Optimisation of SKF's European return handling process

- A qualitative scenario analysis

Master of Science Thesis

Hanna-Mia Persson & Jenny Vogt

Department of Technology Management and Economics
Division of Logistics and Transportation
CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden, 2011
Report No. E2011:033

Optimisation of SKF's European return handling process

- A qualitative scenario analysis

HANNA-MIA PERSSON
JENNY VOGT

Supervisor, Chalmers: PhD. Árni Halldórsson
Project Leader, SKF: John Öhrvall

Department of Technology Management and Economics
Division of Logistics and Transportation

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2011

Optimisation of SKF's European return handling process
- A qualitative scenario analysis
Hanna-Mia Persson, Jenny Vogt

Master's Thesis E 2011:033

Department of Technology Management and Economics
Division of Logistics and Transportation
Chalmers University of Technology
SE-412 96 Gothenburg, Sweden

Chalmers Reproservice
Gothenburg, Sweden 2011

Abstract

Traditionally reverse logistics has attracted little attention as companies have focused on the forward moving supply chain. But today interest in the field of reverse logistics is growing as many types of businesses have identified it as a vital part of the overall supply chain. The global company SKF - the leading global supplier of products, solutions and services within rolling bearings, seals, mechatronics, services and lubrication systems - has also identified reversed logistics and return handling as an important area with many possible improvements.

SKF has built up a strong distribution network to secure a high service level to the customers and the company has implemented a centralised return handling process with a collecting point in Tongeren, Belgium, which serves the European market. However, the existing policy is not followed and also, the company was interested in investigating whether the policy is the optimal solution or if there might be other superior solutions. The aim with this thesis has been to find the optimal return handling process for the European market in terms if cost, lead time, carbon emissions, and the customer’s convenience of making a return. Identified sub aims has been to investigate the scale and nature of the returns at SKF and review prominent theory regarding the subject reversed logistics and return handling.

The methods used in this thesis were site visits, value stream maps, database studies, SKF interviews, workshops and benchmark studies. One important part of the thesis was the development of a model which was used to identify and evaluate different return handling scenarios. The model is based both on theoretical scenarios for return handling and on company specific requirements on the return handling process. The model was used to compare the theoretical scenarios for each requirement and for each one of the objectives cost and lead time. The results were four different scenarios of how the return process could be structured at SKF. The scenarios were then evaluated both qualitatively and quantitatively based on the results from the used methods. The decentralised structure came our as the best alternative for SKF’s return handling process.

The decentralised scenario was given as a recommendation to SKF of how the return handling process should be structured in Europe. Moreover, some general improvements that can be implemented regardless of the return handling structure were also given. Examples of these general improvements are better data management, reduction of the administration and the handling of returns, and better documented work procedures.

Table of contents

1. Introduction

In the introduction both the general problem and the more particular questions related to the problem are presented. This chapter begins with a brief *background* and continues with the *purpose, problem analysis and research questions*. After this the *scope and/or limitations* are presented and finally there is an *outline* which briefly describes the chapters to follow.

1.1 Background

1.1.1 Reverse logistics

Reverse logistics is defined as "the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal" (Tibben-Lembke and Rogers 2002). Traditionally reverse logistics has attracted little attention as companies have focused on the forward moving supply chain. But today interest in the field of reverse logistics is growing as many types of businesses have identified it as a vital part of the overall supply chain. The catalyst that sparked this interest in reverse logistics has been environmentalism. However, many organizations are discovering that improving their reverse logistics processes can be a value-added proposition that may or may not have anything to do with environmental concerns (Retzlaff-Roberts 1998). The added value can also be through reduced cost, reduced cycle time and improved customer service.

1.1.2 SKF

SKF was founded in 1907 as a manufacturer of the self-aligning ball bearing. Today SKF is a global supplier of products, solutions and services in the area of bearings and seals. The Group, with its headquarter located in Gothenburg, Sweden, has 44 700 employees and a presence in more than 130 countries. The business is organized into three divisions; Automotive, Industrial and Service. Each division serves a global market, focusing on its specific customer segments (SKF intranet 2010).

1.1.3 SKF's return handling

SKF has built up a strong distribution network to secure a high service level to the customers. But the existing processes and systems in the return handling have shown problems in the daily life and led to inefficiencies.

For approximately 10 years ago SKF set up a policy for handling returns, see figure 1. The returns at SKF are classified into one of five types of returns; sales errors, delivery errors, technical errors, customer errors, or stock cleanse. When an item needs to be returned, the customer contacts the corresponding sales unit, SU. The sales unit decides which return type to apply, registers the return into the return database, and sends a return label back to the customer. After receiving the return label the customer sends the goods well packed with the attached return label to the closest return point, RP. The return point is then responsible to forward the returned goods to the regional collecting point, RCP. The current system is set up with three centralised RCPs in different continents; in Tongeren (Belgium), Singapore City (Singapore), and Crossville (US). At the RCP the returned goods is visually checked for its condition and accuracy to the registered information about the return. Once the condition of the product has been determined it is either put on stock, repacked and put on stock, forwarded to the appropriate facility for technical inspection or scrapped. The RCP also authorizes credits to the sales units which in turn credit the customers.

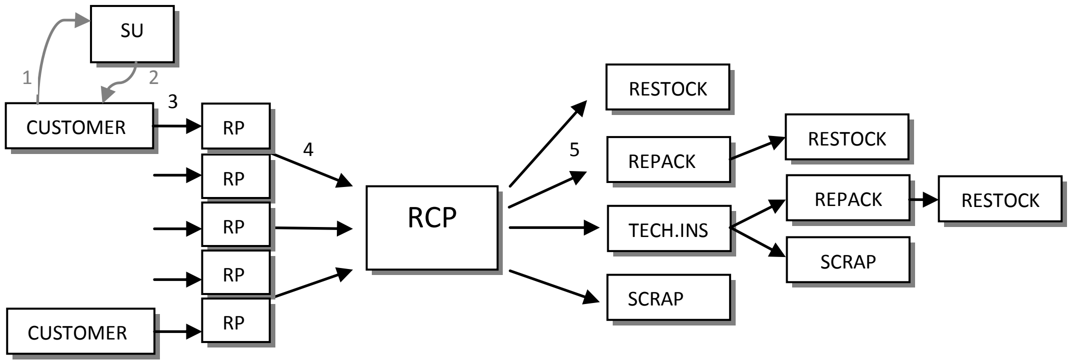


Figure 1, Simplified SKF return handling policy

However, this policy is not always followed and this leads to a complicated return handling structure where both units and personnel develop their own processes. No one in the company has a detailed overview of the situation today. For SKF, it would be of great value to investigate the processes and systems to see how the return handling is executed and if any improvements could be done. By doing this, it will also be possible to estimate the total cost of the return process. Today the total cost is unknown.

1.2 Purpose, problem analysis and research questions

In this section the *purpose* of the thesis is stated. The purpose is followed by the *problem analysis*. Finally, the purpose and the problem analysis are combined into the *research questions*.

1.2.1 Purpose

The final purpose of this thesis is to propose a model for optimisation of SKF's European return handling process in terms of cost, lead time, CO_2 and the customer's convenience of making a return. A sub purpose is to generate an understanding of the current return handling process and also to investigate how the return handling is carried out in reality. In order to understand and investigate the process it is necessary to collect and summarize data from different geographical regions and corporate divisions to get an overview of the total amount of returns.

Another intention, which in addition is necessary for the optimisation, is to review prominent research within reverse logistics and to compile a theoretical framework for the return handling process. This is of value for SKF because it introduces a research related perspective which provides a general understanding, access to actual trends, and insight in good examples and possible best practice.

1.2.2 Problem analysis

SKF has discovered that the implemented return handling process is not always followed and that there are exceptions from the policy. The return handling system set up by SKF is based on centralised return centres, however the return handling is by nature an exception-driven process (Rogers and Tibben-Lembke 1998) and this opens up for exceptions in the handling process.

One example of an exception is where a gatekeeper in the first step of the physical return handling process, in SKF's case the sales unit, decides to take care of the returned item directly and not send it to the centralised return centre. According to Rogers and Tibben-Lembke (1998) gatekeeping means "deciding which products to allow into the reverse logistics system". Hence, the sales unit does not physically take care of the item, but they may decide that the customer shall send the item directly to another destination, for example a factory warehouse, instead of sending it to the centralised return centre. This might imply advantages and make the return process more efficient for that specific item but this exceptional handling needs to be conducted in a structured and approved way. Moreover, the advantages obtained might lead to a sub optimisation of the return handling process that not represents the best overall solution.

In other words, SKF's existing return handling system needs to be analysed with focus on how the return process should look like and what type of exceptions that should be allowed. By handling the returns in a more structured and non exception-driven way, it will also be possible to increase the transparency in the system, both for SKF and for the customer.

SKF's reverse logistics process is complex due to the fact that there are many probabilistic activities, events, and interactions within different sub processes involving a high degree of complexity. For example SKF products belong to different stock categories, have different values, and different dimensions. The customers are located all over the world and the reason why they return products varies. The aim is to look at the process with all these important aspects in mind and at the same time focus on the objectives given by SKF. The objectives set up by SKF are:

- **Cost**
  The total cost associated with return handling at SKF is today unknown. Still, it is of great importance that a future return handling alternative is set up with a cost perspective in mind.

- **Lead time**
  Lead time is used both as an internal measure within SKF but also as an external measure to control the lead time for the customer. For the customer the lead times considered are the *response lead time*, which is how long the customer has to wait to get the return approved, and the *credit lead time*, which is the time it takes until the customer is credited. Both are important for the customer but the one mentioned from SKF as a perceived problem is the credit lead time. Due to long *total lead times* SKF has also identified a problem with high levels of goods in transit. A more efficient return handling process would reduce the total lead time, in other words the time until a returned item can be resold, and therefore also reduce the space consumed by items in the return process.

- **CO_2**
  The focus on environmental questions is increasing and the return handling process needs to be revised with considerations to environmental factors such as CO_2 emissions.

- **Customer's convenience of making a return**
  Amini and Retzlaff-Roberts (1999) mention a problem in reverse logistics concerning the customers. They state that it is important that it is convenient for the customers to return items. This is also true for SKF and it is important to have a customer focus when setting up future return handling proposals. It is of great value that the customers don't lose confidence in the company. This objective was added to the three previous ones after the work with the thesis had started.

1.2.3 Research questions

The purpose and problem analysis above leads to the research questions. The research questions being addressed in this thesis are:

1. What is the scale and nature of returns at SKF?
2. How does SKF's current return handling process look and work like?
3. How could different scenarios for SKF's return handling look like and function? How are they compared to each other in terms of:

    a. Cost?
    b. Lead time?
    c. CO_2?
    d. Customer's convenience of making a return?

1.3 Scope and/or limitations

Due to the limited timeline of the thesis some limitations had to be drawn.

1. First of all, according to the aim given by SKF, the thesis is restricted to *external returns*, in other words; returns from outside the company. Internal returns (returns from within the company) are not considered.

2. The thesis focuses on the *physical flow* of the returns, the corresponding informational flow and financial flow will also be partly considered but the main focus lies on the physical flow.

3. Third, the thesis focuses on the "*product return part*" of the return process which is returns based on faulty deliveries or defective products. This limits the thesis to five types of returns; sales errors, delivery errors, technical errors, customer errors, and stock cleanse. This excludes for example returns in form of recycling end-of-life products and empty packaging material.

4. Fourth, the thesis primarily focuses on SKF's biggest market, *Europe*. Except Europe there are other interesting markets, for example Asia. Although the market in Asia is still growing and the future situation in this region is expected to differ from the situation today, this market is still of interest and the model set up in this thesis will briefly be discussed with Asia in mind in chapter 6.

1.4 Outline

Below follows a short description of the outline of the thesis and what is covered in which chapter. After the introduction in this chapter the chapters are as follows:

Chapter 2: Frame of reference – reverse logistics
This chapter presents a review of the literature with focus on the issues of the field that relate to the questions this thesis seeks to answer. The chapter for example introduces the centralised and the decentralised return handling structures.

Chapter 3: Method
This chapter contains a description of the types of investigation executed to answer the research questions. Here are the actual methods used in this thesis presented; site visits, value stream maps, input through data bases, SKF interviews, workshops, and benchmark.

Chapter 4: Empirical findings
This chapter presents the data that has been collected. The chapter contains data describing SKF's current return handling process and data collected through value stream maps, databases, and interviews. Also, data from the benchmark companies is presented here.

Chapter 5: Analysis
This chapter includes a description of the model used to support the development of the new return handling scenarios at SKF. The chapter also provides a description of all the SKF return handling scenario proposals. This is continued by a return handling data analysis where the scenario proposals are evaluated with help from the existing data and collected information. The last part of this chapter presents general proposals for improvement.

Chapter 6: Discussion
In this chapter the results from the analysis are discussed both from a theoretical and a practical perspective. The subjects for discussion are reversed logistics, the chosen method, the model, the result and contradictions in the result.

Chapter 7: Conclusion
This chapter consists of three subsections: conclusions from the work, contributions from the work, and prospect of future research.

Chapter 8: Recommendations to the company
In this chapter the recommendations to SKF are presented. This chapter consists of the sections European return handling structure, possible efficiency improvements and aspects for further evaluation.

Chapter 9: References
Every citation made in the body of the thesis appears here. The list is in alphabetical order and written in Harvard reference style.

Chapter 10: Appendices
This chapter consists of material that would interrupt the flow of the thesis writing if placed in any other chapter. This can be lengthy data tables, complex charts and graphs, and extensive listings of any kind.

2 Frame of reference – reverse logistics

This chapter aims to provide an understanding of reverse logistics and its importance. This understanding is essential in order to be able to reach the final purpose of the thesis; as stated earlier - to propose a model for optimisation of SKF's European return handling process in terms of cost, lead time, CO_2 and the customer's convenience of making a return. After a short *history*, this chapter moves on with a section of *economic and strategic issues* of reverse logistics. Then, a section on how to *manage and structure reverse logistics* is presented. The last short section, how to *manage and structure forward logistics,* is written in order to function as a benchmark for reverse logistics.

2.1 History

As mentioned earlier in the background (chapter 1.1) most research in the field of logistics has focused on the delivery of products to the market and there has been limited research on the reverse logistics process. Although the phenomenon of reverse logistics has existed for a long time, it did not gain recognition until recently (Bernon and Cullen 2007).

2.1.1 Definition

One of the earliest definitions of reverse logistics (Lambert and Stock 1981) described the process as "one that goes the wrong way down a one-way street" because the majority of product shipments flow in one direction. Roughly, the scope of reverse logistics throughout the 1980s was limited to the movement of material against the primary flow. As time moved on, more refined definitions began to appear, and Rogers and Tibben-Lemke (1998) defined reverse logistics as "the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value, or proper disposal". However, this definition is still a bit narrow due to the fact that the products do not need to be returned to their origin, but may be returned to any point of recovery (De Brito and Dekker 2002).

2.1.2 Scale and management of reverse logistics

In recent years, a number of studies have been trying to identify the scale of the reverse logistics. Raimer (1997) indicated that returns are, and always have been, a fundamental part of retailing. It has also been said that return rates are ranging from 5% to 50% in many industries (Rogers and Tibben-Lembke 1999).

Even though the share of returned goods is significant, the management attention of the reverse logistics process varies dramatically. According to Bernon and Cullen (2007) some companies seem to ignore the significance of reverse logistics, some companies have gradually recognized its importance, and others view reverse logistics as a strategic variable. Rogers and Tibben-Lembke (1999) found that four out of ten logistics managers consider reverse logistics relatively unimportant compared to other issues. This lack of interest in the field has its consequences. Autry (2005) stated that "managers need to realize that effective handling of reverse logistics transactions can result in economic and strategic benefits". For example, these economic and strategic benefits could be improved customer relationships, fewer products in transit, reduced reverse logistics lead times and reduced logistics and handling costs. Poor managed reverse logistics processes lead to high inefficiencies in both logistics and transportation (Bernon and Cullen 2007). Li and Olorunniwo (2007) also pay attention to the subject: "In the modern workplace, effective reverse logistics management should be used as a competitive advantage, a positive profit centre, a tool to cut costs and a tool to improve customer satisfaction".

2.1.3 Future trends

Most likely, reverse logistics will gain more recognition as time moves on. Many companies have yet to realize the importance of this subject. Logically, the primary aspect that will get the managers to focus more on reverse logistics is the idea of reducing cost. To reduce the cost of reverse logistics in the future, companies will need to focus on improving several aspects of their flow. Already in 1998 Rogers and Tibben Lembke suggested five aspects to reduce the cost of reverse logistics:

- Improved gate keeping technology
- Partial returns credit
- Earlier disposition decisions
- Faster processing / shorter cycle times
- Better data management

Even today, several years later, all these aspects might be of interest for the company in this study. A better overview of the costs of reverse logistics will be found in the next section of this chapter.

2.2 Economic and strategic issues

2.2.1 The cost of returns

After a product has been returned, the question is how to maximize its value. The alternatives are: reuse, repair/repackage, return to supplier, resell, junk, recycle and renew (Amini and Retzlaff-Roberts 1999). The objective is to minimize the handling cost while maximizing the value from the goods, or proper disposal (Subramaniam 2004). According to Blackburn, Guide, Souza and Van Wassenhove (2004) the cost of product returns is defined as “the value of the return plus all reverse logistics costs minus revenue recovered from the product”. Figure 2 visually shows how assets are lost in the return stream:

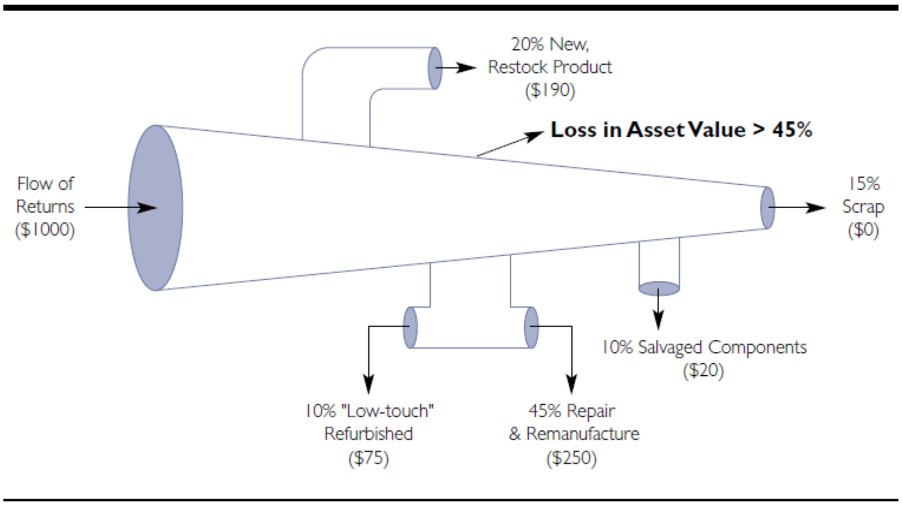


Figure 2, The shrinking pipeline for products returns (Blackburn, Guide, Souza and Van Wassenhove 2004)

So, what is the scale of the problem? In Rogers’ and Tibben-Lembke’s study (1998) the total reverse logistics costs accounted for roughly 4% of the total logistics costs, and Raimer (1997) estimates that the reverse logistics account for between 5 and 6% of the total logistics cost in the retail and manufacturing sectors. Guide and Van Wassenhove (2003) put it in another way, when they stated that the cost of the returns was averaging twice the value of the product itself in 2001. So far for SKF, no study of the total reverse logistics cost has been made.

When talking about costs in reverse logistics, it is also important to keep the time needed to execute the return in mind. Figure 3 shows the effects of time delays and product downgrading on asset loss in a return stream. The upper line represents the declining value over time for a new product, and the lower line represents the declining value over time for a remanufactured version of the same product.

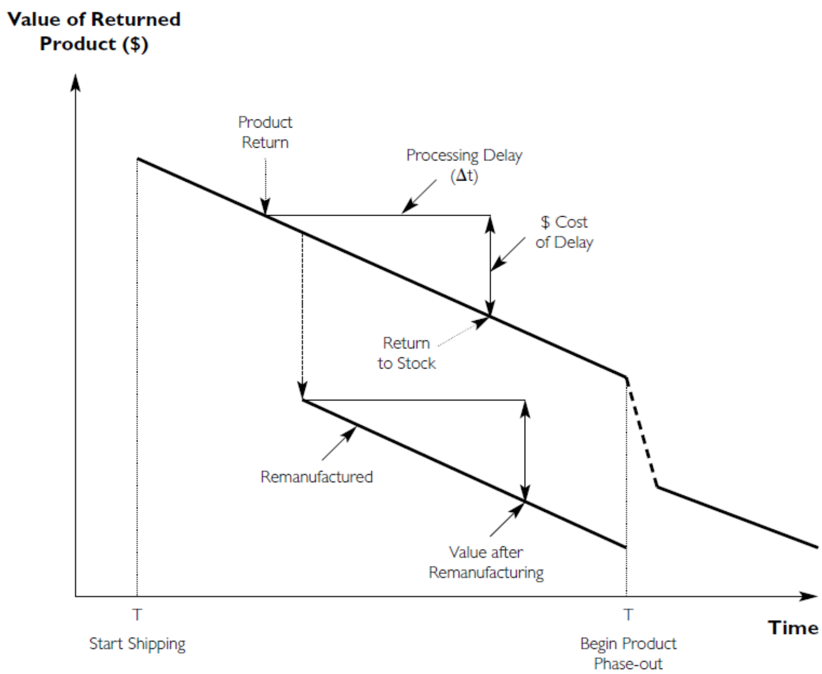


Figure 3, Time value of product returns (Blackburn, Guide, Souza and Van Wassenhove 2004)

In addition to the asset losses and value decreases of time already shown, companies with poorly managed reverse logistics also have to consider what Reese and Norman (2006) refer to as "the hidden costs of reverse logistics". Reese and Norman (2006) identify three types of hidden costs:

- *Hidden labour costs* – when a non automated process incurs costs as employees manually decipher return policies on a one-off basis.
- *Gray-market items* – when for example assets designated as scrap reappear for warranty service.
- *Lack of visibility* – when customers call or e-mail repeatedly because they want to know the status of their return requests, which is not visible (Reese and Norman, 2006).

Rogers and Tibben-Lembke (1998) describe the third hidden cost of reverse logistics – lack of visibility – further. They state that "most firms cannot track returns within their own organisation, much less somewhere outside of their firm". With this in mind, it is not a surprise that the customers can not track their returns either. Today, this is most certainly true for SKF. The two first hidden costs, hidden labour cost and gray-market items, are also accurate for SKF.

For all companies, it is a challenge to reduce the cost of reverse logistics. Essentially, one of the easiest ways to do this is to reduce the volume of products in the flow. As stated by Rogers and Tibben-Lemke: “First, products that do not belong in the flow should be prevented from entering. Secondly, once products have entered the flow, they should be dispositioned as quickly as possible.”

2.2.2 Marginal value of time

Research (Blackburn, Guide, Souza and Van Wassenhove 2004) suggests that significant financial values can be gained by redesigning the reverse supply chain to be faster. These financial values are higher in fast clockspeed industries such as consumer electronics, where the average life cycle of a personal computer is expressed in months, as opposed to slow clockspeed industries such as power tools, with average life cycles of many years. The differences in the marginal value of time, MVT, are shown in figure 4:

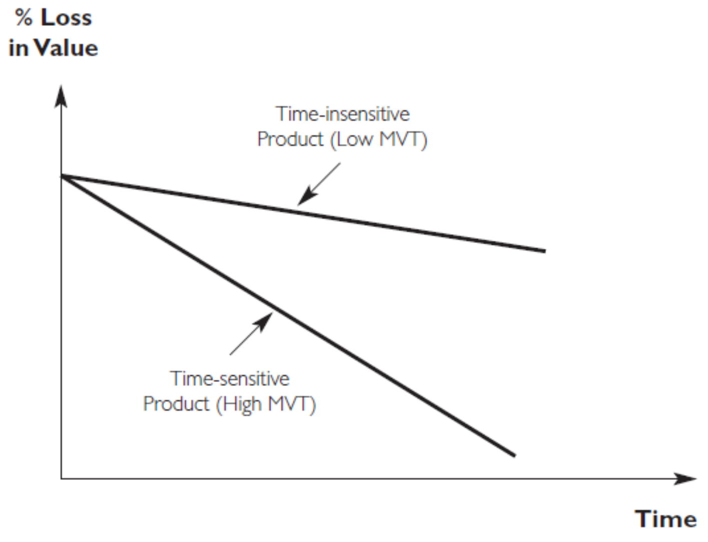


Figure 4, Differences in MVT for returns (Blackburn, Guide, Souza and Van Wassenhove 2004)

Viewed like this, reverse supply chain design is a trade off between speed and cost efficiency. If cost efficiency is the goal, then the chain should be designed to centralise the evaluations. On the contrary, if responsiveness is the goal, then the chain should be designed to decentralise the evaluations in order to reduce time delays (Blackburn, Guide, Souza and Van Wassenhove 2004).

Roughly, all SKF products are time-insensitive. Hence, a preliminary conclusion that SKF’s reverse supply chain should focus more on cost than speed efficiency can be made. This is of big importance to keep in mind for the future investigations in this study.

2.3 Managing and structuring reverse logistics

Reverse supply chains can be designed in several different ways. However, most of them are organized to carry out five key processes (Blackburn, Guide, Souza and Van Wassenhove 2004):

- Product acquisition – obtaining the used product from the user

- Reverse logistics – transporting the products to a facility for inspecting, sorting and disposition
- Inspection and disposition – assessing the condition of the return and making the most profitable decision for reuse
- Remanufacturing – returning the product to original specifications
- Marketing – creating secondary markets for the recovered products

In this section of the frame of reference, different ways of managing the five key processes above are described. First though, is a brief description of the differences between planned and unplanned returns.

