatively fast fixing of a problem when the local company does not have the same level of knowledge compared to the company's employees. There is only one way to deal with and it is to provide all necessary the training regarding the specific characteristics of the production and trust your partner (T. Veittikoski, personal communication, 2010-04-22).

*The lack of forecasting possibilities.* Blackburn et al. (2004), Guide et al. (2003) emphasize the difficulties to predict returns due to the large variations in value, quality, quantity and timing of returns. However, even though in the analyzed cases, the rate of returns is low; the variation of problems is quite wide. It leads to a longer devoted for the problem testing and reparation time, due to the lack of problems' forecasting possibilities and preparation.

A system, which could connect all products and generalize problems and claims for a particular production line, particular parts of production or geographic areas could allow easier problem testing and faster fixing (T. Bohlin, personal communication, 2010-04-23). E.g., the repeating defects in one batch of the production could allow to forecast the future claims of the clients who are using products from the same batch or at least provide more hints for possible damages during the testing.

## 6 Conclusions

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*The conclusions of this research will be presented in this chapter. The aim is to answer the purpose by summarizing the findings for each research question.*

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The purpose of this thesis is to analyze the applicability of the Lean and the Agile concepts in the Reverse Supply Chain strategy, and to investigate the driving forces and challenges for the implementation of the strategy in the Reverse Supply Chain. In order to answer the purpose five research questions were raised. The short summary on each question will be provided here.

Even though the concept 'reverse supply chain' is not very popular in the companies, as it is more associated with 'warranty service', 'returns' and 'claim management', it appears that the strategic actions in the reverse flow of the supply chain are aligned to the overall business strategy. The priorities, such as quality, environment, innovations, or the cost control, raised in the strategic goal of the companies, do not lose the importance in the reverse supply chain too. The outcome of the match between the strategies could be seen as one of the achieved prerequisites for the competitive advantage, because all companies have stayed profitable under inconvenient economical circumstances.

The driving forces for the strategy implementation in the reverse supply chain are green forces, increasing demand for improving the customer service level, cost reduction, and the new retail marketing strategies. All of these factors increase interests in the reverse supply chain from the strategic point of view. When organizing the reverse part of the supply chain, companies have to consider the environment, legislation and customer satisfaction. As well, to plan and engineer the business processes in order to cut costs, especially when no additional value is added.

The criteria to choose the lean or the agile concepts in the strategy of the reverse supply chain are the characteristics of returns, and reasons for returns. The characteristics of returns include size, volume, life cycle, etc. When the company produces long life cycle products it is most appropriate to implement the lean concept in the reverse supply chain. In turn, agile for short life cycle products is suitable. However, when weighing the evidence, it appears relatively more likely that the size of products and the ability to be disassembled is more important than the life cycle criteria. Large products require decentralized return centres or repairing on the customer's site and as a result, it also requires the agility in the reverse supply chain. The reasons for the returns can decide upon the strategic actions. If there are claims under the warranty service, the company needs to react responsively and fast enough in order to keep the customer satisfied. The claims after warranty service or returns from the business customers due to the unsold production can be treated in a more cost efficient way.

The implementation of the lean and the agile concepts was analyzed by considering every process in the reverse supply chain: product acquisition, reverse logistics, inspection and disposition, recovery, re-distribution and sales. In this part there are three main findings:

## Conclusions

- cost efficiency in the RSC part from the manufacturer to the supplier (companies tend to eliminate the waste and achieve cost-efficiency in this part of the reverse supply chain);
- re-distribution and sales are not acceptable for three companies due to the possible bad image on the brand, the fourth company uses it for the B2B returns; and
- the investigation process found in all four companies, was never described in the previous researches, and refers to the deep analysis of the problem in order to make improvements in the future production.

When weighting the results about lean and agile implementation in the reverse supply chain, it seems relatively more likely that none of the companies implement only the lean or only agile approaches. Due to various reasons, there are different material flows and they require different strategic approaches. Agility is implemented close to the customer in order to ensure the speed and high responsiveness. The lean concept is applied to the flows from the manufacturer to the supplier or the third party (recycler, etc.). Even more, the companies seek to find the optimal combination of both strategies, or as it called – leagile. One of the ways to implement leagility is the preponement, when early differentiation of the returns is done. At this stage, returns are divided into different flows and dealt differently: lean, agile or leagile, as one of the flows could have the de-coupling point, there again the lean and the agile concepts are used.

Main challenges in the lean reverse supply chain processes are the lack of formal operating procedures, the lack of information sharing with suppliers, and the ‘false alarm’ returns. All of these challenges create waste and difficulties in the reverse supply chain. The challenges for the agile reverse supply chain are the lack of local competence and the lack of forecasting possibilities. These are the main barriers to ensure higher responsiveness and higher quality regarding the claim management.

## 7 Ideas for Future Research

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*This chapter will propose the ideas for the future researches in the field of the reverse supply chain and the reverse supply chain strategy.*

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There are very few researches made in the area of the reverse supply chain, thus there are many possibilities for the future researches. Some ideas will be presented here.