2.3.1 Planned and unplanned returns

The reverse logistics process includes two general areas: reverse flows consisting mainly of products, or mainly of packaging (Rogers and Tibben-Lembke 1998). Both products and packaging are returned for a variety of reasons, but according to Amini and Retzlaff-Roberts (1999) returns can be roughly divided between those that are unplanned and undesired and those that are planned and desired. *Unplanned returns* are usually restricted to products which customers have purchased, where reasons for returns include:

Returns of new products:

- The customer changed his/her mind
- The product was defective
- The customer perceived the product to be defective
- The product was damaged in transit
- A vendor error (such as wrong item or quality sent)

Returns of used products:

- Warranty returns
- Product recalls

The reverse logistics of unplanned returns are principally complex because organisations do not know what will arrive and when. This is the type of return the company in focus, SKF, mainly deals with.

Planned returns include a wider variety such as:

- Return of reusable packaging or shipping containers
- Trade-in programs
- Company take-backs
- Leased or rented products
- Service work

A benefit of planned returns is that it is much easier for the organisation to know what is coming back when (Amini and Retzlaff-Roberts 1999). Although these types of returns are not included in this study, it is important to know that they exist in order to get a broader understanding of the subject. For this study, the only planned return that might be considered is company take-backs, but for SKF – the company take-backs are not planned. Instead, they have the nature of unplanned returns.

2.3.2 Connection to forward logistics

One important question in the design of a return handling process is whether to use the same structure and resources as for forward logistics. It can be difficult to mix the forward logistics with the return logistics. Lambert and Stock (1981) describes this as "going the wrong way on a one-way street because the great majority of product shipments flow in one direction". But still, it is an option and Chandiran and Prakasa Rao (2008) mention four different alternatives. The first alternative is to use the existing forward supply chain, which means to use the same warehouses and distribution centres, same actors etc. The second alternative is to outsource the entire return handling process to a third part. The outsourcing could include everything between just the transportations and sorting to remanufacturing. The third alternative is to design a separate network of facilities for the return handling which does not interfere with the forward logistics. The fourth and final alternative is to redesign the entire forward supply chain and design a new network which handles both forward logistics and return handling (Chandiran and Prakasa Rao 2008). To summarize, the alternatives are:

1. Use existing forward supply chain
2. Outsource to third part
3. Separated networks for forward logistics and return handling
4. New network which handles both forward logistics and return handling

In order to evaluate the four different alternatives it is important to understand that there are many differences between the reversed logistics and the forward logistics. The authors Chandiran and Prakasa Rao (2008) mention three aspects which differentiate the reversed logistics from forwards logistics. *The first aspect* considers the fact that most forward logistic networks are not constructed to handle returns with a reversed flow. *The second aspect* considers the fact that the returned products cannot be transported, stored or handled in the same way as goods in the forward logistic chain. And finally *the third aspect* considers the fact that the cost for handling a return can be many times higher than the cost for distributing the same product (Chandiran and Prakasa Rao 2008). It is common for companies to use the same facilities for reversed logistics as they do for forward logistics, but usually in a separated area of the warehouses and distribution centres (De Brito and De Koster 2003). In the remaining parts of this section (section 2.3) focus will be on the return handling and not on the forward supply chain.

2.3.3 Outsource to third part

Many companies are not capable of or are unwilling to enter the reverse logistics market. Such reluctance appears to be attributed to lack of knowledge of reverse logistics (Krumwiede and Sheu 2001). For these companies, as well as for companies with knowledge that have deliberately decided not to perform reverse logistics internally, it is possible to hand over the reverse logistics to a third-party provider such as a transportation company. Unfortunately, these third-party providers are not many. This is due to the fact that the return handling, as already mentioned, by nature is an exception-driven process (Rogers and Tibben-Lembke 1998) and many transportation companies are therefore not willing to enter the field of reverse logistics.

However, there are companies willing to handle the task. One of the most recognized is GENCO Supply Chain Solutions. GENCO Supply Chain Solutions operates in North America and the company has set up its own return centres. With the use of these centres it is possible for GENCO Supply Chain Solutions to operate the entire return handling process for other companies. This process includes recall management, testing and warranty, repair and refurbishment and product liquidation to identify areas of improvement (www.genco.com). Often the third part companies are able to perform the reverse activities better, and their customers find that by using these service firms the administrative hassle gets reduced (Rogers and Tibben-Lembke 1998). However, despite the advantages of outsourcing the reverse logistics to a third part, it is also important to keep in mind that there might be disadvantages. One such disadvantage could be missed opportunities of communication with the customers.

2.3.4 Network with a centralised process

An illustration of a reverse supply chain with centralised testing and evaluation is shown in figure 5:

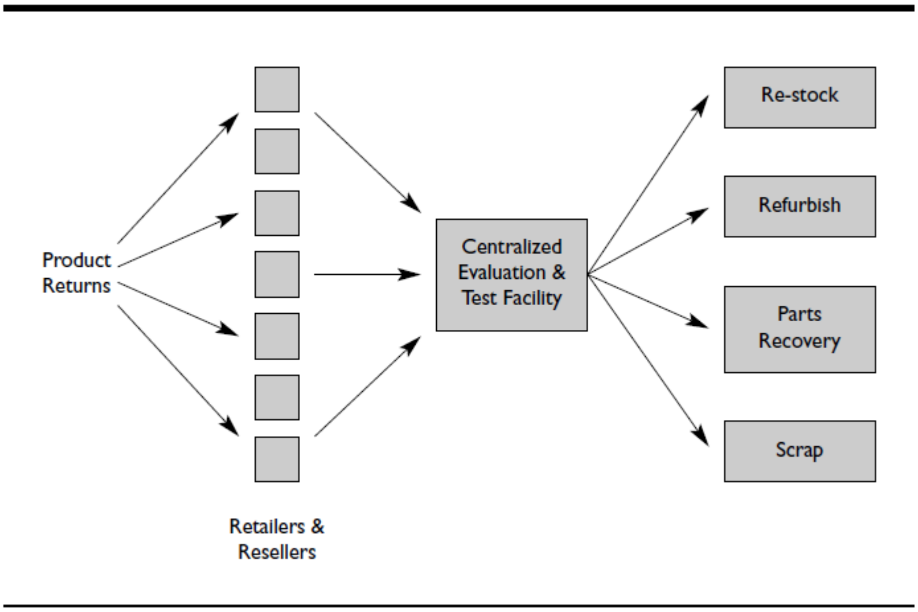


Figure 5, Centralised process (Blackburn, Guide, Souza and Van Wassenhove 2004)

In the centralised structure all products are brought to the central facility, where they are sorted, processed, and sent to their next destination. No attempt is made to evaluate the condition of the product at the retailer or reseller. Thus, the centralised structure has the benefit of "creating the largest possible volumes for each of the reverse logistics flow, which often leads to higher revenues for the returned items" (Rogers and Tibben-Lembke 1998). In addition, the centralised system allows the company to gather sorting specialists who are experts in certain areas. These specialists can find the best destination for each product. To reduce shipping costs the returns are usually shipped in bulk. The goal with this design is to minimize costs, and the price paid - the expense for reaching this goal - is often long delays. The centralised process has been commonly adopted by managers of reverse supply chains (Blackburn, Guide, Souza and Van Wassenhove 2004).

2.3.5 Network with a decentralised process

An illustration of a reverse supply chain with decentralised testing and evaluation is shown in figure 6:

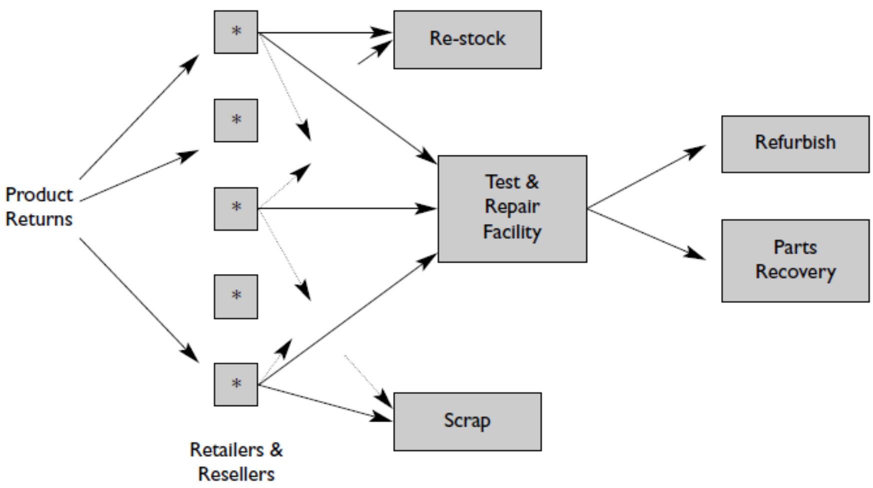


Figure 6, Decentralised process (Blackburn, Guide, Souza and Van Wassenhove 2004)

In forward supply chains, Lee and Tang and others have introduced the concept of product postponement and have shown that it has considerable financial advantages. An alteration of this model can be useful in the reverse supply chain: managers can make a disposition as early as possible to avoid processing returns with no recoverable value, for example scrap. This concept is called "preponement".

In a decentralised system all decisions regarding the disposition of returned products are made at retail and reseller locations (Rogers and Tibben-Lembke 1998). The biggest advantage with a decentralised system with preponement is that it reduces the time delays in two ways. *First*, it reduces the time delays for disposition of new and scrap products. New, unused products usually have the highest marginal value of time and the most to lose from delays in processing, and - on the contrary - if the product is going to be thrown away it is best to do that as early as possible. *Second*, when new and scrap products are sorted away, preponement also speed up the processing of the remaining products - the products that need testing and repair.

There are two important issues that must be in place in order to reach responsive, decentralised reverse supply chains. First is the issue of technical feasibility – in other words, being able to evaluate the condition of the product return quickly and inexpensively. Second is the issue of how to encourage the reseller to do these activities at the first point of return (Blackburn, Guide, Souza and Van Wassenhove 2004).

2.3.6 Zero returns

Worth mentioning is the concept of zero returns. In a typical zero returns program no returns will be accepted, once ordered. Instead, the customer will be given a discount off of the invoiced amount. Depending on the supplier, the retailer either destroys or disposes the products instead of returning them. According to Rogers and Tibben-Lembke (1998) "a zero returns policy, properly executed, can result in substantially lower costs". Despite this, zero returns programs have had mixed results. When the supplier does not command the products back, the products can reappear on a second market (Rogers and Tibben-Lembke 1998). Also, this concept only makes sense if it is the customer who orders the wrong product, or the wrong amounts of products. It is not possible for a supplier to reject returns due to sales errors, technical errors or delivery errors if the supplier still wants good relationships with its customers. Thus, the concept of zero returns is not of interest for the company studied in this thesis.

2.3.7 Managing and structuring reverse logistics summary

Figure 7 summarizes this section (section 2.3 Managing and structuring reverse logistics) of the frame of reference. First, a company has to decide if returns will be allowed or not. If they will, or in other words; if the answer to the question "Zero returns?" is no, the company will have to decide whether to use the same structure and resources as for forward logistics or not.

If the company at this point decides to go for alternative 1 (see 2.3.2) the existing forward supply chain will be used for returns as well. If the company instead decides to go for alternative 2 the return handling will be outsourced to a third part. And finally, if the company at this point decides to go for alternative 3 or 4, the question of whether to go for a centralised or decentralised structure emerges. In this case it is of course possible, or even likely, that the company will decide to go for a mixture between the centralised and the decentralised structure. This opportunity is not shown in figure 7, but will be discussed later on with SKF's special demands on the return handling system in mind.

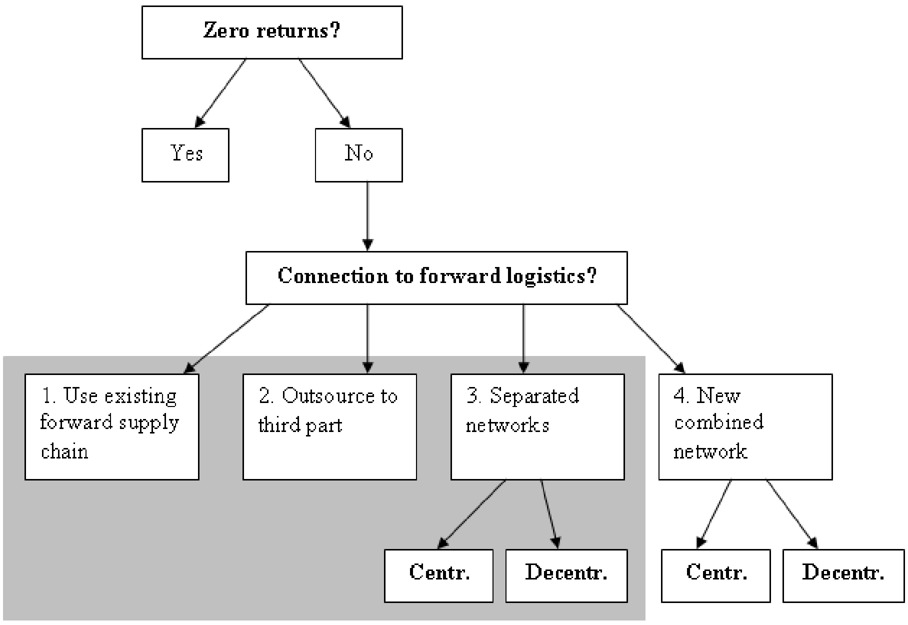


Figure 7, Alternatives for reverse logistics

One part of figure 7 is highlighted in grey. That is the part this thesis will continue to have focus on. As stated earlier, the concept of zero returns is not of interest for SKF and neither is "Connection to forward logistics alternative 4" – a new combined network structure. The latter limitation is due to the size of SKF and the well-established and well-functioning forward supply chain. This makes the alternative to reorganise the forward supply chain not considerable.

2.4 Managing and structuring forward logistics

Due to the limited theory connected to network planning for reversed logistics, focus has also been on supply chain network design for forward logistics. The concept Supply Chain Network Design includes decisions regarding facility locations, facility roles, facility capacities, sourcing, and transportation. The Spinnaker Management Group LLC (2011) presents a network design approach which divides the network design process into three phases; *Strategy Development, Scenario Evaluation, and Operational Planning.*

The first phase, *Strategy Development*, includes:

- Evaluate current business climate
- Identify key market drivers
- Determine objectives
- Develop alternative strategies

In this phase, one important step is to identify critical issues and analyse how they are likely to change in a time period of about 3-5 years. The alternatives can then be identified by analysing the gap between the current system and the future requirements.

The second phase, *Scenario Evaluation*, includes:

- Collect and cleanse data
- Build and validate supply chain network models
- Evaluate alternative strategies

Data need to be collected for the current system in order to function as a baseline when evaluating the alternatives. When all alternatives are evaluated, a sensitivity analysis needs to be conducted to measure the robustness for key factors in the study. When calculating the cost for the new alternatives, a switching cost from the current situation needs to be considered and added to the calculation.

The third phase, *Operation Planning*, includes:

- Assess systems and business processes
- Investigate in-sourcing and out-sourcing
- Develop transition and implementation plan

(Spinnaker Management Group, LLC 2011)

Some parts of these phases might be of interest when evaluating both SKF’s current return handling system and possible future alternatives.

3. Method

This chapter contains a description of the types of investigation executed to answer the research questions. First there is a *timeline* where the thesis is put in perspective, second follows an *overview of the used methods*, and last there is a presentation of the a*ctual strategies used*; site visits, input through databases and value stream maps, SKF interviews, workshop, and benchmark.

3.1 Timeline

The timeline for this thesis has been limited to one semester but the timeline for the whole return handling project is much longer. This is shown in figure 8. As mentioned in the background, the previous return handling process was set up for approximately 10 years ago and has also to some extent been analysed and revised after that. The problem was relatively well defined and there were also many symptoms identified. The thesis started with a further analysis of the problem and the symptoms. Thereafter, different scenarios were developed to solve these problems and a preferred scenario was selected. The next steps will possibly be to implement this scenario and, after a while, to evaluate the implementation but this will not be in the scope of this thesis.

Since the thesis did not start from scratch but took over where previous work had been done there were some secondary data available. However, the main part of the thesis is based on primary data.

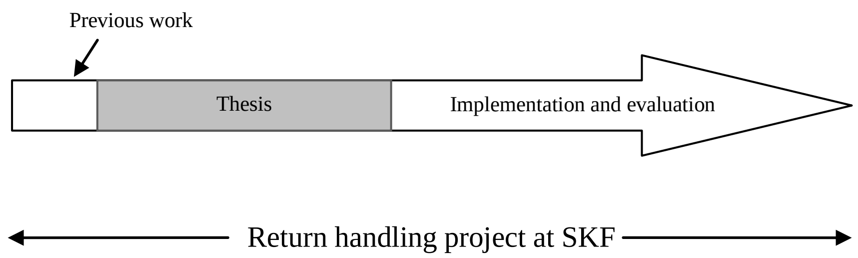


Figure 8, Timeline of the work

3.2 Overview of used methods

In chapter 1.2.3 three research questions were introduced. In order to answer these questions, different methods were needed. How the research questions were answered is shown in table 1.

<u>Research questions:</u>

1. What is the scale and nature of returns at SKF?
2. How does SKF's current return handling process look and work like?
3. How could different scenarios for SKF's return handling look like and function? How are they compared to each other in terms of:

    a. Cost?
    b. Lead time?
    c. CO_2?
    d. Customer's convenience of making a return?

Research question	Research question answered by			
	Theory	Internal Interviews/ Workshops at SKF	Quantitative analysis at SKF	External Interviews
1		x	x	
2		x	x	
3	x	x	x	x

Table 1, Research questions

Theoretical issues were used as an influence when, together with an international team of SKF personnel, brainstorming around possible scenarios on how to best handle SKF's return flow in the future. But primarily, this study is empirical. Several *internal interviews* were held both in order to get an understanding of the return process today and to get input on how the process could work better in the future. As mentioned above a *workshop* with an international team of SKF personnel was also held to get valuable input. *Quantitative analysis,* both through data bases and value stream maps were needed to be able to evaluate and compare the different future alternatives compiled at the workshop. Also, the data analysis gave information of the scale of returns at SKF. In addition, *external interviews* with benchmark companies were held in order to get inspiration to future return handling scenarios.

According to the theory there are numerous ways of collecting empirical data. Quantitative data can for example be collected through on-site studies (primary data) and existing databases (secondary data). As for the qualitative data, Sunders, Lewis and Thornhill (2009) suggest many different research strategies such as experiments, surveys, case studies, action researches, ethnography, questionnaires, observations, interviews and archival researches. The next section of this chapter describes the strategies chosen in this study more in detail.

3.3 Actual strategies

In this section the actual strategies used to answer the research questions are described.

3.3.1 Site visits

The great advantage of doing site visits instead of asking personnel for information by e-mail is the closeness to what is studied. By doing site visits a better general understanding of the return flows was achieved and it was also possible to know that the information was valid. Site visits were made at the factory warehouses acting as return points in Schweinfurt (Germany), Airasca (Italy), and Gothenburg (Sweden) and at the European collecting point in Tongeren (Belgium). Even a site visit at the factory warehouse acting as a return point in St Cyr (France) was planned, but unfortunately this visit had to be cancelled due to time restrictions.

The aim with the site visits was to get an overview over the return flows and to collect data for value stream mapping over these flows. This was explained beforehand by e-mail and phone calls to the SKF personnel responsible for the return handling at each site. Also an agenda was sent out before the visit. Each site visit was performed during one and a half days (except for Airasca, where only one day was scheduled) and consisted of three steps. All steps were performed with help from personnel working with return handling at the current site. Without their help, this would not be possible. The steps were as follows:

Step 1: Walk the flows to identify all processes in each return flow. Here every process (for example goods receiving, visual inspection or repack) in the return flows at the current site was showed and explained by the personnel. The European collecting point in Tongeren have different return flows compared to the factory warehouses acting as return points, and even these sites sometimes have different processes in their return flows. In this step, it was important to get an understanding of all the different processes in the different return flows at the different sites.

Step 2: Agree on and map the current return flows. This step started with a confirmation of the information given in step 1. Then each return flow was mapped on a whiteboard. When finished, three or four return flow maps were drawn, depending on the site and how many different return flows the personnel were handling. In each map every process step were presented in the right order with arrows in between. The maps for each site can be viewed in appendices 10.4-10.7.

Step 3: Collect data - go through and analyse each process (for example goods receiving, visual inspection or repack) and identify input and output, and resources and documentation needed to perform the process. For each process different activities were identified. One process could for example include four different activities. The personnel were asked to estimate the times needed to execute each activity, and in addition to this the waiting times between each activity were also estimated, as well as the waiting times between the processes. All information from Step 3 was collected in so called "Turtles", see figure 9.

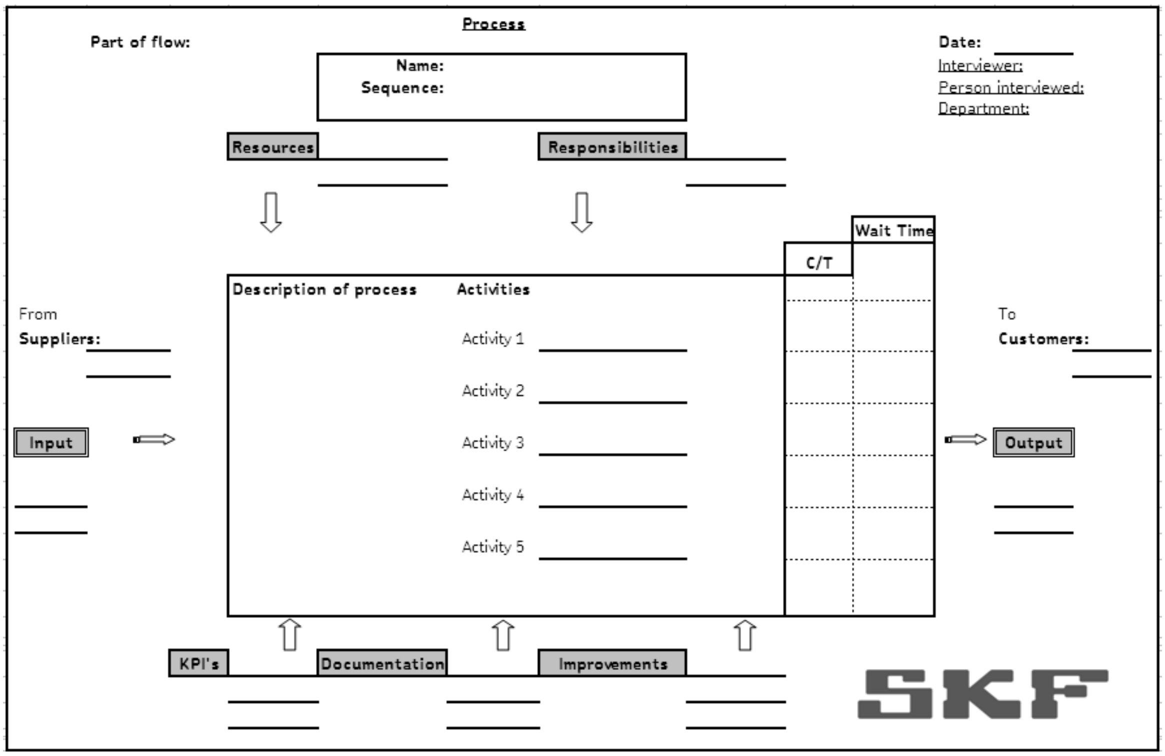


Figure 9, "Turtle"

Exact time studies were not executed since it would have been difficult to perform such studies during the time frame given for this thesis - the waiting times between the activities and between the processes can sometimes be over 200 days. Therefore the times, as stated above, were only estimated. It is also important to remember that it is the waiting times (measured in days) that has most impact on the lead times for the return handling at the sites, not the actual time the returns are handled (measured in minutes). So although exact time studies could have been done for the short handling times, this accuracy would have been eaten up by the estimates made for the long waiting times. However, the estimated handling times were still collected in order to evaluate the efficiency of the process and to serve as a base for possible improvements.

During all steps, photographs were taken as a back up to what was written down. In this way, no details were lost along the way and the photographs could also be used in a later stage to validate the result. In Airasca, where only one day was scheduled for step 1, 2 and 3, the time was limited during step 3 and Turtles for only one out of four processes were made. Because of that, a web-ex meeting were arranged together with the Airasca personnel afterwards to finish the work. This was the only case where an additional web-ex meeting was needed.

3.3.2 Value stream maps

Value stream mapping is a lean manufacturing technique used to analyse and design the flow of materials. The technique originates from Toyota, where it is known as “material and information flow mapping”. Value stream mapping can be applied to nearly any value chain and the main purpose is to deepen the understanding of the value stream by drawing a map of it. A key metric associated with value stream mapping is lead time (Rother and Shook 1999).

One part of the thesis have been to draw value stream maps for each one of the four factory warehouses also acting as return points in Europe as well as for the regional collecting point in Tongeren. The value stream maps are based on the information given in the so called “Turtles”, see step 3 and figure 9 above in chapter 3.3.1. Hence, the value stream maps were not completed during the site visits, but in a later step with the information given at the site visits.

In the value stream maps all the processes at one site were presented in the right order with arrows in between. From one process, for example visual inspection, several arrows to different processes could be drawn depending on the outcome from the visual inspection. By doing it in this way it was possible to get an overview of all the return flows with its different activities at the site.

The value stream mapping has been conducted according to SKF standards by using the already existing templates called “Turtles”. By using these existing procedures, the mapping became consistent with other values stream maps at SKF and the result was easier communicated within the company.

3.3.3 Databases

Normally, collected quantitative data for example raw data from a database, is hard to use in its unrefined form and needs some processing before it can be used to support the analysis. Examples of this processing are to construct graphs, charts and statistics based on the data to illustrate the information in an easier way (Saunders, Lewis and Thornhill 2009). The aim with the quantitative analysis in this thesis is primary to support the scenario analysis and to provide an understanding of the amount and characteristics of the returns at SKF.