- The next research could include the analysis of the statistical data regarding the costs and the time in order to compare the total costs for different flows of returns. It means to weighing opportunities of the lean and the agile strategies' implementation regarding the costs, the time and the customer satisfaction. The research could also include the quantitative method to exam the effectiveness and efficiency of the reverse supply chain from the perspective of the customer.
- A longitudinal study could be done for comparing how does the strategy change in time horizon, the reasons for changes and the influence on the general performance of the company.
- In this research only the reverse supply chain was analyzed, however, the experience of the authors has shown that the reverse and the forward supply chains are tightly connected (e.g. the new parts are sent to the customer for the exchange, and the re-sell goes through the same distribution channel). As a result, the next study could be done in the context of the close loop supply chain.
- The analyzed companies have low volume of returns, thus it is worthwhile to research how the applicability of the lean and the agile strategies changes for higher volume of returns, and to discover if it has an influence on the selection of a strategy simultaneously.
- The authors have only analyzed only the commercial returns, however, the analysis of the lean and the agile concepts' applicability could be done for end-of-life, end-of-use or re-usable items. Even more, the comparison between the differences in selecting the strategy could be performed.

Overall, the strategy for the reverse supply chain is quite a new and undiscovered area, thus any further researches on this topic would be a beneficial contribution for both the academic society and the business world.

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## Appendix 1 Interview Guide

Please introduce yourself, describe your position in the company and describe your responsibilities.

1) Type of Returns (*commercial returns: B2B; B2C; service returns, etc.*)

- a) What type of product returns do you deal with?
- b) What types of returns dominate in your reverse chain?

2) Processes

- a) What are the business processes in reverse chain in your company? (Product acquisition; testing, inspection, and sorting; reverse logistics; recovery; re-distribution)
- b) Could you describe processes involved to handle commercial returns from customers/supply chain partner to place of disposal/recovery/recycling?
  - i) How products are retrieving form the final customer or/and supply chain partner? Who takes control of this process? What are the main problems occur during product acquisition?
  - ii) How where testing, inspection and sorting are done (briefly)? Where process of testing, inspection, and sorting is performed (shops, centralized/ decentralized centres)? What are requirements for costs, and quality? How are they ensured/ met? Who control the process? What are the main problems occur during product testing, inspection and sorting process?
  - iii) What are disposition alternatives for product returns after testing? What are the main criteria that affect choosing appropriate disposition option?
  - iv) What are requirements for reverse logistics activities (transportation, warehousing etc.) in terms of costs, lead-time, service level, quality? What are barriers to ensure smooth flow in reverse chain?
  - v) Do you re-sell product returns? If no, why? If yes, could you describe process of re-distribution and sales)

3) Design

- a) Could you describe network of facilities involved in your reverse chain
- b) What advantages and disadvantages of such RSC design?

4) IT

- a) Could you describe Information Technology System involved in reverse flows' management?
- b) How IT system facilitates RSC processes?

5) Outsourcing

## Appendixes

- a) Do you outsource any of processes/activities in reverse chain?
  - b) Could you explain the reason to outsource/not-outsource?
- 6) Strategy
- a) How could you define your competitive strategy?
  - b) Do you see the reverse supply chain as a strategic part of your business? Do you have a reverse supply chain strategy?
  - c) Do you see business opportunities in reverse supply chain? What are they? Do you see reverse supply chain as an opportunity to keep/ get a customer?
  - d) Do you see problems/ difficulties in your company's reverse supply chain? What are they?
  - e) Do you evaluate performance of reverse supply chain? If yes, then how?
  - f) Do you believe that reverse supply chain gets enough attention from the senior managers?
  - g) Do you plan to implement changes in reverse supply chain in the future?

## Appendix 2 Interview Participants

Company	Given Identity	Position	Type of Interview	Length of Interview	Date dd/mm/yy
<b>Fläkt Woods</b>	Lennart Hed	Transport Manager	Face-to-Face	1h 10min	06/04/10
	Kent Lilja	Quality Manager	Face-to-Face	2h 15min	07/04/10
	Vladimiras Michailovas	Regional Sales Manager	Telephone	35 min	09/04/10
<b>Systemair</b>	Taina Veittikoski	Vice President Purchase and Logistics	Face-to-Face	1h 20 min	22/04/10
	Ronnie Hedlund	Quality Manager	Face-to-Face	25 min	22/04/10
<b>Swegon</b>	Tobias Bohlin	Senior Vice President for Logistics and Purchasing	Telephone	40 min	23/04/10
	Bertil Sjunnesson	Technical Support Manager	Face-to-Face	30 min	23/04/10
	Edvardas Gongapsevas	Business Area Partners East	Face-to-Face	25 min	23/04/10
	Arne Algotsson	Traffic and transportation manager	Face-to-Face	50 min	23/04/10
<b>Rettig ICC</b>	Julian Stocks	Key Account Manager Europe	Telephone	35min	19/04/10
	Jörgen Hedberg	Plant Manager	Face-to-Face	30min	30/04/10
	Anders Ehn	Logistics & Purchasing Manager	Face-to-Face	1h10min	30/04/10
	Jenny Forsell	Quality & Environmental Manager	Face-to-Face	45min	30/04/10