Customer Return Processing database

Data have been collected from different internal databases at SKF but the major focus has been on the Customer Return Processing database. From this database an extraction was made for all the returns passing through the European collecting point, ECP, in Tongeren during the years 2008, 2009 and 2010. The data from 2010 was considered to be the most relevant and was therefore used for the evaluation of the SKF scenario proposals presented in chapter 5.5. The data from 2008 and 2009 was used as reference data to the data from 2010 in order to investigate how the data has changed over time and to analyse possible trends.

The data from the Customer Return Processing database has been used for statistical information of the amount of returns at SKF such as number of returns, number of returned lines, total returned quantity, and total value of returned goods. The data has also been used to map the network densities of the returns in Europe and to illustrate from what regions the returns arriving at the ECP come from. Moreover, the data also provided information about the amount of returns registered by the sales units during the contact with the customers compared to the amount of returns actually processed at the ECP. Finally, the data has been used for a transportation cost evaluation comparing a centralised and a decentralised return handling structure.

Data from local databases at the ECP

In addition to the Customer Return Processing database, data has been received from two local databases with a register of repacked returns and returns sent to technical inspection. With information from the database with the repacked returns, the registered dates for ordering and receiving of repacking material was used to calculate the lead time for receiving packaging material. This database has also been used to confirm the information in the Customer Return Processing database and to add some missing information about repacking. The other database with information about the returns that were sent to technical inspection was also used to confirm and complement the data in the Customer Return Processing database.

Data from the return points

Data has also been requested from the different return points. However, only one of the return points, Schweinfurt, could provide data in a usable electronically format. For example, the return point in Gothenburg could only provide old records in paper form and the personnel in Gothenburg are today not registering the returns in any database. The data from Airasca was never received and any possible data from St Cyr has not been evaluated due to the time restrictions given.

A copy of the database from the return point in Schweinfurt was received from the responsible personnel in Schweinfurt and the database was translated into English. The data in this database was compiled into valuable information about all returns processed in Schweinfurt and also into information about returns which never passed through ECP - in other words returns which were never recorded in the Customer Return Processing database. Hence, this database was used to provide important information about how many returns which were not handled according to the policy.

Additional data

The collected data from the databases contained return order lines with information such as part number/designation, quantity, origin (from which customer), country of manufacturing etc. For some returns data was missing and all the databases did not contain all the necessary information. Based on the requirements for the analysis, additional information was collected from other sources – for example from the product master database, the customer register database, and the warehousing and stocking databases. The collected information was then added to the extracted data from the return databases by crossing tables based on return product designation, customer number etc.

3.3.4 SKF interviews

A significant number of interviews were executed, for further information about the interviewees see appendix 10.2. No questionnaires were used, instead all interviews were non-standardised. The reason for this was that different questions were asked to people with different areas of competence, and even though questionnaires have many advantages they would not have been useful here. The only time the same question was asked to a number of people was when a standardized e-mail was sent out to representatives in each of the European countries asking where they send their returns.

The thesis was performed during 20 weeks at the SKF head quarter in Gothenburg. Since the authors of the thesis were located in SKF's facilities it was possible to have many face-to-face interviews – both pre booked and informal ones. In addition, several indirect contacts at SKF in Gothenburg contributed with information continuously. This was a big advantage and gave the authors a broad network of SKF competence in a natural way. But due to the fact that SKF is a global company with personnel in different countries telephone and intranet-mediated interviews were also needed. These interviews were held both with one person at a time and with focus groups.

In the beginning of the work, it was not possible to know how many interviews, or with whom, that would be needed in order to answer the research questions. The interview calendar developed as time moved on. A compiled list over the interviews held can, as stated above, be found in appendix 10.2.

It was important to reflect upon the information given in each interview. To begin with, all people interviewed had different perspectives and areas of interest. And yet another aspect to keep in mind was the fact that what is true for one person might not be true for everyone. Therefore it was important for the authors to have an understanding both of the general situation and of the position each person interviewed was having.

One area where it has been difficult to find information is the carbon CO_2 calculations. Due to some changes in the SKF organisation, the CO_2 calculation expert left her position and a successor was not expected during the timeframe of this thesis. Therefore, the CO_2 perspective in this thesis will mainly be based on secondary data instead of interviews.

3.3.5 Workshop to identify scenarios

One important part in the design of different SKF return handling scenario proposals was to get feedback from key personnel within return handling at SKF. In order to capture this input a workshop was planned in Airasca with SKF representatives from warehousing, logistics services, return handling and the platform Automation & Motion Control (marked with * in appendix 10.2). The workshop was planned and held entirely by the authors of the thesis and the participants were guided through the workshop step by step. During one day this team worked after a predetermined agenda where the end-of-the-day-goal was to have three or four scenario proposals on how the return handling at SKF could be structured in the future.

The agenda contained four steps. These steps are explained more in detail in chapter 5.3, and are just briefly presented here:

1. *Parameter discussion* – here the different parameters affecting the return handling were discussed.
2. *Evaluation of the matrixes* – here matrixes to help structure the new scenario proposals were evaluated.
3. *Mapping of the current process* – here the current process was mapped and discussed.
4. *Development of new SKF scenario proposals* – here the new proposals were developed.

A workshop or group interview like this was undoubtedly the most advantageous approach to attempt to obtain new SKF return handling scenario proposals. This was due to the fact that the questions were both complex and open-ended and that it was important to gather knowledge from different parts of SKF in order to get discussions, and thereby a broader picture. The key, like for all kinds of interviews, was a careful preparation. The agenda was sent out beforehand to the participants together with compiled material about the parameters and matrixes. During the day whiteboards, different coloured pencils and representative pictures were used. Some of the discussions were recorded. During the day it was important to keep track of time and to always have the main objectives clear in mind.

3.3.6 Benchmark

The fundamental idea was to find inspiration and compile the results from three or four benchmark companies with good, but preferable not equal, return handling structures. The benchmark companies should be identified based on different criteria in order to serve different purposes. One purpose was to find companies with similar return requirements as SKF where the entire return handling process could be compared to the requirements on SKF's return handling. The other purpose was to find companies with different return requirements; for example a return intense industry/company with a well developed return process. Here, the aim was to analyse and evaluate innovative parts of the system even though the whole return process might not be applicable on SKF's return handling requirements.

Several companies were contacted but the task was not easy. First, it was difficult to find companies with a good overview of their own return handling process. And second, it was even more difficult to find companies which were satisfied with the return handling structure they had. Therefore the benchmark only consists of two interviews - Scania Parts and Volvo Parts. In the benchmark section there is also one part about retailer warehouses which originates from theory.

3.3.7 Summary of used methods

The methods used in the thesis are site visits to map the return handling process, value stream maps of the processes, collection of primary and secondary data, internal interviews at SKF, a return handling workshop, and a comparative benchmark. The variety of used methods has given the thesis a multiple source of evidence as a base for the assumptions and the recommendation given to SKF. One example of where this has been valuable is in the mapping of the current return handling process where it during the site visits became evident that the process differed from what was originally given during the interviews. This difference could be explained by the commonly known fact that there is usually a difference between perception and reality. Moreover, the perception is individual and what one person perceives might differ from what another person perceives due to for example different objectives, previous experiences etc.

4 Empirical findings

In this chapter the data that have been collected is presented. First there is a description of the *return handling at SKF*. After this description the chapter continues with sections about *return handling value stream maps* and *return handling data*. Finally there is a section about *benchmark companies*. The empirical findings presented in this chapter are later on used as a base for analysis presented in chapter 5.

4.1 Return handling at SKF

In Europe there is one regional collecting point; the European collecting point in Tongeren, and four different factory warehouses acting as return points; Schweinfurt, Airasca, St Cyr and Gothenburg. Also there are several factories, so called product divisions or PDIVs, producing goods.

Today the customers are supposed to send their returns to the closest return point. From there the technical returns should be forwarded directly to the owning product division, PDIV, and the other returns should be forwarded to the regional collecting point in Tongeren for further decision. However, this policy is not always followed. Here follows descriptions and process maps over the regional collecting point and the above mentioned factory warehouses acting as return points, but first there is some general information about the return handling at SKF.

4.1.1 General information about the return handling at SKF

The information in this section (4.1.1) is collected from SKF's return handling policy as stated today and through interviews with representatives from the Group Demand Chain, Service Division and Automotive Division at SKF.

Stock category
SKF divides products into planned items and non-planned items.

- *Planned items* are items that are either available on stock or have a planned availability.
- *Non-planned items* are "make to order" or items that are obsolete or samples. (Not to be compared with the definition of planned and unplanned returns in chapter 2.3.1.)

Packaging category
SKF has many different types of packaging. The most common ones are single pack and multi pack:

- *Single pack* is items packed one by one.
- *Multi pack* is items of the same sort packed many together. This packaging category is also referred to as industrial pack and is usually for customers that use the products directly as parts in their own production or for some other reason order larger quantities.

In general, the European distribution centre, EDC in Tongeren, stores products for the aftermarket which mainly consists of single packed products. The international warehouses serves original equipment manufacturers, OEM customers, and are mainly stocking multi packs/industrial packs.

Type of error
The return handling process for goods at SKF is classified into one of five types. When a return is registered the sales unit decides which type to apply. This dictates what mandatory information that will be needed to complete the return.

- *Sales Error Report, SER* – These are administration errors made by the sales unit with the result that the customer receives the wrong product or quantity.

- *Delivery Error Report, DER* – These are errors made by the warehouses or forwarders with the result that the customer receives the wrong product or quantity or that the product is damaged.

- *Stock Cleanse, STO* – These are negotiated returns mainly from a distributor where usually a large volume of products are returned in order to keep the stock up to date, hence, there has been no complaint.

- *Customer Error Report, CER* – These are errors made by the customer where the customer has ordered the wrong product or the wrong quantity.

- *Technical Error Report, TER* – These are returns due to technical failures of the product which can be discovered when the product arrives or when the customer has started using the product.

Responsibilities
The *sales unit* is responsible for:

- Approving all customer returns
- Registering the returns into the return database

The *customer* is responsible for:

- Using the appropriate packaging to pack and ship the goods with the proper documents

The *return point* is responsible for:

- Cross docking of return goods to the regional collection point (SER, DER, CER, STO)
- Cross docking of return goods to PDIV (TER)

The *regional collecting point* is responsible for:

- Receiving the goods from the customer
- Visually inspecting the goods for damage
- Verifying the shipment against the documents
- Authorizing internal credit
- Ensuring that the goods are in resalable condition
- Scrapping of goods not fit for resale if approved by the customer
- Possibly shipping the goods to a final stocking point or re-stocking
- Inform the supply planners of return of goods

On behalf of the owning product division (PDIV) the *regional collecting point* has the exclusive right to decide if products should be:

- Repacked
- Technical inspected
- Restocked
- Scrapped or returned to the customer

The *owning product division (PDIV)* is responsible to:

- Decide if non planned items can be resold to other customers
- Execute technical inspection
- Repack if products need to be processed with special repack equipment/machine
- Supply the regional collecting point with packing material

The *stocking point* is responsible to:

- Stock approved returned products

Limits

No products under the value of 1000 SEK will be repacked. Instead these products are scrapped.

The PDIVs can decide not to technically inspect goods with a value under a certain amount. In Gothenburg for example, only goods packed in wooden boxes or plastic so called proof boxes will be forwarded to technical inspection.

Return rules

Rules for SKF errors:

- *SER:* The customer must contact SKF within 30 days. Once the return is approved by the sales unit the customer has 30 days to ship the product back. The customer will be credited 100% if the product is returned in the same condition as received. If packaging or goods are damaged as a result of customer handling, a reduced credit or no credit will be given. Logistics costs related to the return will be charged to the sales unit.

- *DER:* The customer must contact SKF within 30 days. Once the return is approved by the sales unit the customer has 30 days to ship the product back. The customer will be credited 100% if the product is returned in the same condition as received. If packaging or goods are damaged as a result of customer handling, a reduced credit or no credit will be given. Logistics costs related to the return will be charged to the shipping warehouse.

- *TER:* The customer must contact SKF within the warranty period. Once the return is approved by the sales unit the customer has 30 days to ship the product back. The customer will be credited 100% if the product is returned in the same condition as received. If packaging or goods are damaged as a result of customer handling, a reduced credit or no credit will be given. Logistics costs related to the return will be charged to the PDIV.

Rules for customer errors:

- *CER:* The customer must contact SKF within 30 days. The sales unit decides if the return is approved. If so the customer has 30 days to ship the product back. The customer will be credited according to local policy if the product is returned in the same condition as received. If packaging or goods are damaged as a result of customer handling, a reduced credit or no credit will be given. It is strongly recommended that all handling costs are passed on to the customer.

- *STO:* Stock cleansing is part of an agreement with the customer. Once the return is approved by the sales unit the customer has 30 days to ship the product back. The customer will be credited according to local policy if the product is returned in the same condition as received. If packaging or goods are damaged as a result of customer handling, a reduced credit or no credit will be given. It is strongly recommended that all handling costs are passed on to the customer.

Crediting
Before a customer can be credited, SKF needs to inspect the goods to determine the amount to be credited. SKF have had troubles with long return handling credit lead times to the customer and much of this lead time have been a consequence of the transportation of the product to a regional collection point, for example the European collecting point, ECP, in Tongeren. The products have been sent to this collection point for inspection and the customer has not been credited before the inspection has been performed. This process has resulted in credit lead times up to several months. Due to these long lead times, different parts of SKF have changed the return handling process in order to serve the customers better. The customer returns can be divided into different processes based on the different types of errors and depending on the type of error the crediting is now performed differently:

Crediting for SKF errors:

- For *SER*, *DER* and *TER*, which logically are credit lead time critical, the customer is credited as soon as the goods are received at the return point. The products are then sent to the European collection point, ECP, for inspection. The time between when the goods are received at the return point until the customer is credited is about one day.

Crediting for customer errors:

- For *CER*, the product needs to be inspected before any credit can be given to the customer and the credit lead time to the customer is the time until the goods are inspected at ECP.

- For *STO*, where SKF accepts to buy back part of the stock from the customer, the credit lead time is not as critical and can take up to months. The lead time for stock cleansing is in general longer because it might be difficult and time consuming to identify the product and connect it to an order (which might be issued several years ago).

One possible problem in the return handling process that can occur is returns which *cannot be identified*. When this happens, a lot of work is required at SKF in order to identify which delivery that is coming back, what it includes, and which invoice it belongs too. It is also necessary to identify both what have happened to the goods and who is responsible for the damage. This might in some cases lead to a conflict between the customer and SKF, with long lead times as a result. The question is where SKF's responsibility ends and where the customer's responsibility begins.

4.1.2 Return handling logistics

The logistics activities at SKF are carried out by SKF Logistic Services, SLS, which is an independent business unit within SKF. SLS provides services as warehousing, transport management, customs, consignment and stock handling for long distance suppliers, and factory logistics. The services are mainly offered internally at SKF but also to external customers. SLS also performs value added services such as kitting and assembling product packing, labelling, reverse logistics, VAT represents, and vendor managed inventory (SKF intranet 2011).

The daily transport system
One part of SLS's business is the European daily transport system, DTS, which is the road transport network operating in Europe. A picture of SKF's current structure for the forward logistics supply chain in Europe can be viewed in figure 10.

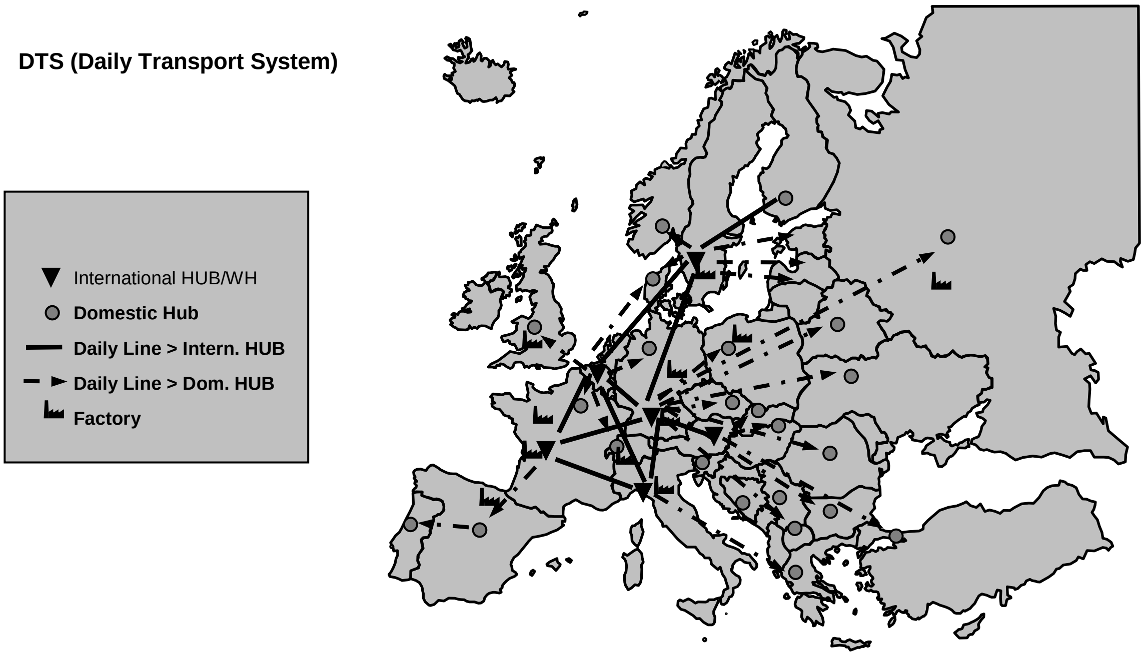


Figure 10, SKF's forward logistics daily transportation system

In the picture, the solid lines represent the transports between the international hubs/warehouses in Tongeren, Schweinfurt, Airasca, St Cyr, and Gothenburg. Between these hubs the transports are daily and operated in both directions. The trucks usually have a high fill rate.

SLS return handling

SLS handles the returns after they arrive at one of the return points mentioned as international hubs in the previous section. The transport from the customer to the return point is in Europe usually handled by an external freight forwarder that provides an economy parcel service. After this first transport the return enters the SLS network and from here on SLS is responsible for transportation, administration, sorting, and storing. SLS is charging a fixed cost per return order line to the unit responsible for the return.

4.1.3 Different divisions and product platforms

The SKF products are organised into different product categories and categorised into the platforms; *Seals*, *Bearings and Units*, *Lubrication systems*, *Mechatronics*, and *Service* (see figure 11). As mentioned in chapter 1.1.2, SKF is also divided into the three divisions; *Automotive division*, *Industrial division*, and *Service division.* The three different divisions can serve their corresponding customers with products from all platforms.

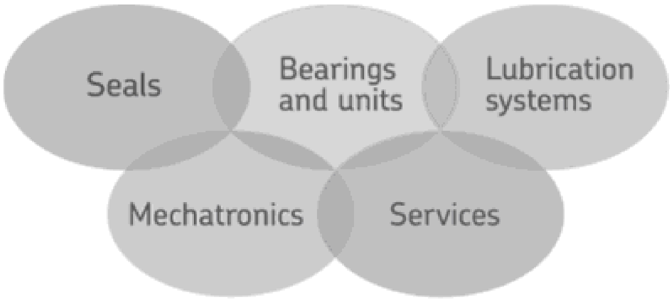


Figure 11, SKF's platforms (SKF Intranet 2011)

Division differences

The *Automotive division* could be seen as the most lead time critical division with a lot of original equipment manufacturers, OEMs, as customers. For these customers the products from SKF are going straight into their production and in many cases these customers practice a just in time concept and keep minimal stock. For the automotive division, the most critical part is to quickly arrange a replacement product and the credit lead time is secondary.

The *Industrial division* can be considered as the second most lead time critical division with some OEM customers.

The *Service division* can be considered as the least lead time critical division since many products are used for maintenance and usually put on stock. However, there are exceptions where the customers in the service division are lead time sensitive, for example in projects when many different resources are planned to a specific time.

Platform differences

The return handling process at SKF is mainly set up for the bearing platform where the process with specified return numbers and return labels is well defined. For the other platforms the procedures differ and are in many cases not clearly defined. Some platforms or business units have set up their own return handling process and one of those business units is the *Vehicle service market.* This unit will be presented in the section below.

Vehicle service market

The vehicle service market, VSM, business unit is an aftermarket business unit within the automotive division. VSM serves three different segments; product kits to distributors, direct bulk supply to OEM customers, and direct bulk supply to competitors. The main part, about 75%, is product kits to distributors. The VSM business unit has its own sales units all over the world and within Europe basically one in each country.

The VSM business unit has around 6000 different products stocked at EDC and these products are per definition planned items. EDC is the only location where VSM products are stocked, and the products are shipped to EDC directly from the four different production sites in St Cyr (France), Poggio Rusio (Italy), Gothenburg (Sweden) and Singapore City (Singapore). When products are sold in bulk to OEMs or competitors, the products are sent directly from an international warehouse but the sales unit is still VSM.

One part that is unique with the VSM business unit in comparison to the other business units within SKF is that the VSM business unit delivers 90% of the market assortment to the distributors and therefore also has to buy products from competitors and repack these products in SKF boxes.

A separate return handling process

The VSM business unit has a separate return handling process which was built up because the regular return handling process was too expensive. The return handling project ran for about 9 months and was implemented in July 2004. The regular return handling process charges a cost based on order lines and VSM has in general low quantities on each order line which causes a high cost per item. Another reason for the VSM business unit to develop its own process was that they believed that they were the best ones suitable for inspecting the returns. This is due to the fact that the products in many cases are kits containing both SKF made products and products bought from external suppliers. The later requires a slightly different quality perspective. After the parts (both SKF parts and external supplier parts) have been combined into a kit they are treated as a new product. The returns within the VSM unit are shipped either with SKF Logistic Services or via the customers own transports depending on the agreement with the sales unit.

For the VSM business unit all the returns within the category stock cleansing, STO, are sent directly from the customers to the return handling centre in St Cyr. The return handling area is within the same site as the packaging operations for VSM. The return handling process is set up with different procedures compared to the regular return handling process and a somewhat different terminology is also used. The STO returns from the distributors are limited to 2% of the product value. The sales units can accept more returns but then the sales units themselves have to take the extra costs. The sales units are credited 50% of the product value. Both the VSM sales units and the VSM factories are in the same business unit and it has therefore been easier to establish rules and policies which are followed.

The STO returns within VSM in Europe, which is mainly Western Europe because the service division sells VSM products in Eastern Europe, had the value of 5.4 million SEK in year 2010. This corresponded to 0.6% of the sales volume and 8000 order lines with 32000 items. Notably to consider is that these figures only represents the product kits to distributors. There are no dedicated people working only with return handling as the returns arrive sporadically. The production manager takes experienced people from his team to support the return activities. With both the checking and administration this approximately corresponds to 1.5 to 2 man years.

The DER returns for the loose bearing are sent to the warehouse which shipped them to the customer. This could be for example EDC and in this case the goods are sent back to ECP. If the goods are sent from another warehouse like for example Schweinfurt or Airasca the goods are sent back to this warehouse. The receiving warehouse registers the return using the customer complaints database routine for loose bearings. In the case of a kit, they are sent back to the VSM returns centre in St Cyr. If the return is a kit the customer is asked to accept the product and if not return it with the STO agreement. The quantity of DER is low.

The amount of SER is limited and corresponds to less than 12 returns a year in Europe. If the SER return is an item the customer usually orders the customer is asked to accept the product and if not return it with the STO agreement. If the customer does not keep the product it is returned to the warehouse where it was delivered from using the customer complaints database routine (for loose bearings rather than kits). If it is a kit the one off returns process is used and the return is sent to the VSM returns centre in St Cyr.

The TER returns are handled by each sales unit. They apply a rule called “No quibble complaints” which means that the value is to low for the goods to be returned. The customers advice the details of the return either into the VSM “No quibble database” or via manual paperwork and instead of returning the goods, the customers are told to keep the goods for two months so that the sales unit can make random inspections at the customers. After the two months the customers can scrap the goods. Credits to the customers are usually raised within 5-10 days on the “No quibble complaints”.

CER returns are usually handled as described in the SER procedure. For large returns where the pallets have not been opened, the VSM returns centre is always asked if they wish to receive the goods or if the goods could be sent straight to the EDC. However, the returns are usually sent to the return centre so the personnel can guarantee that the kit consists of the correct components.

There are currently no discussions or projects running to change the return handling process and the current process is considered to be good. In the past, there have been discussions about whether the 2% STO limit is enough or not and some competitors are allowing a higher percentage. However, this has not been discussed recently and the main perception today is that this limitation is sufficient.

4.1.4 The regional collecting point, RCP

Tongeren is located in the east of Belgium. Here, both the European collecting point, ECP, and the regional warehouse, RWH, are located. The regional warehouse in Tongeren is called EDC (European distribution centre) and is positioned in a building approximately one kilometre from the ECP. According to the policy, all SKF's returns except technical error returns, TER, are supposed to pass by the ECP. The returns arriving at the ECP are either sent from a SKF facility handling returns or sent directly from a customer. In reality, not all returns except TER arrive at the ECP, but still the majority of the non-TER goods are sent via the ECP. At the ECP, three different return flows are handled:

1. Goods to put on stock
2. Goods to repack
3. Goods to send to technical inspection or channel repack

When visiting the ECP in Tongeren, the different steps in all three return flows were shown and described further by the personnel. The information has been compiled in flow charts (appendix 10.4.1-10.4.3).

Here follows a basic description of the return handling process at the ECP (also shown in figure 12: After receiving the goods, personnel at the ECP visually inspect the goods and decide to which one of the three flows the goods belongs. After taking this decision, the return is administrated. The administrative processes differ slightly depending on which flow the returned goods will follow – stock, repack or technical inspection/channel repack. After this step the three flows follow different paths. The *goods to put on stock* are sent to RWH (EDC) or to a factory warehouse, FWH. For the *goods in need of repack*, repack material is ordered and the goods are put in the repack waiting area. When the repack material is received the personnel first repack the goods and then send the goods to RWH (EDC). The last flow, the *goods in need of technical inspection or channel repack*, are prepared for transport and sent to the owning PDIV.

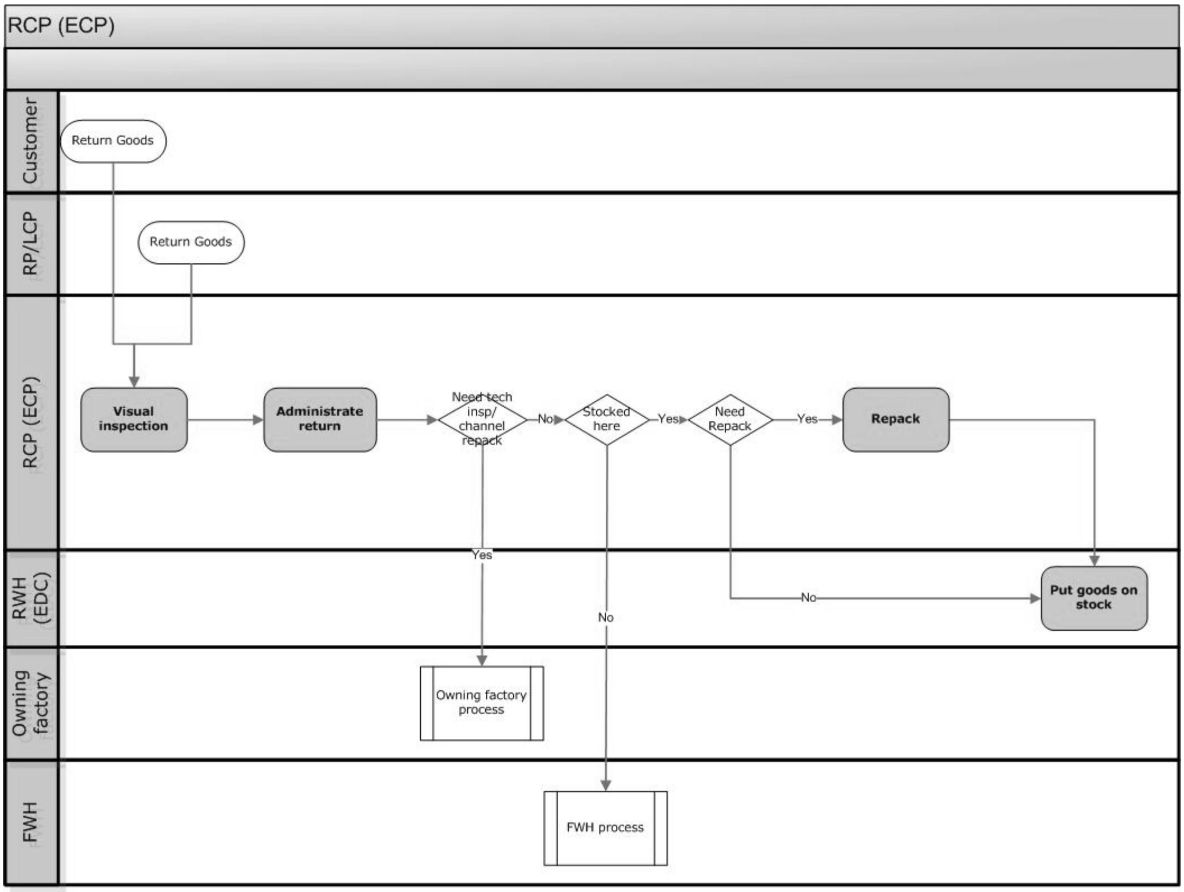


Figure 12, Return handling at RCP (EDC)

4.1.5 Local collecting points, LCPs

As mentioned above there are four different factory warehouses acting as return points; Schweinfurt, Airasca, St Cyr and Gothenburg. According to SKF's return handling policy the return points are only supposed to cross dock returns to either the regional collecting point or, in case of a TER, to a PDIV. However all the above mentioned return points do additional activities such as visual inspection and administration, and it happens that they also take decisions about the returns. Therefore these return points are more of the nature of collecting points, and from now on they will be referred to as local collecting points, LCPs, in this thesis.

All the sales units have been asked about where their customers are told to send their returns, that is to which LCP. The answers have been compiled in the chart below, figure 13. No sales units were found in Iceland, Luxembourg or Belarus and no answers were received from Greece or Russia. These countries are *black* in the figure. The *darkest grey* countries are the countries with LCPs, the *middle grey* countries are the counties sending their returns to a return point or a LCP in another country and the *lightest grey* countries are the countries sending their returns directly to the ECP.

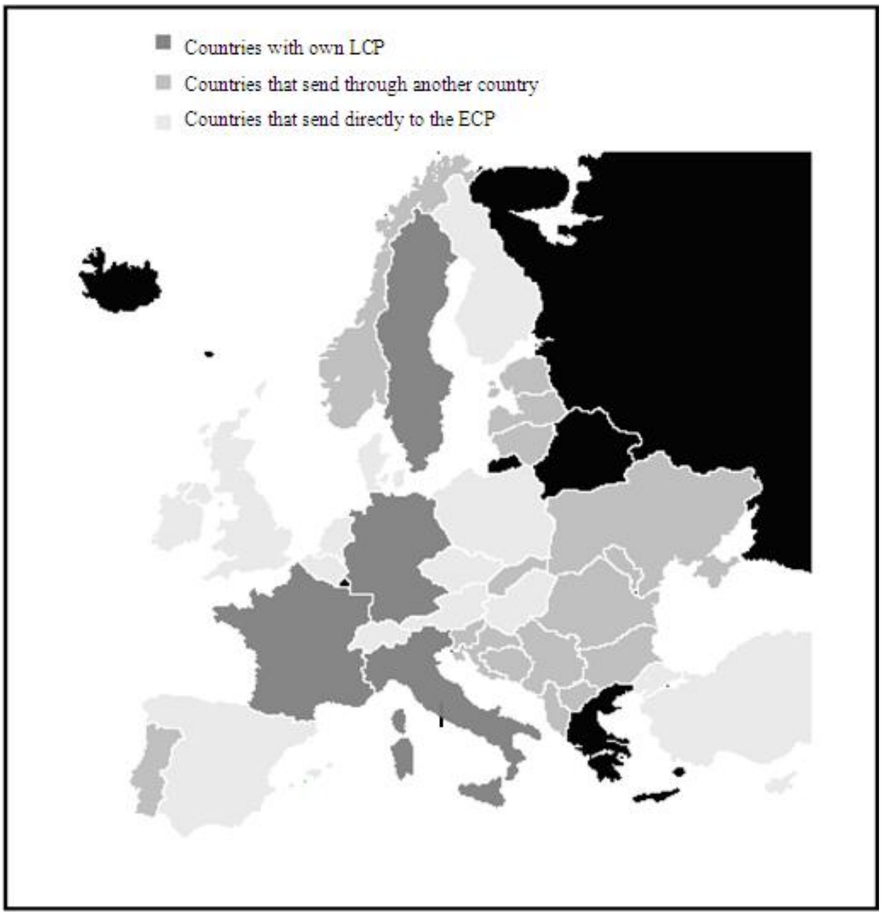


Figure 13, Return areas

Among the middle grey counties Norway send their returns to Gothenburg, Portugal send their returns to a return point in Spain and all the others (the Eurotrade countries) send their returns to Schweinfurt.

To the local collecting points both administrative and technical error returns are sent. The returns can be sent either from a customer within the area in question or from a customer outside the area in question (in this case forwarded by the European collecting point if it is an administrative error return or forwarded by another local collecting point if it is a technical error return). Yet another aspect is that the returned goods can either have been produced at a product division within the area in question or outside the area in question. Two small tables summarize all the alternatives:

ADMINISTRATIVE ERROR RETURNS	**PDIV within area**	**PDIV outside area**
Customer within area	*Alt. A*	*Alt. B*
Customer outside area	*Alt. C*	*Alt. D*

Table 2, Administrative error returns to a LCP

TECHNICAL ERROR RETURNS	PDIV within area	PDIV outside area
Customer within area	*Alt. E*	*Alt. F*
Customer outside area	*Alt. G*	*Alt. H*

Table 3, Technical error returns to a LCP

Since no returns are forwarded to an area where the products are not produced alternative D and H can be removed from the matrixes. In addition to this, alternative A and B should both be handled in the same way according to SKF's return handling policy. All administrative returns sent directly from a customer should be forwarded to the European collecting point no matter where the products were produced. But since the return handling policy is not always followed (sometimes a local collecting point decides to keep their own products) it is not possible to totally merge these two alternatives into one. But finally, alternative E and G can be totally merged. All technical error returns arriving at a local collecting point where they belong are handled there no matter who sent them. With this information in mind the tables can be updated and renumbered:

ADMINISTRATIVE ERROR RETURNS	PDIV within area	PDIV outside area
Customer within area	*Alt. 1A*	*Alt. 1B*
Customer outside area	*Alt. 2*	-

Table 4, Administrative error returns to a LCP

TECHNICAL ERROR RETURNS	PDIV within area	PDIV outside area
Customer within area	*Alt. 3*	*Alt. 4*
Customer outside area	*Alt. 3*	-

Table 5, Technical error returns to a LCP

Here follows descriptions of how each local collecting point more specifically handles the returns:

Schweinfurt, Germany

Schweinfurt is located in the middle of Germany, approximately 175 kilometres east of Frankfurt. In Schweinfurt SKF has several factories (PDIVs), a LCP and a factory warehouse (FWH). Goods produced at factories in Germany and Austria is stored in the factory warehouse in Schweinfurt. Since the local collecting point in Schweinfurt does not always follow the policy both alternative 1A and 1B exist. The different return flows are as follows:

- 1A. Administrative error returns from customers within the area. PDIV within the area.
- 1B. Administrative error returns from customers within the area. PDIV outside the area.
- 2. Administrative error returns from customers outside the area. PDIV within the area.
- 3. Technical error returns from any customer. PDIV within the area.
- 4. Technical error returns from customers within the area. PDIV outside the area.

When visiting the LCP in Schweinfurt, the different processes in all return flows were shown and described further by the personnel. The information has been compiled in flow charts (appendix 10.5.1-10.5.3).

Here follows a basic description of the flows (also shown in figure 14):

Flow number 1A is administrative error returns from a customer within the area, where the owning PDIV is also located in the area. After the returns are received they are visually inspected. After this inspection they are administrated and finally prepared to be put on stock, repacked and put on stock, scrapped or sent back to the customer.

Flow number 1B is administrative error returns from a customer within the area, where the owning PDIV is not located in the area. After the returns are received they are visually inspected. After this inspection they are administrated, prepared for transport and shipped to the European collecting point, ECP, in Tongeren.

Flow number 2 is administrative error returns from customers outside the area. These returns have been forwarded by the European collecting point, ECP, in Tongeren. In this case the owning PDIV is in the area. After the returns are received they are visually inspected. After this inspection they are administrated and finally prepared to be put on stock, repacked and put on stock, scrapped or sent back to the customer. This is the same procedure as for flow number 1A except for the administration which is carried out differently.

Flow number 3 is technical error returns from any customer (may or may not have been forwarded from another local collecting point) where the owning PDIV is in the area. After the returns are received they are visually inspected. After this inspection they are administrated and finally prepared for transport to the PDIV in Schweinfurt.

Finally, *flow number 4* is technical error returns from customers within the area where the owning PDIV is not in the area. In this case the returns are received, visually inspected, administrated and finally prepared for transport to the owning PDIV, which may be any PDIV except Schweinfurt.

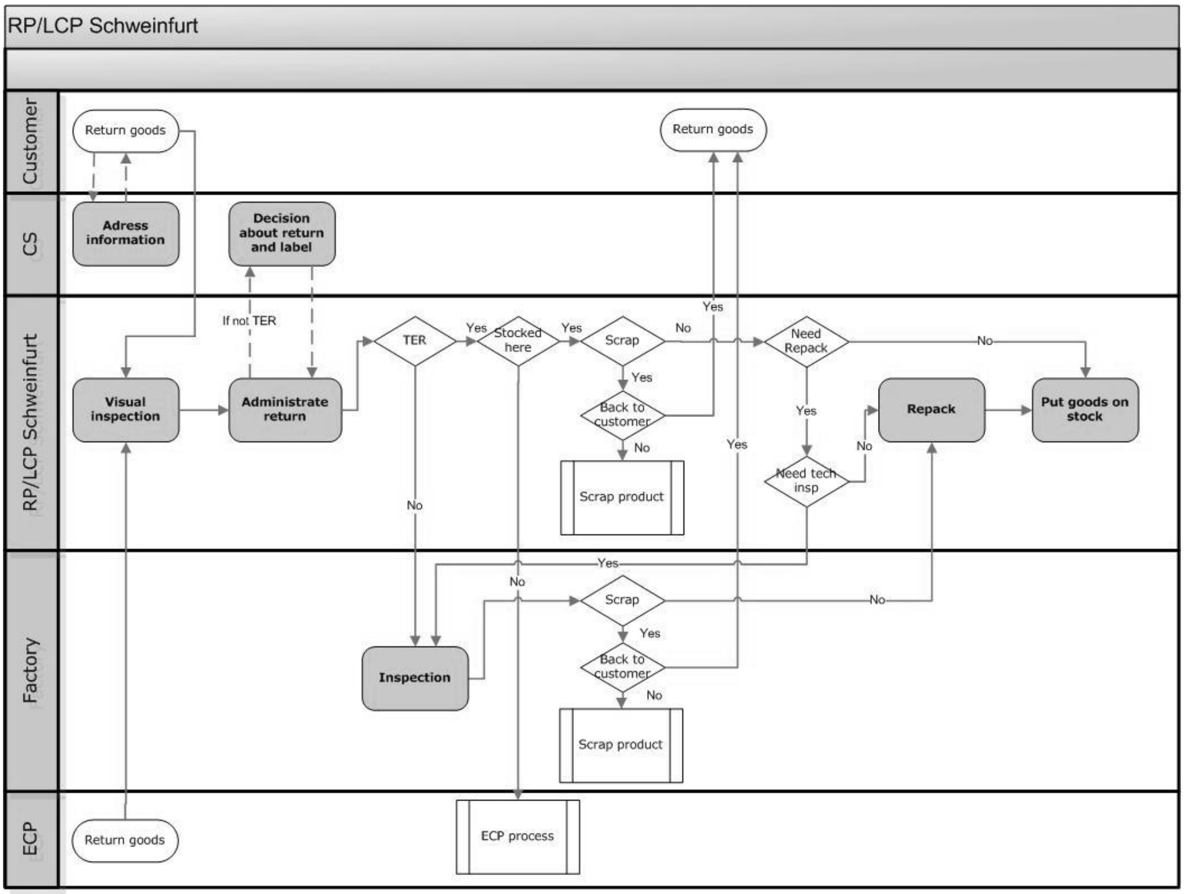


Figure 14, Return handling in Schweinfurt

Airasca, Italy

Airasca is located outside Torino, in the northwest of Italy. In Airasca SKF has a factory (PDIV), a LCP and a factory warehouse (FWH). Since the local collecting point in Airasca follows the policy four strictly different return flows are handled, hence there is no alternative 1 a and 1 b. The different return flows are as follows:

1. Administrative error returns from Italian customers. PDIV anywhere.
2. Administrative error returns from non Italian customers. PDIV Italy.
3. Technical error returns from Italian and non Italian customers. PDIV Italy.
4. Technical error returns from Italian customers. PDIV not Italy.

When visiting the LCP in Airasca, the different processes in all four return flows were shown and described further by the personnel. The information has been compiled in flow charts (appendix 10.6.1-10.6.4).

Here follows a basic description of the flows (also shown in figure 15):

Flow number 1 is administrative error returns from Italian customers, where the owning PDIV can be any PDIV, including the PDIV in Airasca. After the returns are received they are prepared for transport and shipped to the European collecting point, ECP, in Tongeren.

Flow number 2 is administrative error returns from non Italian customers that have been forwarded by the European collecting point, ECP, in Tongeren. In this case the owning PDIV is Airasca. After the returns are received they are visually inspected. After this inspection they are administrated, prepared for transport and transported either to the stocking area, to the repacking area or to the PDIV. All these three destinations are in Airasca. The PDIV can decide to scrap a return or, if the customer wants the return back, send it back to the customer.

Flow number 3 is technical error returns from Italian customers and non Italian customers (may or may not have been forwarded from another local collecting point) where the owning PDIV is Airasca. Directly after the returns are received they are prepared for transport and transported to the PDIV in Airasca.

Finally, *flow number 4* is technical error returns from Italian customers where the owning PDIV is not Airasca. In this case the returns are received, directly prepared for transport and thereafter shipped to the owning PDIV, which may be any PDIV except Airasca.

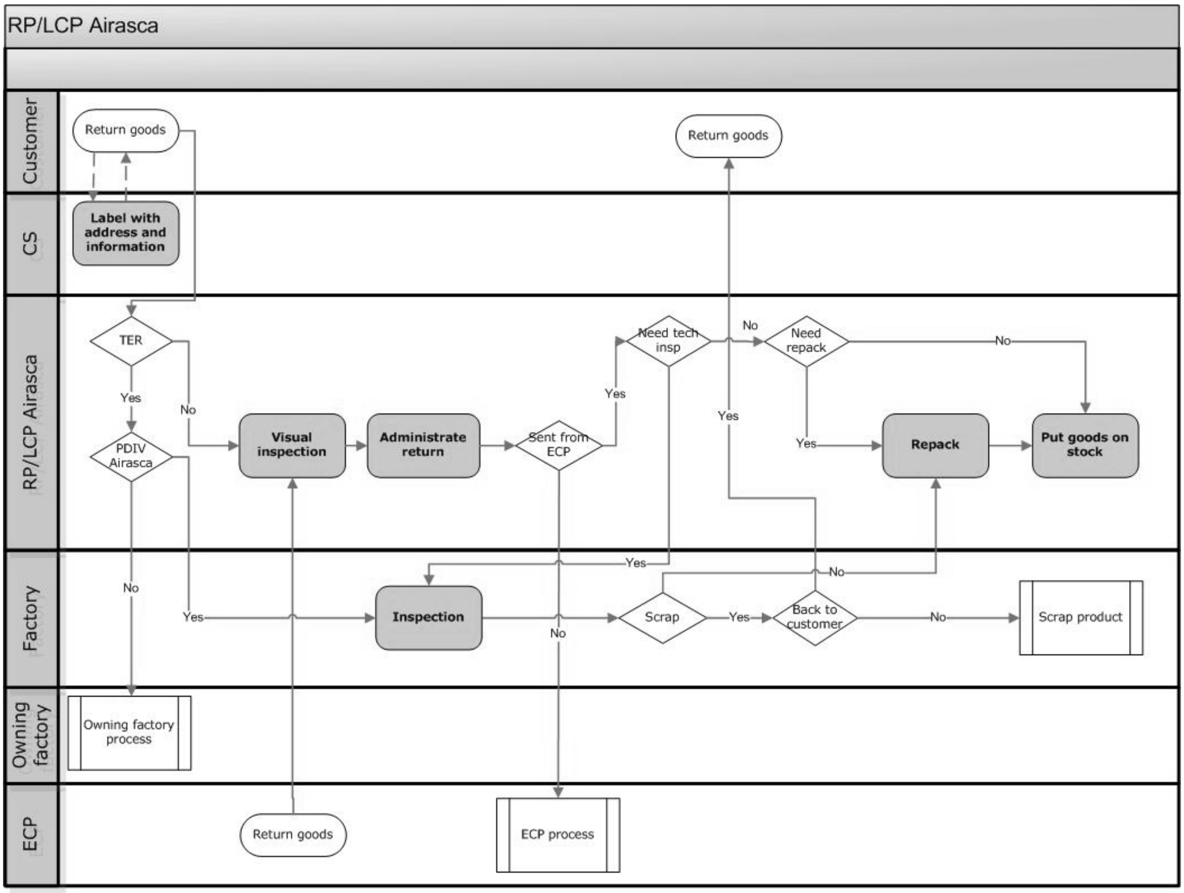


Figure 15, Return handling in Airasca

St Cyr, France

St Cyr is located in France, south west of Paris. No site visit was made here due to time restrictions and therefore it is not possible to describe the return handling flows in St Cyr in this thesis. A basic picture of the flows is shown in figure 16 though. This picture is the result from previously done studies at SKF.

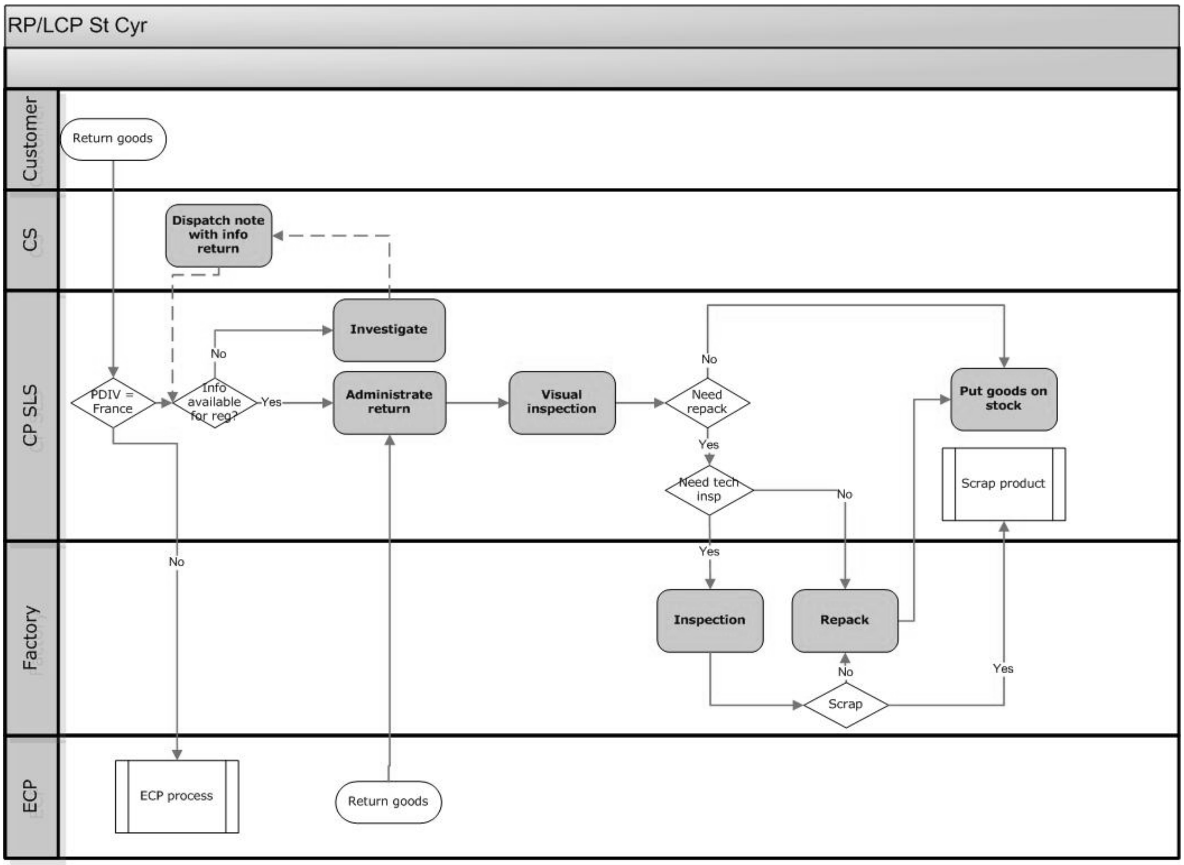


Figure 16, Return handling in St Cyr

Gothenburg, Sweden

Gothenburg is located on the west coast of Sweden. In Gothenburg SKF has factories (PDIV), a LCP and a factory warehouse (FWH). In Gothenburg all returns marked as technical errors, TER, are only cross docked at the LCP before reaching the PDIV. Hence, the return handling at the LCP only handles administrative error returns. For the administrative error returns the policy is followed and there is only one alternative 1 (not 1 a and 1 b). The return flows are as follows:

1. Administrative error returns from customers within the area. PDIV anywhere.
2. Administrative error returns from customers outside the area. PDIV within the area.

When visiting the LCP in Gothenburg, the different processes in the two return flows were shown and described further by the personnel. The information has been compiled in flow charts (appendix 10.7.1-10.7.2).

Here follows a basic description of the flows (also shown in figure 17):

Flow number 1 is administrative error returns from customers within the area, where the owning PDIV can be any PDIV, including the PDIV in Gothenburg. After the returns are received they are visually inspected. After this inspection they are administrated and prepared for transport and shipped to the European collecting point, ECP, in Tongeren.

Flow number 2 is administrative error returns from customers outside the area that have been forwarded by the European collecting point, ECP, in Tongeren. In this case the owning PDIV is Gothenburg. After the returns are received they are visually inspected. After this inspection they are administrated and either put on stock, repacked and put on stock, scrapped or sent to lab for further inspection. The lab is also located in Gothenburg. The lab can decide to scrap the return or send it back to the LCP for repack or to a waiting area before channel repack. In the case of channel repack the LCP sends the return to the PDIV when they are ready. After repack or channel repack the goods is put on stock by the personnel at the LCP.

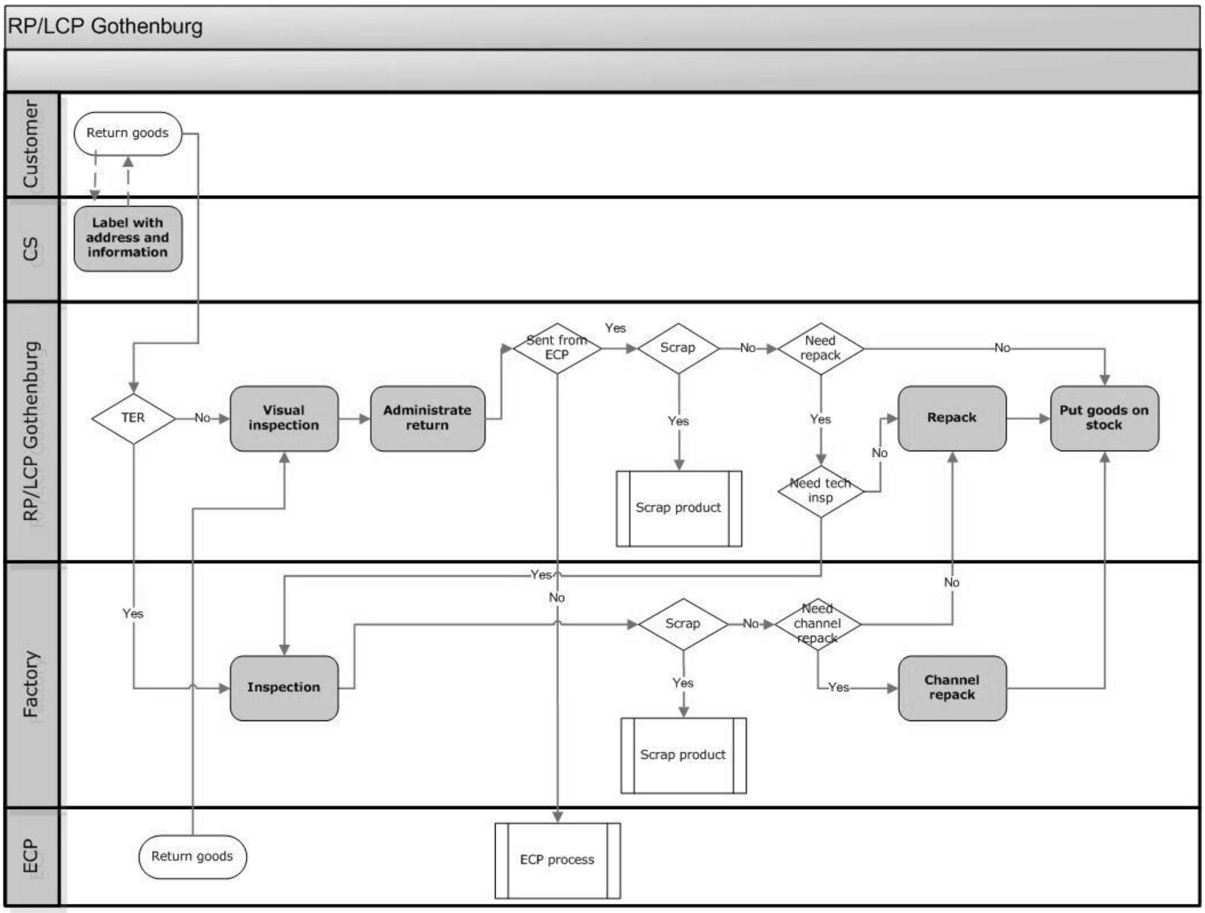


Figure 17, Return handling in Gothenburg

Summary of the differences between the local collecting points, LCPs

When visiting the LPCs it was possible to see that there were both similarities and differences between them. Here focus is on the differences and a compiled list of the most striking ones has been made:

- In Schweinfurt the returns are registered in a local access database, while in Airasca and Gothenburg there are no registers.
- When administrating returns in Schweinfurt the personnel contacts the sales unit and the sales unit takes a decision about the return before a return label is sent. In other European countries the sales unit sends the return label directly to the customer.
- In Schweinfurt returns produced in the area (in Germany or Austria) are usually kept and not sent to ECP.
- In Schweinfurt one person is dedicated to work with the return administration, and another person works with the physical handling. In the other LCPs the same person handles both.

- TER never reaches the return handling in Gothenburg since these returns are directly cross docked and forwarded to the PDIV.

- According to the personnel in Airasca they do not visually inspect the ADM returns before sending them to ECP. In the other LPCs they do.

4.2 Return handling value stream maps

Value stream maps were made for the European collecting point in Tongeren and for each one of the local collecting points in Schweinfurt, Airasca, and Gothenburg.

The aim in the beginning of the thesis was to not only map the physical flow, but also the informational flow. After visiting the first local collecting point, Airasca, time was dedicated to this mapping but it was difficult to get the arrows right. This is due to the fact that the informational flow is not carried out in a structured way and it can be performed differently from time to time. In addition there are also differences between different people handling returns. Therefore a decision was taken not to spend any more time on this – the knowledge that the informational flow is carried out in a non-structured way is enough. And anyhow, the informational flow will change with a new return handling structure.

Due to confidentiality issues it is not possible to present the value stream maps in this report, but they have been compiled and can be viewed by the company. Although one example, where the actual times have been erased, is shown in figure 18. This example shows the return flows “Put on stock” and “Repack” for the European collecting point in Tongeren.

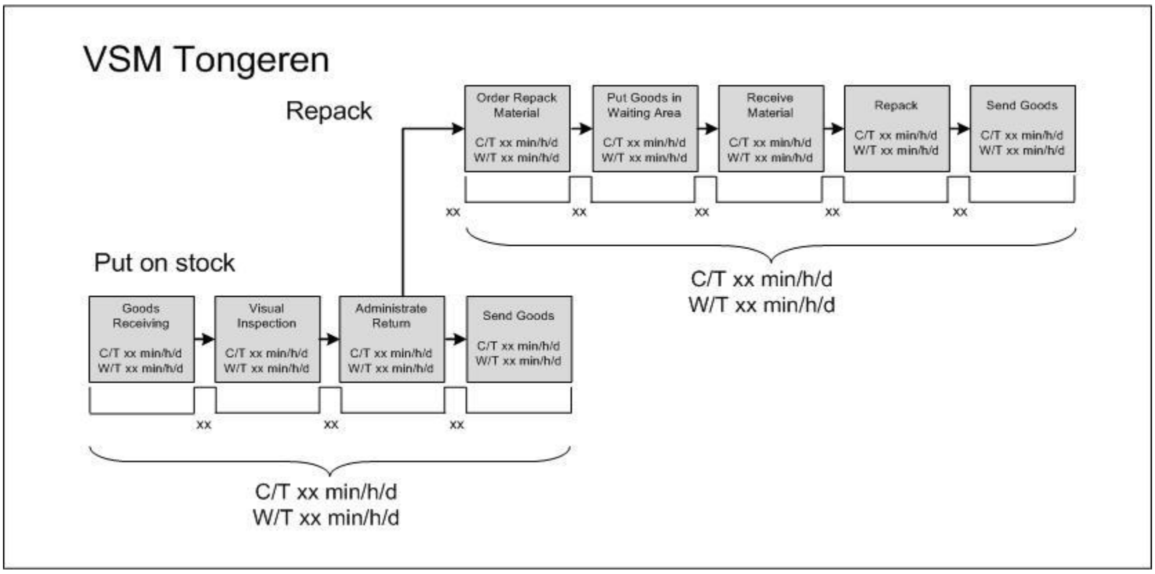


Figure 18, VSM for two flows in Tongeren without times [1]

[1] Figures have been censored in the report but are presented to SKF and are available for the supervisor at Chalmers

Even though it is not possible to show the value stream maps, general information from them can still be presented. When viewing the maps it is feasible to see that:

- There are differences between the local collecting points in terms of return flows, processes within the flows, cycle times and waiting times.
- The waiting times dominates and are by far longer than the actual time a return is handled.
- The time variation within a site for a specific return flow can be immense.
- Each time a returned item enters a local collecting point or the regional collecting point it takes a significant amount of time. This is true even in the cases when the item is not taken care of at the actual location but forwarded to another destination.
- Repack is done faster at the local collecting points compared to the regional collecting point.

4.3 Return handling data

This chapter will present the empirical findings from the quantitative data collection from several different SKF databases. The first database that is presented is the Customer Return Processing database which is the main database recording the returns at SKF. Second, data from additional local databases will be presented, both from the ECP and from the different LCPs. Finally, the chapter concludes with a cost analysis comparing different return handling structures based on the data extracted from the previous mentioned databases.

Most of the values in this data presentation are measured in performance standard cost, PS or PS cost, which is the SKF measure of standard cost. The standard cost and the performance standard cost are the same even if one product is produced at multiple locations; in this case the performance standard cost corresponds to the standard cost at the factory with the highest volumes produced of the specific product. The PS cost is used as a measure in this thesis because it gives a good overview of the returns. In addition, the PS cost in many cases correlates to the dimensions and weight of the product. When comparing different return flows the best way is to compare the total PS costs, instead of comparing for example the quantities. This is due to the fact that the value, weight and dimensions vary between different products.

4.3.1 Customer Return Processing database

The data collection from the Customer Return Processing database has served as the main contribution to the quantitative data collection. The Customer Return Processing database is a global SKF database where all returns except the return type TER are recorded. The data in the database is divided upon the three RCPs, representing the regions Europe, America and Asia. The data relevant for this thesis is the data corresponding to the European collection point, ECP.

General about the database

When a customer contacts the sales unit to make a return, the sales unit representative starts up a return case by first identifying the original order in SKF’s system for customer order handling, COH. When the original order is identified, a matching return record is created in the Customer Return Processing database. The sales unit representative registers the product designation, the quantity, and the error type reported by the customer. An exception from this is when it is not possible to connect the return to a specific order in COH, and then the information regarding customer number, pack code, and the country of manufacturing needs to be filled in manually.

When the returned goods arrive at the ECP, the same database is used to process the return. Here information about the arriving product designation, quantity, and condition is added in the database. Sometimes this information differs from the information originally entered by the sales unit representative. Based on the condition of the product, a decision is taken at the ECP whether the product is in a good condition and can be put back to stock, in a good condition but need repack before it can be put back on stock, or if the condition is unknown and the product needs to be sent for technical inspection at the belonging PDIV. This information is also added in the database.

An extraction was made from the Customer Return Processing database for the years 2008, 2009, and 2010 for the returns belonging to the ECP. The first extraction that was received only contained the information provided by the sales unit and not the additional information added at the ECP. In other words, no information about what happened with the return after the visual inspection at ECP was included. Therefore, a new extraction containing all the required information was ordered. The new extracted excel file lists the returns with return ID, customer name and number, designation, quantity, product value, SKF division, date, return reason etc.

Modification

In order to compile the desired statistics from the Customer Return Processing database, some data from additional sources have been added. The added data consists of corresponding sales unit, PS cost, and currencies for conversion to a common currency, in this case Euro.

For some of the return order lines information about the sales unit were included. For the rest of the lines, this information had to be added. Each return in the database has a specific return ID number where the first four digits are corresponding to a sales unit and this information was used to add the sales unit for the return lines where the sales unit was missing. These numbers were looked up in the ERP list found in the code master database.

A majority of the return order lines contained the PS cost for the designation but for some lines the PS cost was missing. Therefore, an extraction of the PS cost was made from the SKF product database Prod Mast for all the designations occurring in the Customer Return Processing database. The PS cost was then added for the return lines where the PS cost was missing by crossing tables with the designation as a base.

The return lines are representing returns from not only European countries but also from countries in other continents. The PS cost for the return lines were given in local currency, and all lines not already expressed in Euro were therefore converted into Euro. The conversion factors used were based on the daily market exchange rates 2011-04-26 from the SKF intranet (SKF intranet 2011).

Error types

The error types handled at the ECP are STO, SER and DER. The proportions between these error types are illustrated in figure 19 below.

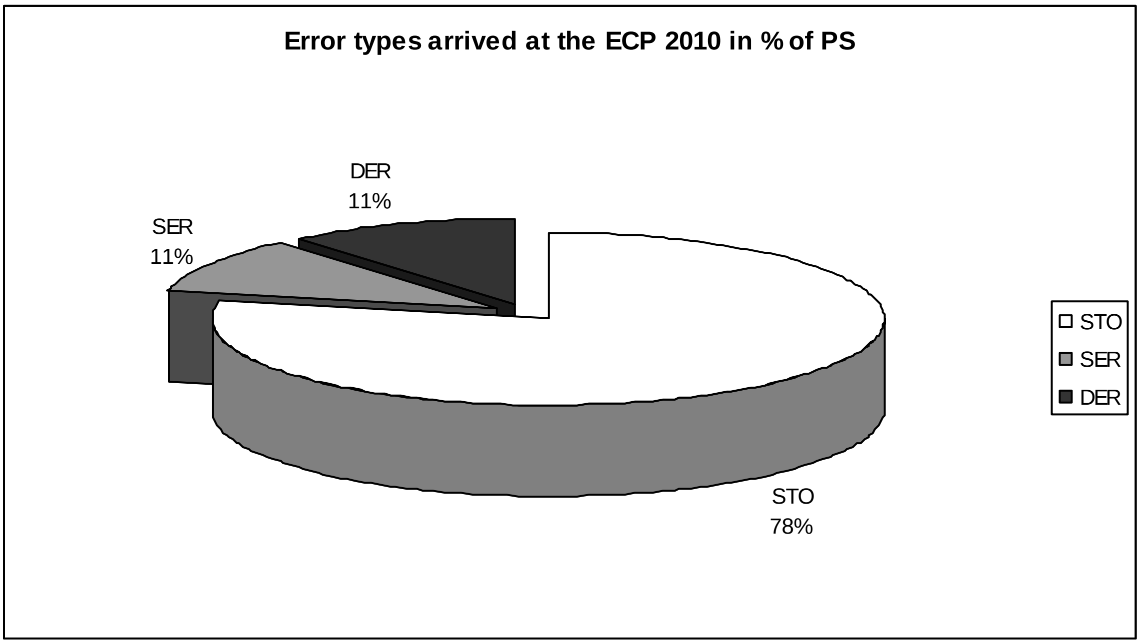


Figure 19, Error types at the ECP 2010

Pack codes

Most of the returns that were registered in the database were registered with the pack code 12 which means that it is a single packed product. Compared in terms of PS cost, the percentage of single packed items corresponded to about 77%.

Received returns compared to returns registered by the sales unit

The database consisted of three different types of lines; the original lines added by the sales unit that have not been amended, the original lines added by the sales unit that have been amended, and the new lines corresponding to the lines that have been amended. Lines where the field *Condition of the product* is blank have not been processed at the ECP (this was confirmed by personnel at the ECP). When a return is processed at the ECP, the lines' status in the field *Condition of the product* is put as "Amended". A new line is then automatically created. This new line contains the added information, such as received quantity and product designation. The new line also contains information about the condition of the product in the field *Condition of the product*.

In the database there are many lines not registered as "Amended" in the *Condition of the product* field after investigation. Only 35% of the number of returns was processed at the ECP. The percentage calculated in return order lines was 36. However, the share of quantity and PS cost handled at the ECP was significantly lower with 17 and 7%.

Condition of product

For the lines processed at ECP the field *Condition of the product* is set to one of the following; 0, 50, 100, TBD, or Scrap without credit note. This status indicates what credit note that has been given to the sales unit. 0, 50 and 100 stands for the credit note given in percentage, TBD stands for "To be determined", and Scrap without credit note is when the goods is scrapped with no credit note given to the sales unit. Here it is important to separate the credit note given to the sales unit and the final credit note given to the customer. If for example the sales unit is credited 0% the customer can still be credited 100%, but in this case the sales unit itself has taken the cost.

The *Condition of the product* also indicates what action that has been taken with the returned items. Returned goods with 100% credit note was goods in good condition that could be put directly back on stock. A credit note of 50% means that the goods either needed repack before it was put back on stock or that the goods needed technical inspection before it could be repacked and finally be put back on stock. A credit note of 0% was either sent to scrap or back to the customer. One example of when goods can be sent back to the customer is when the error is made by the customer (for example the customer ordered the wrong product) but the goods is not in a resalable condition when it arrives - and therefore no credit note will be given. In these cases the customer can choose to take the product back or tell SKF to scrap it. Figure 20 below illustrates the condition of the product in percent for all the returns that arrived at the ECP in the year 2010.

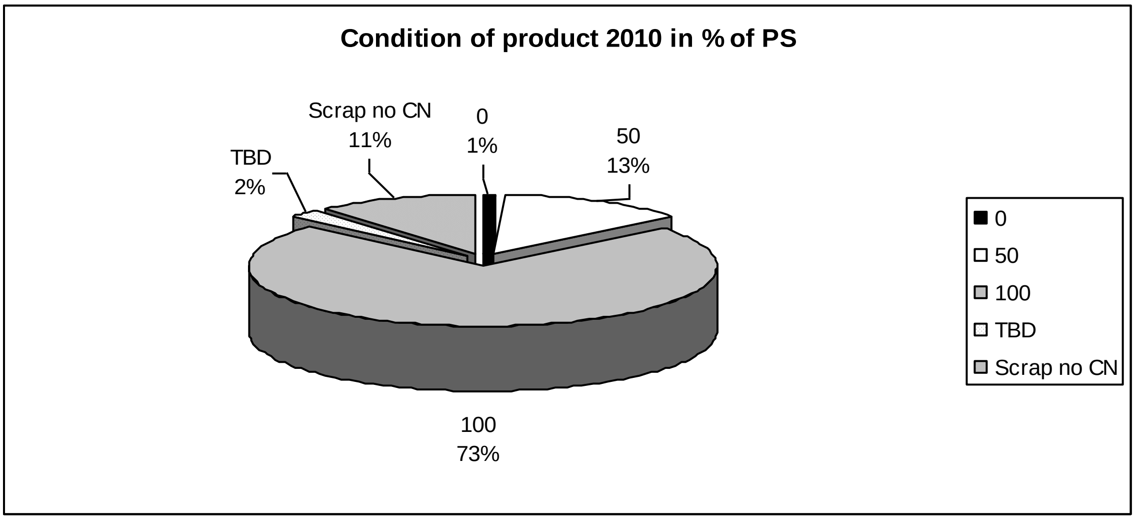


Figure 20, Condition of product 2010

Amount received from the sales units in each country

In figure 21 below the total amount of returns (in PS cost) that arrived at the ECP in 2010 from the sales units in the different countries are compiled.

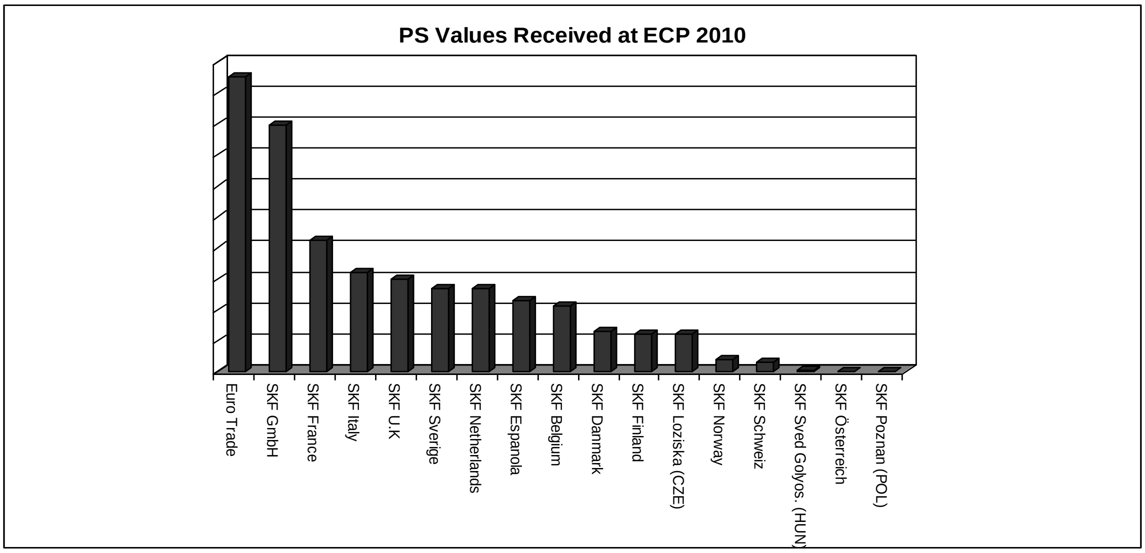


Figure 21, PS values received at ECP from different countries [2]

The amount of returns received from the different sales units are also shown in a geographical chart, see figure 22 below.

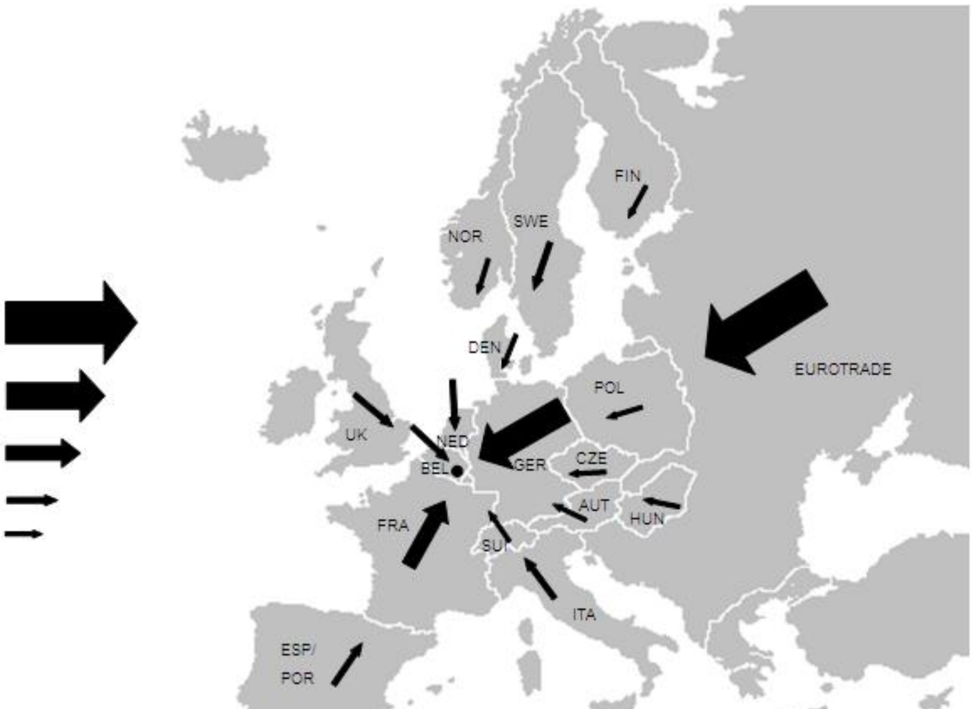


Figure 22, PS values received at ECP from different countries

[2] Figures have been censored in the report but are presented to SKF and are available for the supervisor at Chalmers

4.3.2 Data from local databases at the ECP

In addition to the data from the Customer Return Processing database, data from the ECP have also been received from two local access databases. One of these databases was used as a tool for registering the returns that needed to be repacked and to automatically send out emails to order packaging material. This database included dates for ordering and receiving packaging material, and by using those dates the lead time between order and delivery of packaging material could be calculated. The other database was used to register the returns that needed technical inspection or for some other reason needed to be sent back to the corresponding PDIV. This database was used to send out automatic requests for approval to send goods to the PDIVs.

Statistics

The average lead time for material delivery was calculated to XX[3] days in 2010. In 2009 this lead time was more than twice as long. These numbers represents the average for all packaging material orders and for all sending PDIVs. However, there are great differences between the different PDIVs, some differences which can be explained by geographical distances but also differences which are not as easy to explain. In figure 23 below the average lead times for the different PDIVs are shown.

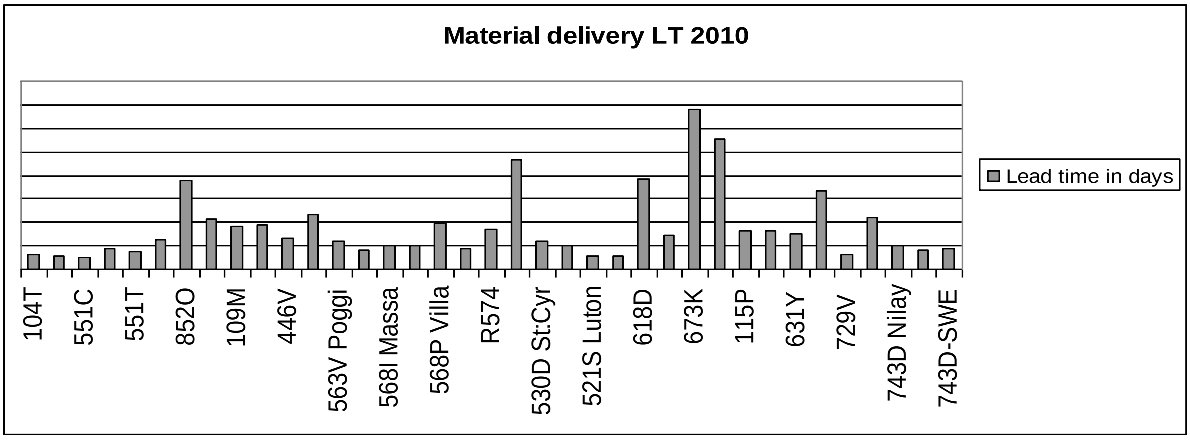


Figure 23, Material delivery lead time to ECP 2010 [3]

In these averages, lines with a lead time of zero are not included in the calculations due to the fact that the underlying reason is unknown. A lead time of zero could signify that the material already was available at the ECP but also that the material never arrived at the ECP.

4.3.3 Data from the Local Collecting Points

As already mentioned in the method (chapter 3.3.3), the only LCP that could provide data in a usable and electronically format was Schweinfurt. This is therefore the only data that will be presented in this section and the results are to be viewed as a case study more than a comparative analysis.

The Schweinfurt database

At the LCP in Schweinfurt, all returns processed were recorded in a local access database. The returns could be separated into administrative returns and technical returns and the following data statistics is based on the administrative returns for the year 2010. The database contained

[3] Figures have been censored in the report but are presented to SKF and are available for the supervisor at Chalmers

information about in what country the returning customers were located and this information was compiled into statistics of the returns received from each country. This information is presented in figure 24 below.

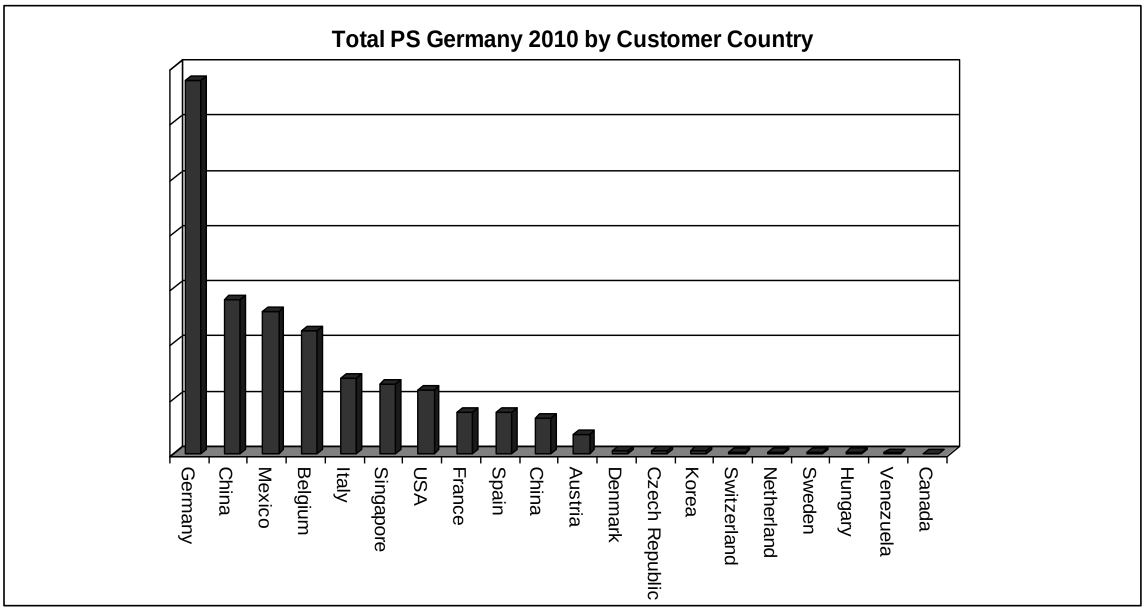


Figure 24, Returns sent to Schweinfurt in PS value [4]

The amount of administrative returns processed in Schweinfurt is large in comparison to the amount of returns processed at the ECP. The amount of returns processed at the ECP is larger but with consideration to the fact that the ECP should handle all the administrative returns in Europe, the amount of returns in Schweinfurt is still large. The returns processed in Schweinfurt corresponds to the following percentages of the returns processed at the ECP; 45% based on number of returns, 46% based on number of return lines, 60% based on quantity, and 99% based on PS cost. In other words, in terms of PS cost, the ECP and the LCP in Schweinfurt handles about the same amount of returns (it only differs by 1%).

The amount of returns received at the ECP from Schweinfurt has also been compared to the total amount of returns handled in Schweinfurt. This comparison reveals that only 19% of all the returns processed in Schweinfurt are sent to the ECP. The results from the site visits and process mapping in Schweinfurt show that returned products that can be stocked in the Schweinfurt warehouse are kept in Schweinfurt and this amount corresponds to the 81% that are not sent to the ECP.

The data in the Schweinfurt database contained information about start and end date of the return processing. The start date represents the date when the returns are visually inspected by the return handling personnel and given by the information from the process mapping this was generally done one day after the return arrived in Schweinfurt. The end date represents the date when the decision regarding the return is taken by the sales unit representatives. According to the process mapping, the return is usually taken care of the same day as the decision is taken. The average lead time between the start and end date for the administrative returns given by the data is XX[4] days.

---

[4] Figures have been censored in the report but are presented to SKF and are available for the supervisor at Chalmers

4.3.4 Transportation cost analysis

One important aim with the data collection was to investigate the costs associated with the return handling and also to be able to compare different return handling structures. One fundamental aspect in reversed logistics is as mentioned in the frame of reference (chapter 2.3.4 and 2.3.5) the centralised and decentralised structures. Based on the collected data from the Customer Return Processing database, a transportation cost analysis comparing these two structures could be conducted. This analysis was based on shipped returns that passed through the ECP during 2010 and with this information the transportation cost of sending the returns in a centralised versus a decentralised structure could be compared.

The necessary information from the database was; point of entry of the returns, the final destination of the returns, and the amount of returns in terms of weight. In addition to this, a standard cost for transportation per kilo for the different routs within the daily transport system, DTS, in Europe was received from SKF Logistic Services.

The sales units are usually country specific and therefore the entry points of the returns in the SKF network were given. For example, an order sold by the Swedish sales unit will always be returned by the customer to the return point in Gothenburg. The sales units included in the cost analysis are Sweden, Germany, Italy and France. This is due both to the fact that for these countries the point of entry is completely known and to the fact that transportation costs were given in both directions between these countries. For the other countries, the point of entry was not completely known (see chapter 4.1.5) and the transportation cost only existed for the reversed logistics. The remaining data used in the cost analysis corresponds to 23% (of the weight) of the total data in the year 2010.

The final destination was based on the information in the field "Condition of product" in the database. This field gives the information about whether the product was put back on stock, repacked, sent to technical inspection or scrapped. The data was also complemented with information from the access database Repack which contains information about products repacked at ECP, and the access database Returns which contains information about returns sent to technical inspection or stock at another location. Finally, the information was crosschecked with an extraction made from SKF's warehouse system which contained information about where each designation is stocked. This information summary gave a comprehensive picture of where the final destinations of the returns are.

The shipped weight was calculated by first adding the weight of each designation and the specific pack code with information from SKF's product database Prod Mast. Then the quantity at each return line was summarised and finally the total amount was summarized for each origin to each destination. See example in the table 6 below.

Shipments in Kg						
	Destination					
Sales Unit (Country)	Airasca, Italy	Schweinfurt, Germany	Gothenburg, Sweden	EDC Tongeren, Belgium	St Cyr, France	Scrap
Sweden	XX	XX	XX	XX	XX	XX
France	XX	XX	XX	XX	XX	XX
Germany	XX	XX	XX	XX	XX	XX
Italy	XX	XX	XX	XX	XX	XX

Table 6, Return shipments in kg between return origin and final destination [5]

After the shipped amounts between the different entry points and final destinations were determined, the next step was to compare how the shipments would have been carried out for a centralised versus a decentralised structure. In the centralised structure, everything is sent to the ECP in Tongeren before any inspection is done. The returns that can be put on stock at the EDC, returns that can be repacked and put on stock at the EDC, and returns that are scrapped after visual inspection will only be transported to one destination. The rest of the returns, for example the products not stocked at the EDC, will be transported to two destinations. This is shown in table 7 below.

Shipments with a centralised structure						
	Destination					
Sales Unit (Country)	Airasca, Italy	Schweinfurt, Germany	Gothenburg, Sweden	EDC Tongeren, Belgium	St Cyr, France	Scrap
Sweden	GOT-EDC-AIR	GOT-EDC-SCH	GOT-EDC-GOT	GOT-EDC	GOT-EDC-SCY	GOT-EDC
France	SCY-EDC-AIR	SCY-EDC-SCH	SCY-EDC-GOT	SCY-EDC	SCY-EDC-SCY	SCY-EDC
Germany	SCH-EDC-AIR	SCH-EDC-SCH	SCH-EDC-GOT	SCH-EDC	SCH-EDC-SCY	SCH-EDC
Italy	AIR-EDC-AIR	AIR-EDC-SCH	AIR-EDC-GOT	AIR-EDC	AIR-EDC-SCY	AIR-EDC

Table 7, Shipments with a centralised structure

In the decentralised structure, where the sorting and inspection of the returns are carried out at the point of entry, the average numbers of shipments are reduced. This is due to the fact that the returns can be sent directly to the final destination; hence they do not need to be sent through the ECP. Sometimes this also means that the return can stay at the current location because the

[5] Figures have been censored in the report but are presented to SKF and are available for the supervisor at Chalmers

current location is the same as the final destination. Moreover, scrap can be sorted out right away and does not need to be sent anywhere. This is shown in table 8 below.

Shipments with a decentralised structure						
	Destination					
Sales Unit (Country)	Airasca, Italy	Schweinfurt, Germany	Gothenburg, Sweden	EDC Tongeren, Belgium	St Cyr, France	Scr ap
Sweden	GOT-AIR	GOT-SCH	-	GOT-EDC	GOT-SCY	-
France	SCY-AIR	SCY-SCH	SCY-GOT	SCY-EDC	-	-
Germany	SCHAIR	-	SCH-GOT	SCH-EDC	SCH-SCY	-
Italy	-	AIR-SCH	AIR-GOT	AIR-EDC	AIR-SCY	-

Table 8, Shipments with a decentralised structure

The results from the cost calculation showed that the transport cost for the centralised structure was higher than for the decentralised structure. The cost for the decentralised structure corresponded to 54% of the cost for the centralised structure.

4.4 Return handling benchmark

In this section of chapter 4, interviews with representatives from benchmark companies have been compiled. The return handling process at *Scania Parts* is followed by the return handling process at *Volvo Parts*. The last part of this section, *retailer warehouses*, originates from theory.

Scania Parts and Volvo Parts were identified as companies with similar return handling requirements as SKF. These similarities originates from the similar type of product, the large variety in products, the customer segments with many dealers and distributors, and the comparable presence in Europe. The benchmark with retailer warehouses serves another purpose than comparing similar companies to SKF. Instead, a return intense industry is identified which could be studied and state an example of a well-developed return handling process.

4.4.1 Scania Parts

Scania has a centralised return handling process with a collection point in Belgium which handles all returns from the distributors in Europe except for products with technical errors. Scania Parts has around 700-800 distributors all over the world and some of them are owned by Scania. Of all parts sold by Scania part, about 90% are products which are used in reparations at a repair centre; only the remaining 10% are sold to a customer over the counter.

Scania practices a high level of vertical integration and controls the stocks at all distributors. Returns are collected at the distributors and are sent to the centralised collection point in Belgium four times a year. According to the person contacted, the returns are kept at a low level due to both the fact that the stock is kept fresh and the fact that Scania controls the stock. In the rest of the world the same practice is applied and centralised collection points are already established or about to be implemented. The described returns here correspond to the SKF type of return stock cleansing, STO.

All parts sold to customers are accepted as returns if the return takes place within 14 days from the sale. The customer returns the product to the reseller who credits the customer. If the returned item is in a resalable condition (unbroken package) and if the reseller has a demand of the product, the returned item is directly put on stock at the reseller. If the product on the other hand is in a non-resalable condition, or if it needs repacking which the reseller can not perform, the product is sent to the centralised collection point in Belgium (for the European market). These returns are temporarily stored at the reseller and sent with the shipment to Belgium which goes fours times a year. Exceptions can be made for high value products which the reseller wants credit for right away. In order for the distributors to get credited for the returns, the returned parts need to be in a resalable condition.

The products sent to the regional collecting point are inspected and repacked. On a global level, Scania handles a large amount of returns every month and around 25 to 30 employees work in Belgium with returns. The facility in Belgium has the capability to repack all products. The return handling area is located in the distribution centre in Belgium but has a separated area.

The only return type which does not go through the centralised collecting point is technical error returns, TER. These returns are shipped with the same transportations from the resellers but do not enter the centralised collecting point. Instead, they are sent to Södertälje (Sweden) for technical inspection. For Scania, the technical inspections are an important part of assuring the overall product quality and sometimes the technical inspections can give an indication that systematic production errors have been made.

4.4.2 Volvo Parts

Volvo Parts is the aftermarket solution provider for the Volvo Group and provides service solutions from aftermarket engineering in early product project phases, through parts sourcing, advanced workshop tools, hard and soft parts supply chain management to end customer support (www.volvogroup.com).

Volvo Parts has set up a structure with *central warehouses, regional warehouses* and *support warehouses*, see figure 25 below. In Europe the main central warehouse is located in Gent, Belgium. This warehouse delivers the full range of parts to other warehouses, dealers and customers. In Europe there is also one regional warehouse located in Moscow, Russia. This warehouse distributes stock and emergency orders to both warehouses and dealers. And finally there are the support warehouses, in Europe for example located in Gothenburg (Sweden), Bologna (Italy) and Madrid (Spain). These warehouses distribute emergency orders to dealers.

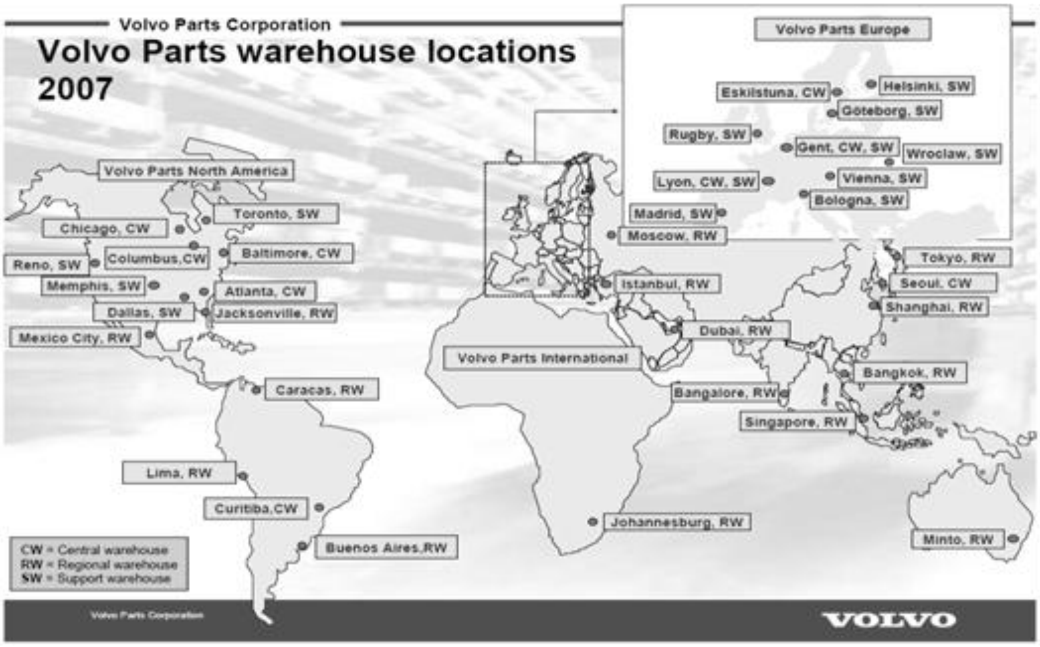


Figure 25, Volvo Parts warehouse locations 2007 (www.volvogroup.com)

For the reverse logistics, Volvo Parts has different kinds of flows:

1. *The discrepancy flow.* This flow can for example consist of damaged parts and miss picked parts. It can be compared to SKF’s return flows SER, DER and CER. These returns are sent back directly to the warehouse from where they were ordered.
2. *The buy backs.* This is the biggest flow, and it consists of items which have been bought back from the dealers. Three times a year Volvo Parts calculates the best stock for their dealers and proposes buy backs. This flow can be compared to SKF’s return flow STO. These returns are sent back directly to the warehouse from where they were sent.
3. *The exchange systems.* This is a flow where old parts are taken back, renovated or repaired and exchanged for new parts which are sellable on the market. In Europe, 90% of these returns are sent back directly to the main central warehouse in Gent. The remaining 10% are sent to local hubs for quality checks.
4. *The quality systems.* This flow consists of parts which have had quality issues. Volvo Parts can in this case decide to recall all parts in all markets which have been produced at the same time in the same factory. This flow can be compared to SKF’s return flow TER. These returns are sent back directly to the site where they were produced.

99% of the returns are pre advised in the systems, and all warehouses have access to this database. The only time when the regional warehouse or the support warehouses forward incoming returns to the main central warehouse in Gent is when they for some reason cannot identify the returns in the system. This happens more and more frequently.

In Gent the return flow by nature is bigger than it is in the other warehouses, and as a consequence Gent has higher manpower handling returns. The manpower in Gent is also well educated and has a high degree of competence. The goal is to handle a return in 2 days for external flows, and in maximum 2 weeks for internal shipments once the dealer or customer has been credited. These goals are well reached, but in periods with higher pressure it is more difficult.

Volvo Parts states that it is important to remember that how well the set up goals are reached also depends on the transporters. In this area Volvo Parts sees potential for improvements. Reverse logistics is considered as less important by the Volvo Group than forward logistics, and this is the main reason why it is not possible to have expensive logistics solutions. The aim is to use the same trucks for reverse logistics as for forward logistics, but this is not always possible. The reverse logistics becomes, as like many other areas, a trade off between time and money.

4.4.3 Retailer warehouses

Comparatively, retail warehouses have a high degree of product returns and the average return rate is approximately 25% (Rogers and Tibben-Lembke 1998). Hence, these companies have had to progress their management of returns. De Koster, De Brito, and Van de Vendel (2001) have done an exploratory study with nine retailer warehouses – three food retailers, three department stores and three mail-to-order companies. The nine retailers were all located in the Netherlands and the main focus in the study was to explore the factors causative to the decision of how to organize the return handling: by combining or separating inbound and outbound flows during the return handling process. As mentioned in the frame of reference (chapter 2.3.2) it is common for companies to use the same facilities for reversed logistics as they do for forward logistics, but usually in a separated area of the warehouses and distribution centres (De Brito and De Koster 2003).

The study (De Koster, De Brito, and Van de Vendel 2001) focuses on three stages of the return handling; transport, receipt and storage. Out of the nine retailer warehouses mentioned earlier, all the retailers with stores (food and department stores) united the transport of returns with the transports of outbound flows. All the nine warehouses received the returns in a separated area. On storage, five retailers combined the flows - only one separated the flows and the remaining three retailers had a mixed arrangement. Here, the decision taken weather to combine the storing or not depended on the market, if the market for returns were the same as the original market or not.

Hence, to summarize the return handling process of the nine Dutch retailer warehouses: the first part (transport) was combined with the inbound flow, the second part (receiving) was separated from the inbound flow and the last part (storage) depended on the market of returns. In other words, it is not possible to draw overall conclusions on whether to combine or separate inbound and outbound flows.

5 Analysis

In this chapter the analysis is presented. First there is a short *benchmark* analysis. This is continued by a description of the *model* used to support the development of the new return handling scenarios at SKF. After the model development follows a section about the *return handling workshop in Airasca*. The outcomes from Airasca, the *SKF return handling scenario proposals* are then presented. Next there is a *scenario proposal evaluation* where the scenario proposals are evaluated to each other in terms of cost, lead time, CO_2 and the customer's convenience of making a return. And finally, there is a section about *possible general improvements*. These improvements are not dependent on the scenario proposals, but can be implemented with or without a new return handling structure.

5.1 Return handling benchmark

When analysing the results from the benchmark studies it was possible to draw a couple of conclusions. The most obvious one was that it was difficult to find companies with a good overview of a satisfying return handling process. This is in line with what had already been stated in the frame of reference about reverse logistics and return handling. But also, it was possible to draw conclusions from the return handling processes of the companies described in chapter 4.4:

- It was interesting to see that both Scania Parts and Volvo Parts (as well as SKF) have their major distribution centres, and also return centres, located in Belgium. This is no coincidence. The Belgian ports are located in the middle of a major financial and commercial area, and in addition Belgium has a central location in Europe.

- Both Scania Parts and Volvo Parts (as well as SKF) send TER goods directly to the location where they can be taken care of.

- Both Scania Parts and Volvo Parts turn their STO returns into planned returns by scheduling their transports to three (Volvo Parts) or four (Scania Parts) times a year. The advantage by doing it in this way is that it is possible to plan when the STOs are coming back, and the disadvantage is that it takes longer time for these products to be put back on stock and resold if they are not already resold by the distributor in question.

- Yet one conclusion is that all companies studied, including the nine Dutch retailers, have separated areas in the warehouses or distribution centres for return handling. This is also true for SKF.

With exception of the STO handling all of the above mentioned conclusions from the benchmark are also true for SKF. When analysing if the way Scania Parts and Volvo Parts handle their STO could influence SKF it is possible to notice that nothing has been said during the work of this thesis about planned STO returns for SKF. It is possible that this concept exists, but in this case it has not been brought up during the interviews. Maybe this could be an area for further analysis for SKF.

5.2 Model development

In order to analyse how the return handling process could be organized in the future and to generate different return handling scenarios which could be evaluated, a theoretical framework was searched. However, the theory around reversed logistics, and especially around return handling, is limited and an appropriate framework was not found. Therefore a model has been developed based both on the identified theory and the analyses of the SKF return handling process. The most important contributions from the theory are the different strategies for return handling. They are used as base scenarios and are evaluated to specific requirements identified from SKF. The requirements are referred to as design parameters.

5.2.1 Theoretical scenarios

In the Frame of reference (chapter 2) different strategies to structure the return handling were introduced and discussed. These strategies were also compiled in a figure, figure 7. As mentioned in chapter 2.3.7 one part of the figure was highlighted in grey. That part is shown here, in figure 26. That is also the part this thesis will continue to have focus on:

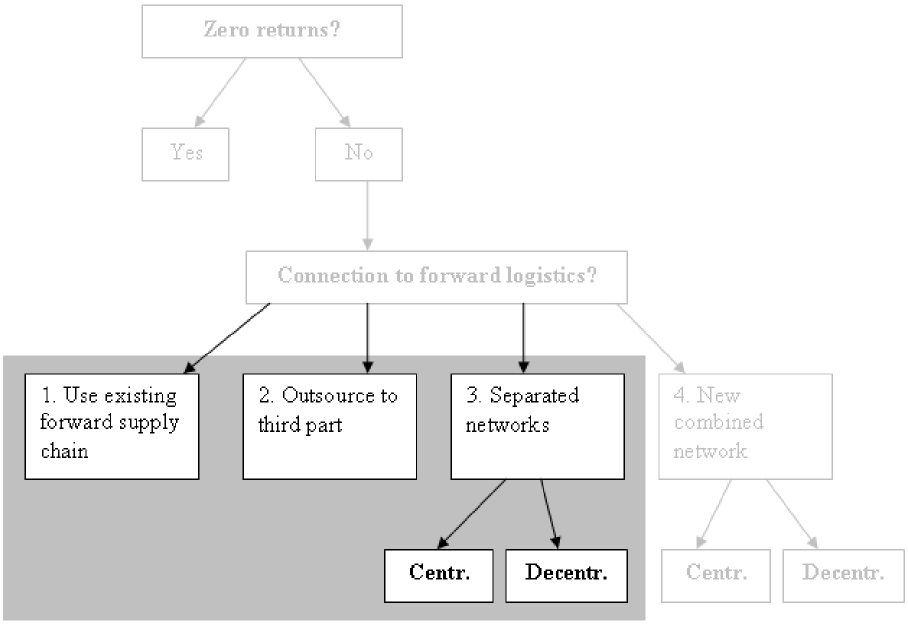


Figure 26, Alternatives for reverse logistics

The four highlighted scenarios will now be renumbered and referred to as **theoretical scenarios** and are as follows:

1. Using *the same structure as the forward logistics supply chain*, with the only difference that the products are moving backwards in the system (no 1 in the figure).
2. *Outsourcing the operation* to third-party logistics (3PL) providers (no 2 in the figure).
3. Using a return supply chain with *centralised testing and evaluation of returns*. No attempt is made to judge the condition or quality of the product at the retailer or reseller (the first alternative of number 3 in the figure).
4. Using a return supply chain with *decentralised testing and evaluation of returns*. Instead of a single point of collection and evaluation, the products are initially evaluated at multiple locations – when possible, at the point of return from the customer (the second alternative of number 3 in the figure).

All alternatives are theoretical. More detailed information about scenario number 1 can be found in chapter 4.1.1, whereas more information about scenarios number 2, 3 and 4 can be found in chapter 2.3.3, 2.3.4 and 2.3.5.

5.2.2 Design parameters

The complexity of SKF's reverse logistics process is due to the fact that there are many probabilistic activities, events, and interactions within different sub processes involving a high degree of complexity. The aim was to look at the process with all important aspects in mind. At an early phase of the mapping and analysing of the current return handling process at SKF, several different parameters which complicated the return handling process were identified. These parameters resulted in heterogeneous return flows, which entail requirements for different return handling structures. The model was set up to evaluate the theoretical scenarios for each one of these different parameters. The parameters are described below.

Stock category:

In this design parameter both planned items and non-planned items (described in chapter 4.1.1) are considered, but for the rest of the design parameters planned items are assumed.

Type of error:

- Sales Error Report, SER
- Delivery Error Report, DER
- Stock Cleanse, STO
- Customer Error Report, CER
- Technical Error Report, TER

Location of customer:

- Customer located within a short distance to the regional collecting point, RCP.
- Customer located within a long distance to the regional collecting point, RCP.
- Customer located within a strong market where there is a high demand of products from the distributor.
- Customer located within a weak market where there is a low demand of products from the distributor.

Product value:

- Products with high value.
- Products with low value.

Value decrease of time:

- Products with high marginal value of time (fast value decrease).
- Products with low marginal value of time (slow value decrease).

Product dimensions:

- Large products.
- Small products.

5.2.3 The matrixes

The aim with the model was to evaluate theoretical scenarios based on specific requirements from SKF - the design parameters. In this matrix (table 9) the four selected theoretical scenarios are constructing the columns and are displayed at the top on the first row. It is important to remember that these four scenarios are only theoretical. The design parameters are presented at the left side with a section of rows for each parameter, and these parameters represent SKF's requirements.

The matrix was used to evaluate which theoretical scenario that was most appropriate for each parameter. The scenarios were marked with an X, or ranked with numbers if several scenarios were appropriate for a specific parameter. The matrixes marked with Xs are to be found in appendix 10.3.

Scenarios evaluated for each objective				
Design parameters	**Same structure as forward logistics**	**Outsource to 3PL**	**Centralised structure**	**Decentralised structure**
Stock category				
Planned Items				
Non Planned Item				
Type of error				
Sales Error, SER				
Delivery Error, DER				
Technical Error, TER				
Customer Error, CER				
Stock Cleansing, STO				
Location of customer				
Close to RCP				
Far from RCP				
Located in Strong Market				
Located in Weak Market				
Product value				
High Value				
Low Value				
Value decrease of time				
High Decrease				
Low Decrease				
Product dimensions				
Large Products				
Small Products				

Table 9, the Matrix – without Xs

5.2.4 The objectives

The main aim with the thesis is to optimise the return handing process in terms of cost, lead time, CO_2 and the customer's convenience of making a return. To obtain this, these four objectives needed to be included in the matrix. However, the complexity of adding another dimension to the matrix (which would turn it into a three-dimensional matrix) favoured the easier option to create different matrixes for each one of the four objectives. After further analysis a decision not to make a matrix for the forth objective, the customer's convenience of making a return, was taken. This was due to the fact that this objective is a soft, none measurable objective. Hence the forth objective needs to be evaluated in a more qualitative way in a later step.

The result was then three identical matrixes that only differ in the way they were evaluated. Hence, the matrixes plot out which scenario that is most suitable for different parameters, but the matrixes differ in their aim. The first matrix aims to keep the cost low, the second matrix aims to keep the lead time short and the third matrix aims to keep CO_2 low.

The first matrix, which evaluates the scenarios with consideration to cost (appendix 10.3.1), includes cost related to transportation, storing, inspection, and administration. The second matrix, which evaluate the scenarios with consideration to lead time (appendix 10.3.2), considers three different lead times; *Respond time* which is the lead time from when the customer contacts the sales unit until the return is accepted or declined, *Credit lead time* which is the lead time until the customer is credited, and *Total lead time* which is the lead time until the product is put back on stock or scrapped. The third matrix, which evaluates the scenarios with consideration to CO_2 emissions, includes CO_2 emissions from transportation and, if relevant, from storing.

5.2.5 Analysis with support from the model

Once the matrixes in the model were filled in, the idea was that they would give an understanding of the requirements of the return handling process. In some cases the matrixes clearly indicated one of the theoretical scenarios as the most appropriate whilst in other cases, the matrixes were scattered and it was hard to draw conclusions. However, the idea with the model was not to choose one of the theoretical scenarios but rather to illustrate for example for which products a theoretical scenario is favoured and for which products another scenario is favoured. Probably, in most cases a mix of the scenarios will be appropriate due to the fact that the theoretical scenarios all represent extremes.

The aim was to use the outcome of this model and develop different return handling process proposals. The SKF scenario proposals will most likely be combinations of the different theoretical scenarios and will serve as a base for further analysis.

5.3 Return handling workshop in Airasca

In this section of the analysis the different steps of the workshop in Airasca are described and the results from these steps are presented.

5.3.1 Parameter discussion

The first step of the workshop was to evaluate the requirements on SKF's return handling process. The requirements were based on the design parameters identified in the developed model, see chapter 5.2.2 above. These parameters were first introduced and explained to the workshop participants and this was followed by a discussion about possible parameters to add. The feedback was that the parameters were highly relevant and no additional parameters were added. After this discussion the parameters were ranked by the participants individually. Each participant were asked to give three points to the most relevant parameter, two points to the second most relevant, and one point to the third most relevant parameter. One of the participants (participant number 4) chose not to rank the parameters and therefore the same points have been put for all the chosen parameters from this participant. The result is displayed in the table below (table 10):

	Scores from each participant				
Parameters	Participant 1	Participant 2	Participant 3	Participant 4	Total
Stock category	3	3	3	2	11
Type of error	2		1		3
Location of customer		1		2	3
Product value	1	2	2		5
Value decrease of time					0
Product dimension				2	2

Table 10, Scores from the workshop

The table shows that for SKF the most relevant parameter, without question, is Stock category and the least important is Value decrease of time. For other companies, with for example products with high value decrease of time, the situation could be totally different.

5.3.2 Evaluation of the matrixes

The second step of the workshop was to evaluate the theoretical scenarios from the developed model based on the identified requirements, the design parameters. The matrixes were first introduced and explained and thereafter followed by a discussion about which theoretical scenario that was most appropriate for each one of the six parameters. In the case of multiple appropriate scenarios for one parameter, the scenarios were ranked with different weights or the scenarios were left with comments explaining areas demanding further analysis. Only the matrixes for cost and lead time were completed in the workshop. Due to time restrictions the CO_2 matrix was saved for later, but after considerations the CO_2 perspective was instead analysed based on theory, SKF internal documents, and logical reasoning (see chapter 5.5.3). Therefore there is no matrix for CO_2.

Results from the matrixes

The cost matrix, which was evaluated first in the workshop, gave a scattered result. The scenario *Outsource to 3PL* was not favoured by any of the parameters and will therefore not be considered further in the cost matrix evaluation. Moreover, only one parameter favoured the scenario *Same structure as forward logistics* and this parameter was *Stock category, Non planned item*. This parameter also favoured the scenario *Decentralised structure*. In other words, the scenarios that were frequently favoured were *Centralised structure* and *Decentralised structure.* To summarize, the *Centralised structure* was favoured by *Planned items, Sales errors, Delivery errors, Customer errors, Stock cleansing, Customers close to the RCP, Customers in weak markets, Products with low value,* and *Products with small dimensions.* On the other hand, the *Decentralised structure* was favoured for *Non-planned items, Technical errors, Customers far from the RCP, Customers in strong markets, Products with high value, Products with high value decrease of time*, and *Products with large dimensions.* For the parameter *Products with low value decrease of time* no scenario was marked (see appendix 10.3.1).

The lead time matrix gave a more concentrated result. Most of the parameters favoured the scenario *Decentralised structure* with just a few exceptions. The exceptions were for the parameters *Stock cleansing* and *Customers close to the RCP*. Instead, these two parameters favoured the *Centralised structure.* For one of the parameters, *Planned items*, a *Centralised structure* was chosen if *Product on stock lead time* was considered but a *Decentralised structure* was chosen if *Credit lead time* was considered. In this matrix the scenario *Outsource to 3PL* was favoured by one parameter, *Customer in a weak market* (see appendix 10.3.2).

5.3.3 Mapping of the current process

The third step of the workshop was to illustrate the current return handling with a process map and to analyse how this process satisfies the identified requirements. Due to the complex current return handling process, where the determined policy not reflects the process in practice, two separate processes were mapped - one for how the return handling process is determined in the SKF policy and one based on how the return handling process is carried out in reality. These two scenarios will be presented further in section 5.4.

5.3.4 Developing new SKF scenario proposals

The fourth and final step of the workshop was to develop new SKF scenario proposals of how the return handling process could be structured. This was done by brainstorming around the matrixes and it resulted in two new SKF scenario proposals which will be evaluated and compared to the two existing scenarios, both the existing policy and the existing reality. This adds up to four separate SKF scenario proposals:

1. Current process in practice, As Is
2. Current process according to the policy
3. Process proposal, Separated flows
4. Process proposal, Decentralised structure

The two new scenarios will be presented further in section 5.4.

5.4 SKF return handling scenario proposals

In this section the four separate SKF scenario proposals presented in chapter 5.3.3 and 5.3.4 will be explained further.

SKF's fundamental idea was that the return handling policy should be followed. In this case the policy and the As Is would be the same. But today the policy and the As Is differ. Here, both are shown, but only the policy is an alternative for the future. This is due to the fact that the actual return handling at SKF today, the As Is, need to be improved. Hence, this section shows four different SKF scenario proposals, but only the last three are considered as future alternatives.

1. Current process in practice, As Is
2. Current process according to the policy
3. Process proposal, Separated flows
4. Process proposal, Decentralised structure

} Future alternatives

For all four SKF scenario proposals some activities are the same:

When a customer for some reason wants to return an item to SKF, the customer contacts the sales unit. The sales unit receives information from the customer about the return, looks up the original order in the customer order handling database, COH, and determines the type of return. A return approval and a label are then sent by e-mail to the customer (exception for As Is in Schweinfurt, see below). The customer can now print the label and send the goods to the closest LCP or directly to the ECP. In some countries the returns are sent to a return point before forwarded to a LCP or the ECP. The label contains information about where the returned item should be sent.

The returns can be rejected if the products sent from the customers are not sold by SKF, if the returns are not approved before the goods are sent, or if the customers have damaged the products. As a consequence these returns will not be repaired or credited by SKF.

A final similarity between all four scenario proposals is that in case a decision to scrap a non rejected return is taken, the customers should either be credited or asked if they want the product back. Goods could be scrapped either after visual inspection or after technical inspection.

The four SKF scenario proposals will now be presented one by one. Last in this section there is a short summary of the SKF scenario proposals. The abbreviations used in the pictures means the following:

RCP	Regional collecting point; in Europe the European collecting point in Tongeren.
RP	Return point, the first SKF facility which handles goods. Only cross docking to a collecting point.
LCP	Local collecting point; in Europe Schweinfurt, Airasca, St Cyr and Gothenburg.
PDIV	Product division, where the goods are produced.
LAB	Laboratory for technical inspection.

RWH	Regional warehouse; in Europe the European distribution centre in Tongeren.
FWH	Factory warehouse, a warehouse belonging to a PDIV.

5.4.1 Current process in practice, As Is

General

This process describes the current situation, but will not be considered as an alternative for the future. If all units followed the return handling policy this process would not exist. One major reason why the policy is not followed is that the LCPs have to handle the returned goods in order to shorten the credit lead time to the customers (see chapter 4.1.1). If the LCPs only cross dock the returned goods to the RCP the credit lead time becomes too long.

In detail

When the goods arrive at the RP/LCP from a customer, the goods are either sent to the RCP for further action or straight to a PDIV if they are classified as technical error reports, TER.

Goods arriving at the RCP (sent either from a RP/LCP or sent directly from a customer) can follow different paths:

- Goods in resalable condition are sent to stock at the RWH or, if the product does not have a stocking point at the RWH, to the FWH which stocks the product.
- Goods in resalable condition with damaged packaging are repacked at the RCP and afterwards also sent to stock at the RWH or to a FWH.
- Goods in need of technical inspection or channel repack are sent to the corresponding PDIV for further action.

However, sometimes exceptions to these procedures are made. For example, a RP/LCP can decide not to forward the return to the RCP. Instead the RP/LCP may send the return straight to another RP/LCP or decide to keep the return and send it directly to stock at the FWH. This is shown in figure 27:

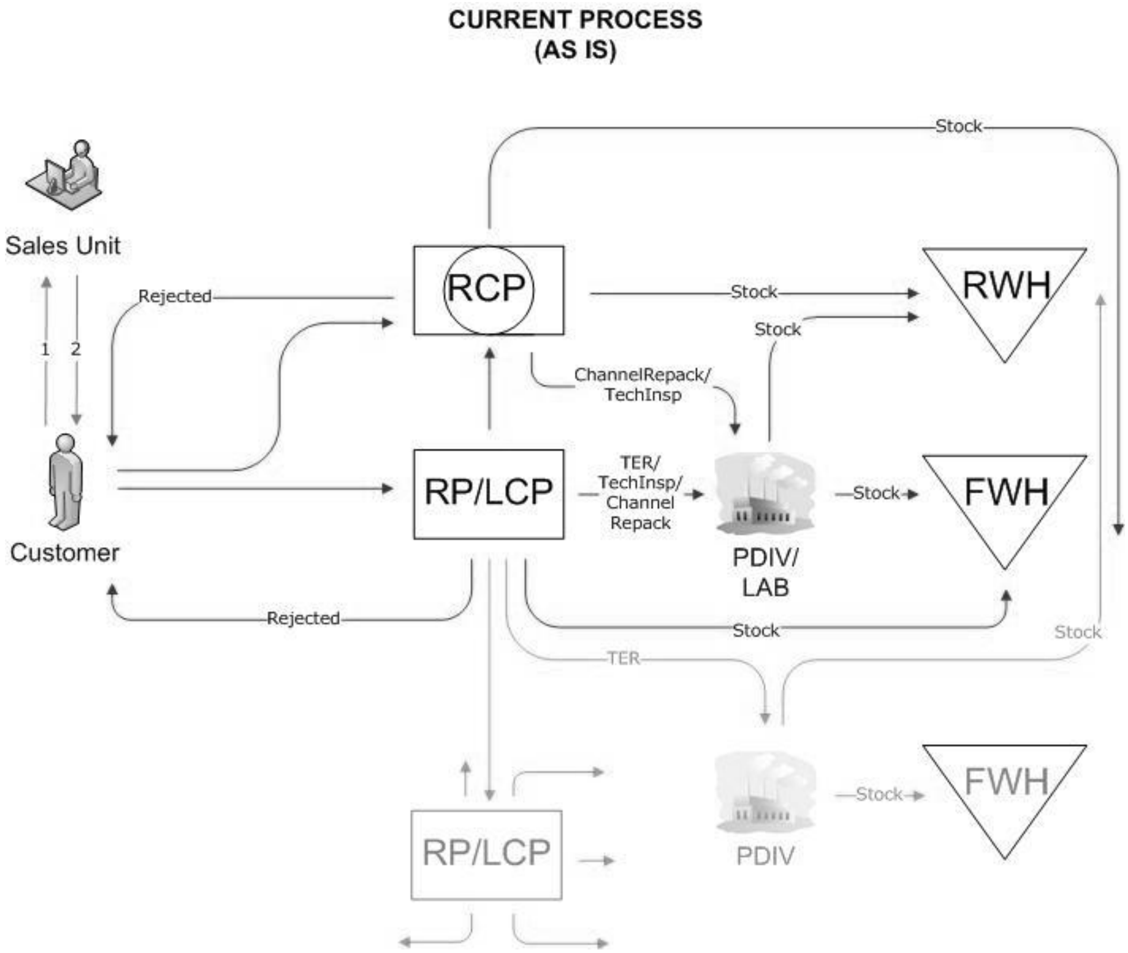


Figure 27, As Is (Numbered arrows are information flows)

As mentioned earlier, there are four different factory warehouses in Europe acting as local collecting points; Schweinfurt, Airasca, St Cyr and Gothenburg. How these collecting points decide what returns to send where varies between the different collecting points. A short description of how the four mentioned collecting points sort the returns follows below. More information about this can be found in chapter 4.1.5. How the regional collecting point sorts the returns is described in chapter 5.4.2.

Schweinfurt

In Schweinfurt the sales unit handles the return requests from the customers differently from the other sales units. Instead of determining the type of return from information given by the customer, the sales unit waits for additional information from the administration in Schweinfurt return handling before entering anything in the data base. The administration in Schweinfurt return handling gives the information to the sales unit once they have received the returns. Hence the sales unit does not send a return approval or a label by e-mail to the customer. Instead they only give the customer the address to the local collecting point in Schweinfurt. After receiving additional information from the administration in Schweinfurt, the sales unit determines the type of return and sends the information together with a label back to the administration.

In Schweinfurt the normal case is to forward returns to the ECP (appendix 10.5.1). This is done except for two cases;

- Administrative returns, which mean all types of returns except technical errors, TER, from customers within and outside the area with PDIV in the area → goods is kept in Schweinfurt (appendix 10.5.2)
- Returns from all customers when the type of error is TER → goods is sent to the quality department in Schweinfurt (appendix 10.5.3)

All types of returns in Schweinfurt are visually inspected and administrated. During the administration the returns are put in a waiting area. When the personnel working with the returns receive directions from the administration further action is taken.

Airasca

In Airasca, all returns are sent to the ECP (appendix 10.6.1) except for three cases;

- Administrative returns, which mean all types of returns except technical errors, TER, from non Italian customers with PDIV in Italy → the goods is sent from the ECP and the goods is kept in Airasca (appendix 10.6.2)
- Returns from all customers when the type of error is TER and the PDIV is in Italy → goods is sent to the corresponding Italian PDIV (appendix 10.6.3)
- TER returns from Italian customers with PDIV outside of Italy → goods is sent to the corresponding PDIV (appendix 10.6.4)

This means that all administrative returns from Italian customers are sent to the ECP. These returns are not visually inspected before they are sent. Airasca is the LCP handling the returned goods closest to the policy.

St Cyr

No site visit was made.

Gothenburg

In Gothenburg, all returns are sent to the ECP (appendix 10.7.1) except for two cases;

- Administrative returns, which mean all types of returns except technical errors, TER, from customers outside the area with PDIV in Sweden → the goods is sent from the ECP and the goods is kept in Gothenburg (appendix 10.7.2)
- Returns from all customers when the type of error is TER → goods is cross docked to the PDIV in Gothenburg or to another corresponding PDIV for further action

This means that all administrative returns from customers within the area are sent to the ECP. The returns sent to the ECP are administrated in Gothenburg and the incoming goods are booked on transport to the ECP. Sometimes exceptions to this procedure can be done though. These exceptions are made when the returns have a heavy weight and a big volume and originally come from the PDIV in Gothenburg. In these cases the personnel working with the return handling in Gothenburg send pictures of the goods to the ECP instead of sending the actual goods. In this way these returns do not have to travel to the ECP and back, but the personnel at the ECP can still register the goods as if they had arrived.

5.4.2 Current process according to the policy

General

This process describes what is stated in the return handling policy today, and is an alternative for the future. This process is centralised. The European return points, RPs, in the picture are Schweinfurt, Airasca, St Cyr and Gothenburg. They are only cross docking the goods.

In detail

When the goods arrive at the RP from a customer, the goods is either sent to the RCP for further action or straight to a PDIV if it is classified as a technical error, TER.

Goods arriving at the RCP (sent either from a RP/LCP or sent directly from a customer) can follow different paths:

- Goods in resalable condition are sent to stock at the RWH or, if the product does not have a stocking point at the RWH, to the FWH which stocks the product.
- Goods in resalable condition with damaged packaging are repacked at the RCP and afterwards also sent to stock at the RWH or to a FWH.
- Goods in need of technical inspection or channel repack are sent to the corresponding PDIV for further action.

This is shown in figure 28:

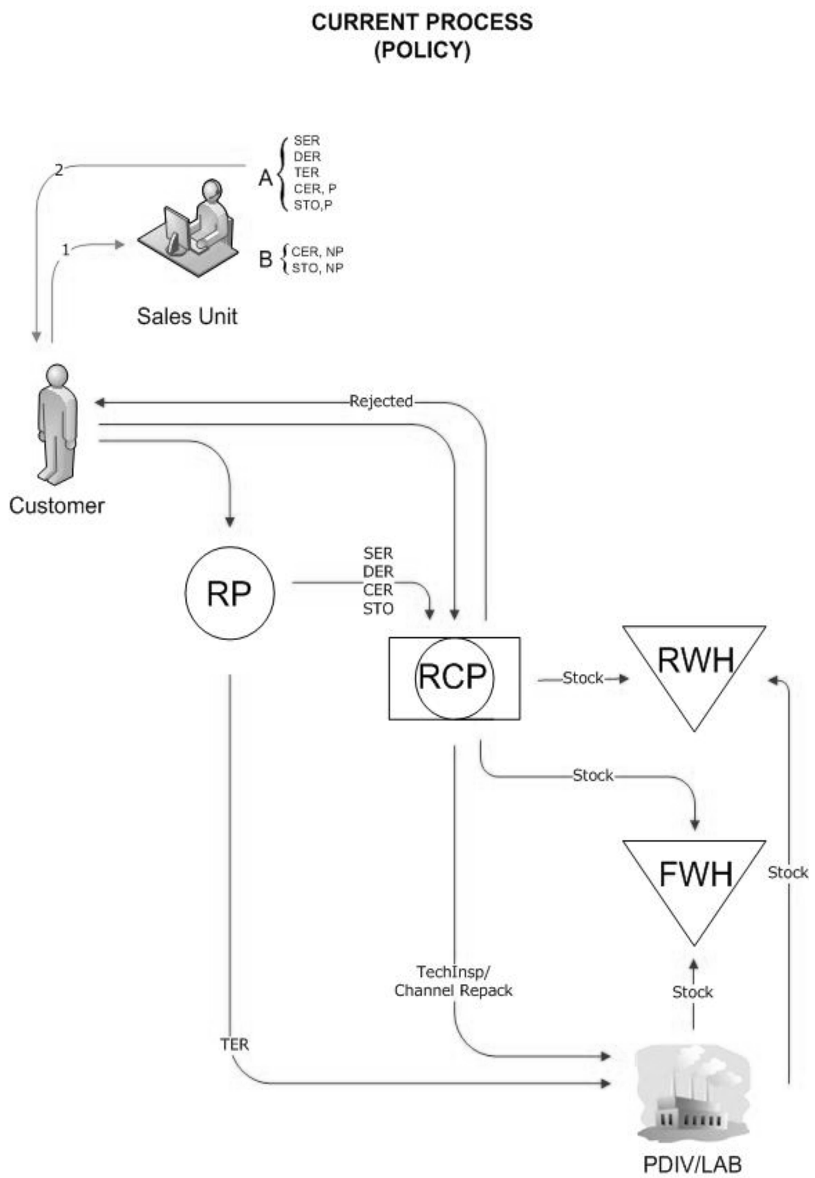


Figure 28, Policy (Numbered arrows are information flows)

5.4.3 Process proposal, Separated flows

General

This proposal is based on the current "As Is" process with a few modifications, and is considered as an alternative for the future. The fundamental idea with this proposal is that all returned products except technical errors (TER), stock cleansings (STO), and products which cannot be put on stock (non-planned items) should be forwarded to the closest availability point. The closest availability point is either the RWH or a FWH. In this proposal the sales unit plays an important role. The thought is that the sales unit includes information on where the goods should be forwarded on the label - hence the RP/LCP does not need to take this decision.

The supposed advantages in this proposal compared to the current situation are that the returned items in many cases travel a shorter total distance, and that the returned items also may travel with fewer stopovers. However, there are also disadvantages. By decentralising the flows economies of scale at the RCP can be lost and in addition to this, the sales units in this proposal get more tasks.

In detail

When the returns arrive at the RP/LCP from a customer the goods are sorted. All the decisions about where the returns should be sent have already been taken by the sales unit. Stock cleansings, STO, are sent directly to the RCP. This is shown by flow A in figure 29. Goods that are categorized as planned items (items that are either available on stock or have a planned availability) are sent directly to the closest availability point. This could be either to a RP/LCP, or to the RCP. If the closest availability point is the RP/LCP in question the goods are kept. This is shown by flow B in figure 29. Goods that on the other hand are categorized as non planned items (items that are "make to order", obsolete or samples) are sent directly to the RP/LCP corresponding to the owning PDIV for further action. This is shown by flow C in figure 29. And last, technical errors, TER, are sent directly to the owning PDIV for further action. This is shown by flow D in figure 29.

Goods arriving at the RCP can follow different paths:

- Goods in resalable condition are sent to stock at the RWH or, if the product does not have a stocking point at the RWH, to the FWH which stocks the product.
- Goods in resalable condition with damaged packaging are repacked at the RCP and afterwards also sent to stock at the RWH or to a FWH.
- Goods in need of technical inspection or channel repack are sent to the corresponding PDIV for further action.

Goods that are forwarded to the RP/LCP from another RP/LCP and goods from customers that are kept due to the fact that the current RP/LCP is the closest availability point are inspected and handled. These products are either sent to stock at the FWH, to the lab for technical inspection or to the PDIV for channel repack.

In this proposal, the RCP considered is the existing regional collecting point in Tongeren. The RP/LCPs considered are the return points today working as collection points, in other words Schweinfurt, Airasca, St Cyr and Gothenburg.

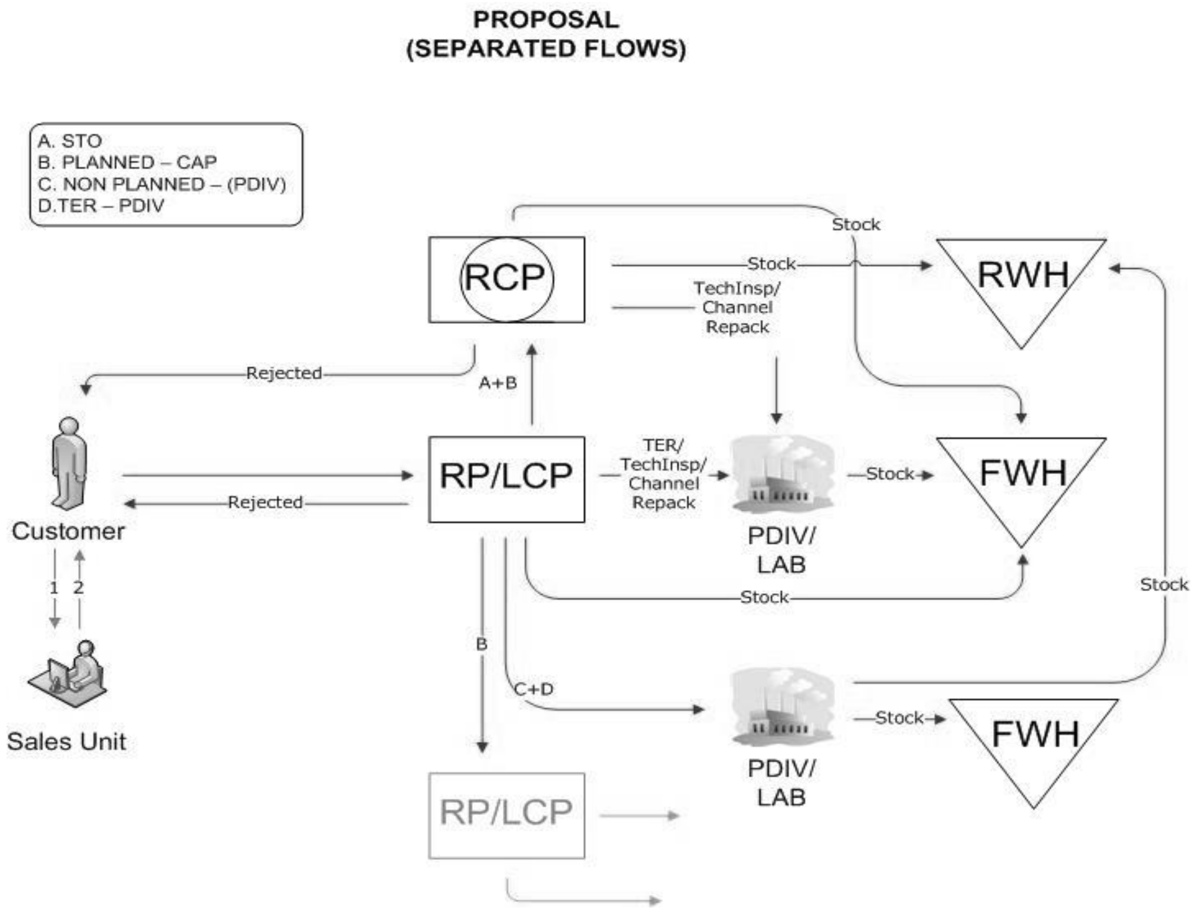


Figure 29, Separated flows (Numbered arrows are information flows)

5.4.4 Process proposal, Decentralised structure

General

This proposal is the most decentralised and the fundamental idea is that all the RP/LCPs are able to take all decisions regarding the returns. All the RP/LCPs have equal responsibilities and the RCP does not exist. When a returned item has arrived from a customer, the item should always be inspected at the RP/LCP in question.

The supposed advantages in this proposal compared to the current situation are that the returned items in many cases travel a shorter total distance, and that the returned items also may travel with fewer stopovers. Yet another advantage is that the total lead time can be shortened. However, there are also disadvantages. By decentralising the flows economies of scale can be lost and in addition to this it is important that the right competence is in place at all RP/LCPs. It is also possible that the workload will become more uneven at the RP/LCPs compared to the current situation, with more extreme ups and downs.

In detail

When the returns arrive at the RP/LCP they are sorted.

- Technical error reports, TER, are sent directly to the corresponding PDIV.

All other returns are inspected and a decision is taken about the next step.

- If the returned item is in a resalable condition the item is sent to stock at the closest availability point. This could be either to the RWH or to a FWH.
- If the returned item is in a resalable condition but with damaged packaging (not in need of channel repack) the item is sent to the corresponding RP/LCP, repacked and sent to stock at the corresponding FWH or to the RWH.
- If the returned item is in need of channel repack the item is sent to the corresponding PDIV.
- Finally, if the returned item is in need of technical inspection the item is sent to the corresponding lab.

This is shown in figure 30:

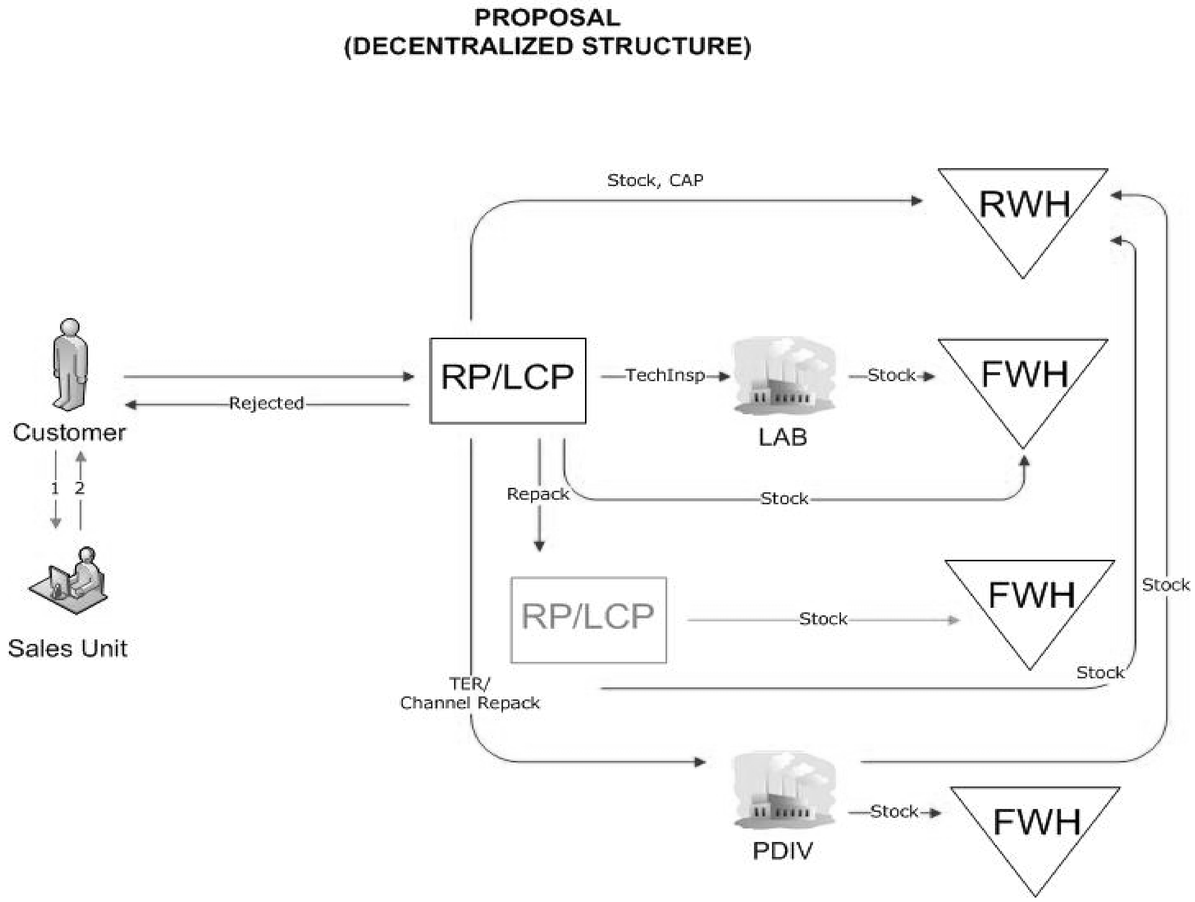


Figure 30, Decentralised structure (Numbered arrows are information flows)

5.4.5 SKF scenario proposals summary

Here a short summary of the SKF scenario proposals is presented. The table consists of both general information and advantages and disadvantages. By viewing it in this way it is easier to make comparisons:

1. CURRENT PROCESS IN PRACTICE, AS IS	2. CURRENT PROCESS ACCORDING TO THE POLICY
General: Not an alternative Both centralised and decentralised structure + - Not structured	**General:** An alternative Centralised structure + Structured Economies of scale Possibility to even out the workload from different countries - Many stopovers and long distances Longer lead times
3. PROCESS PROPOSAL, SEPARATED FLOWS	**4. PROCESS PROPOSAL, DECENTRALISED STRUCTURE**
General: An alternative Decentralised structure + Structured Shorter distances and fewer stopovers Shorter lead times - Lost economics of scale More tasks for the sales units	**General:** An alternative Decentralised structure + Structured Shorter distances and fewer stopovers Shorter lead times - Lost economics of scale More competence needed at the RP/LCPs Uneven workload at the RP/LCPs

Table 11, SKF scenario proposals summary

5.5 Scenario proposals evaluation

In this part of the analysis the scenario proposals are evaluated and compared to each other in terms of *cost, lead time*, *CO_2* and *the customer's convenience of making a return*. Here only the proposals considered as alternatives for the future are analysed. Finally there is a *summary* of the evaluations mentioned above. In this summary the alternative recommended to the company is discussed further.

5.5.1 Cost

General

There are many types of costs associated with reversed logistics and return handling, some of them obvious – like *transportation cost, administration and handling cost* and *cost of tied up capital*, and others not so obvious – like the costs referred to in the theory (chapter 2.2.1) as *the hidden costs of reversed logistics*. One example of the latter is hidden labour costs. Cost is one of the parameters in the scenario evaluation and the costs in the scope for this analysis are the first mentioned costs; *transportation cost, administration and handling cost,* and *cost of capital*.

Transportation cost

The transportation cost analysis is based on the data extraction from the Customer Return Processing database and the calculations are performed with assumptions and simplifications already mentioned in chapter 4.3.4. One simplification is that the calculations only consider a centralised alternative versus a decentralised alternative, in this case representing the alternatives (2) Current process according to the policy and alternative (4) Process proposal, decentralised structure. The final alternative (3) Process proposal, separated flows, will in terms of transportation have some parts similar to the centralised alternative and some parts similar to the decentralised alternative and will therefore be assumed to have a transportation cost somewhere in between these two extremes.

The results from the cost analysis show that the transportation cost for the decentralised alternative only corresponds to about half (54%) of the transportation cost for the centralised alternative. However, the result for the transportation cost analysis is only based on an amount of data corresponding to 23% (calculated based on total weight) and should not be used as exact information about the costs but as an indication of the costs the different alternatives might imply. The data included in the analysis is returns of products sold by sales units in Germany, Italy, France and Sweden but the results based on these 23% can be assumed to be representative for the whole quantity. Moreover, the data registered by the German sales unit only represents the data corresponding to the returns sent to the ECP and not all the returns that are kept in Schweinfurt. However, if this data was to be included in the analysis, the result would favour the decentralised structure even more since for the decentralised structure the returns would be kept in Schweinfurt while for the centralised structure the returns would be forwarded to the ECP and in some cases back to Schweinfurt.

The result is in line with what was concluded in the theory chapter 2.3.5 regarding advantages with for example sorting out scrap before it is forwarded. The cost benefits in the SKF case have also derived from returns that have arrived at a location where they can be taken care of right away (at a LCP stocking the product) and where no shipments at all are required.

Administration and handling cost

The main part of the administration and handling costs originates from the cost of human labour and this is also the cost that will be considered here. Other costs associated with administration and handling are for example the cost for forklifts and other types of equipment to move goods, and electricity for computers etc. However these additional costs will not be considered in the evaluation. The reason for this is the complexity and uncertainty in the estimation of these costs, their relatively small importance, and most importantly the assumption that they are equal regardless of where they are carried out. Nevertheless, in the case a scenario requires new investments of this type of equipment these costs will be discussed further in chapter 5.5.5.

To be able to evaluate the different scenarios and compare them to each other in term of labour cost it is necessary to answer the following questions:

- Are there economies of scale associated with the administration and handling of returns?
- Would the cost for administration and handling of returns be different at different locations (both considering the geographical location and if the work is carried out at a RCP or a LCP)?

The first question is answered with help from the results from the process mapping and the value stream mapping that has been conducted at the different LCPs and at the RCP. The results show that the administration and handling of the returns mainly consists of manual work with a high degree of variations and exceptions. The conclusion is that it is not possible to perform the activities faster or with less cost per unit with larger volumes. In other words, the activities are not influenced by economies of scale. One exception though is the process of repacking goods where the observations indicate that there might be economies of scale. This will be discussed further in chapter 5.5.5.

The second question, regarding the cost for administration and handling of returns based on different locations, contains two parts. The first part is whether the cost for administration and handling of the returns could vary for different geographical locations. The general answer to this is that it could vary significantly between different countries and an expression commonly referred to in this matter is "low cost countries". However, in this evaluation all alternatives considered have the activities in countries with similar cost levels and this aspect will therefore not be analysed further in the thesis. The second part of the question is whether it would be more cost efficient to administrate and handle the returns at a RCP than at a LCP. Based on the results from the site visits and the process mappings it can be concluded that processes such as inspection and administration are conducted in the same way at the RCP as at the LCPs. Technologies for return handling and administration are not more advanced at the RCP compared to at the LCPs. The cost is therefore assumed to be the same regardless if the process is carried out at the RCP or at a LCP.

Tied up capital

The final costs that will be included in the evaluation are the costs associated with the built up stock of the returns in process. These are the costs of having capital tied up in stock and also the marginal value of time. The cost of tied up capital is proportional to the time that the goods is waiting until it can be put back on stock and resold to another customer (for the returns that are scrapped there is no cost associated with tied up capital). Hence, the costs for tied up capital will be lowest for the scenario with the shortest lead time. The lead time analysis will executed in the next section (chapter 5.5.2).

The marginal value of time, described more in detail in chapter 2.2.2, is considered to be low for SKF's products. This is due to the fact that the value of the products is time-insensitive. Hence, the marginal value of time is not a factor when doing cost analysis of the tied up capital.

Summary

SKF return handling scenario proposals (the three future alternatives) ranked only by considering cost:

- 4. Process proposal, decentralised structure
- 3. Process proposal, separated flows
- 2. Current process according to the policy

5.5.2 Lead time

General

When analysing the different scenario proposals with consideration to lead time it is important to keep in mind that there are three different lead times to pay attention to. The first lead time is the *response lead time*, which is how long the customer has to wait to get the return approved. The second lead time is the *credit lead time*, which is the time it takes until the customer is credited. And finally the third lead time is the *total lead time*, which is the time it takes until the returned item is put back on stock (or scrapped/sent back to the customer). These lead times were also presented in chapter 1.2.2.

But due to the fact that the first two lead times, the response lead time and the credit lead time, are more relevant to analyse with consideration to the customer's convenience of making a return (analysed later in chapter 5.5.4) the only lead time relevant for this analysis is the total lead time.

Hence, the total lead time is the lead time considered here. Both value stream maps and existing data have been used in the analysis.

Value stream maps

The value stream maps completed for three of the local collecting points in Europe as well as the value stream maps for the regional collecting point in Tongeren are important tools when analysing the total lead times. It is not possible to evaluate the different scenario proposals by looking at one value stream map at a time, but it is possible when analysing and comparing the value stream maps to each other. Therefore the value stream maps described in chapter 4.2 have been consolidated. The consolidated results are shown in table 12.

SCHWEINFURT	**CT (min)**	**WT (days)**
Send goods to ECP	x	x
Put goods on stock	x	x
Repack goods	x	x
Scrap goods	x	x
Send goods to PDIV (without further action)	x	x
Send goods back to customer	x	x
AIRASCA		
Send goods to ECP	x	x
Put goods on stock	x	x
Repack goods	x	x
Send goods to PDIV (ADM)	x	x
Send goods to PDIV (TER)	x	x
Send goods to PDIV (non-Italian)	x	x
GOTHENBURG		
Send goods to ECP	x	x
Put goods on stock	x	x
Repack goods	x	x
Scrap goods	x	x
Send goods to PDIV (Repack)	x	x
Send goods to PDIV (Channel repack)	x	x
TONGEREN		
Put goods on stock	x	x
Repack goods	x	x
Technical Inspection		
A,C,P Items	x	x
N Items, Approved	x	x
N Items, Not Approved, Value > 4000	x	x
N Item, Not Approved, Value > 4000, Scrap	x	x
N Item, Not Approved, Value < 4000, Scrap	x	x

Table 12, Compiled lead times at the collecting points [6]

When looking at table 12 and analysing the total time it takes for different local collecting points to perform the same procedure, for example put goods on stock, it is possible to see that the times are not equal for the different local collecting points. When realizing this it is tempting to compare the local collecting points to each other and draw conclusions through this comparison, but these conclusions would neither be fair nor correct. This is due to the facts that the different local collecting points have different resources (structure, number of full time employees etc.) at hand and that the times are only estimated. Moreover, there are also uncertainties with the times estimated by the personnel due to personal objectives and there might be cases where these times are estimated to low in order to reflect the local return handling process as more efficient than it

[6] Figures have been censored in the report but are presented to SKF and are available for the supervisor at Chalmers

actually is. For example, in the data compiled from the Schweinfurt database the average lead time for administrative returns was calculated to XX[7] days while the longest lead time in the value stream mapping was around half as long.

But even though it is not possible to draw direct conclusions about which local collecting point that is best in practise, it is still possible to learn from the value stream maps and the compiled lead times. Here, the observations from the empirical findings (chapter 4.2) which can be used when evaluating the different return handling scenario proposals are once again presented but this time they are also analysed further:

- Each time a returned item enters a local collecting point or the regional collecting point it takes a significant amount of time. This is true even in the cases where the item is not taken care of at the actual location but forwarded to another destination. The reasons why it takes time to forward returns are that the returns in general are sorted, registered, the sales unit is contacted (and the customer can be credited), transport documents and labels are written and the returned item must wait for transportation.
- Repack is done faster at the local collecting points compared to the regional collecting point. This is due to the fact that the regional collecting point has to order repackaging material. This knowledge does not come as a surprise since it was easy the see that many products were waiting for repack when visiting the regional collecting point in Tongeren.

Even though time can be saved by repacking at the local collecting points and not at the regional collecting point this time does not weigh as much as the time which can be saved by fewer stopovers. Although when a product in need of repack is at the regional collecting point it is still better to order repackaging material than to send the product itself to a local collecting point. Hence, the final conclusion drawn from the value stream maps is that the best solution would be the solution with the least amount of stopovers for the returns – that is alternative (4) Process proposal, decentralised structure. The only comment is if the time consuming activities executed during the stopovers in the cases where the items are forwarded could be removed. If so, the lead times for a centralised structure would improve. This option, and its consequences, will be discussed further in chapter 5.5.5 – Scenario proposals evaluation summary.

Summary

SKF return handling scenario proposals (the three future alternatives) ranked only by considering the total lead time:

- 4. Process proposal, decentralised structure
- 3. Process proposal, separated flows
- 2. Current process according to the policy

5.5.3 CO_2

General

Environmental issues are of great importance to SKF. Therefore not only the production but also other areas within the company need to be revised with considerations to environmental factors such as CO_2 emissions. Here, both the CO_2 calculations at SKF and the CO_2 emissions for the return handling are described and discussed.

[7] Figures have been censored in the report but are presented to SKF and are available for the supervisor at Chalmers

CO_2 calculations at SKF

Since 2005 the company has worked with a program called Beyond Zero which is an initiative with the aim to secure that SKF has a net positive impact on the environment. This includes SKF's own environmental impact but also the effect that SKF's products have on the customers' environmental impact. The main idea is that by helping the customers to reduce their impact; the total measured impact for SKF can be beyond zero (SKF 2010 Sustainability report).

SKF has identified CO_2 as the greenhouse gas of most importance which derives from the business and the company is actively measuring the amount of CO_2 emitted according to the GHG Protocol. The GHG Protocol is a partnership between the *World Resources Institute* and the *World Business Council for Sustainable Development* and the protocol is the most recognised tool for green house gas emission calculations (www.ghgprotocol.org). In 2006 SKF decided to reduce their total CO_2 emissions with 5% annually.

SKF are working with sustainability questions in a proactive way and the company is recognising sustainability as a key strategic issue instead of just adapting to regulations and guidelines. "SKF is committed to sustainability – not only as a responsibility but also as one of the strategic drivers – Profitability, Quality, Innovation, Speed, and Sustainability" (SKF 2010 Sustainability report). One example of this proactive way of working is the implementation of solar cell modules on the roof of the international warehouse in Schweinfurt. These cells supply the warehouse with 90% of the power requirements (SKF Intranet).

CO_2 emissions for the return handling

To be able to calculate the total amount of CO_2 related to the return handling process there are different sources of CO_2 that need to be evaluated. The main source of CO_2 is the transportation of the returned goods. Other sources of CO_2 are the storing, handling, and administration of goods.

In all cases of storing, handling, and administration of returns at SKF the activities are performed in general warehouses for forward logistics that provide the return handling departments with small areas within the warehouses. In other words, it is hard to allocate CO_2 deriving from the return handling from a storing point of view. Moreover, the return handling activities such as handling and administration correspond to very low CO_2 emissions and the only activity that by some means could be targeted for CO_2 calculations is the movement of the returned goods with forklifts. However, this amount of CO_2 would be very time consuming to estimate and would not provide a significantly important result for this thesis.

The CO_2 in this thesis present one important objective in the process of evaluating different return handling scenarios. The different scenarios basically present different levels of centralisation of the activities related to storing, handling, and administration. However, these activities provide a low level of CO_2 in general and the emission can also be assumed to be relatively constant and independent of the location. The CO_2 deriving from storing, handling, and administration could therefore be assumed to be equal for all the different scenarios.

The remaining activity is then the transportation which represents the large source of CO_2 emissions. The scenario corresponding to the lowest level of CO_2 would be the scenario that implies the lowest amount of transportations in terms of weight and distance. In this case it is possible to assume the same transport mode and the same fill rates no matter if considering a centralised or a decentralised return handling structure. This assumption can be done because the transportations between the international hubs are carried out with mostly full trucks by the daily transport system, DTS.

The scenario proposals with the least amount of transportation are the most decentralised scenarios. This is motivated by the fact that the returned goods are inspected as soon as possible and sent to the right location right away. In this way, unnecessary transportation is eliminated.

Scrap products are scrapped right away in the decentralised scenario proposal and not transported to be scrapped. Returned goods in need of technical inspection are sent directly to the owning factory (PDIV) instead of going via the RCP.

The conclusion is that with a CO_2 perspective, the decentralised scenario will always be preferable. However, this result is based on the simplification that only transportations are worth calculating and on the assumption that all trucks within the daily transport system, DTS, are sent full. Moreover, this result only represents the CO_2 perspective and assumes that the monetary resources are unlimited and that it is possible to fully equip a decentralised structure with the right competence in order to do correct inspections.

Summary
SKF return handling scenario proposals (the three future alternatives) ranked only by considering CO_2:

- 4. Process proposal, decentralised structure
- 3. Process proposal, separated flows
- 2. Current process according to the policy

5.5.4 Customer's convenience of making a return

General
When presenting a future scenario proposal for the return handling at SKF it is vital to pay attention to the customers. It is important for every company to have good relationships with its customers, and this statement might be even more accurate when it comes to handling returns. When the return is due to a sales error, delivery error or technical error the customer expects a fast, smooth and professional management. In the cases of customer errors or stock cleansings the demands are not as high but still it is of great importance for the company to have a professional approach. Smooth return handling can be an area where a company can obtain competitive advantages, no matter the reason for the return.

When analysing the different scenario proposals with consideration to the customer's convenience of making a return there are mainly two aspects which need to be taken into consideration. The first one is the lead time, both the response lead time and the credit lead time, and the second one is the fact that SKF needs to have one face to the customer so that the customer does not have to contact different units within SKF or send return items to different locations.

Response lead time
When a customer has a return the customer contacts the sales unit in the area. This is the same sales unit the customer contacted when purchasing the products. When the sales unit approves the return the response lead time is over. The approval is based on information given by the customer and the decision is usually taken immediately and almost always within 24 hours. In case the return is approved most sales units send an e-mail with a return label to the customer. The response lead time is not mentioned as a problem by SKF and there is no reason to change this procedure for any of the possible future scenario proposals.

The only scenario that might have longer response lead time is alternative (3) Process proposal, separated flows. In this proposal the sales unit has to include not only the first destination the return should be sent to, but also the final destination on the label sent to the customer. But in case alternative (3) Process proposal, separated flows, is the one chosen, the idea is also that the general return handling processes and systems will improve and that this information will be given automatically. Therefore this lead time has no impact on the ranking of SKF's return handling scenarios. All scenarios are equal in this matter.

Credit lead time

The other lead time which is important for the customer is the credit lead time, or the time it takes until the customer is credited. SKF mentions this lead time as a perceived problem today since it in some cases can be to long.

For alternative (2) Current process according to the policy, the idea is that all returns except technical errors, TER, should be forwarded directly to the ECP from the local collecting points and not be inspected until they arrive at the ECP. For this alternative the credit lead time for these returns can be longer since the customer can not be credited before the condition of the return is determined and the time of the cross docking at the local collecting point is not equal to zero. This reasoning is also accurate for alternative (3) Process proposal, separated flows. Here, the final destination is already determined by the sales unit and the goods is only cross docked at the local collecting point and not visually inspected if it is not already at home. For alternative (4) though, Process proposal, decentralised structure, the credit lead time can be shortened in all cases except for the technical errors, TER, where the credit lead time remains the same. This is due to the fact that in this alternative all returns except TER are inspected after arrival at the local collecting point before further decisions about where to send the goods are taken.

One face to the customer

If a customer has to contact different units within SKF for purchasing products, get return approvals, receive answers regarding the returns and receive answers regarding crediting it is not optional. It would also be both annoying and time consuming for the customer if different SKF products had to be sent to different locations.

Today the customer contacts its sales unit when purchasing SKF products. The same sales unit is contacted for returns. This sales unit either directly tells the customer to what address to send the returned items or sends an e-mail with a return label and the address. The address is always the same. There is no reason to change these procedures for any of the return handling scenario proposals and therefore this factor has no impact on the ranking. All scenarios are equal in this matter.

Summary

SKF return handling scenario proposals (the three future alternatives) ranked only by considering the customer's convenience of making a return:

- 4. Process proposal, decentralised structure
- 2. Current process according to the policy, 3. Process proposal, separated flows

5.5.5 Scenario proposals evaluation summary

Further reasoning

When putting all the evaluations (cost, lead time, CO_2 and the customer's convenience of making a return) together it is possible to see that all of them point in the same direction:

- 4. Process proposal, decentralised structure
- 3. Process proposal, separated flows
- 2. Current process according to the policy

Hence, the scenario proposal recommended is alternative (4), Process proposal, decentralised structure. This alternative is presented further in chapter 5.4.4.

When looking at alternative (4) it is possible to see that the EDC in Tongeren is in place but that the ECP does not exist. This is controversial and needs to be discussed and analysed further. After taking the consolidated work executed in this thesis under consideration it is possible to realize that:

1. Customers in many countries in Europe (Belgium, Finland, Poland, Netherlands, Spain, Portugal (through Spain), Hungary, UK, Austria, Switzerland, the Check Republic and Turkey) send their returns to the ECP in Tongeren and not to one of the LCPs. In many cases the returns go via a hub in the country in question, but in these cases the hubs send the returns directly to the ECP.
2. EDC stocks a high degree of designations. It is even possible that products produced at a site (where they can also be repacked) are not stocked at the corresponding FWH. This statement is even more accurate for products packed in single pack. The FWH might stock multi packs but not singles, and the returns are to a high degree single packs. In the case of repack, a product sent to repack at one site might still have to be forwarded to Tongeren afterwards.
3. It is cheaper to ship a product from a LPC to Tongeren than it is to ship products between different LCPs. The tariffs are not dependent on the reverse flows but are based on the flows of the forward supply chain. Due to the fact that the reverse flows are small compared to the forward flows the tariffs will not change even if the reverse flows change.
4. The procedures for returns at the ECP are well functioning and the needed equipment is in place.

Due to the statements above it would not be wise to remove the return handling from the ECP. The evaluations (cost, lead time, CO_2 and the customer's convenience of making a return) are comparing a centralised proposal (alternative 2), a decentralised proposal (alternative 4) and a proposal somewhere in between (alternative 3). The conclusion from the evaluations is that the decentralised proposal (alternative 4) is the one preferred. However, this conclusion would not be different if ECP also handles returns and has the same rights and responsibilities as the LPCs. The structure is still decentralised, but this time with five LCPs instead of four. The name ECP will still be used though, since this is the collecting point connected to the EDC and therefore this collecting point is still somehow different from the other LCPs which are connected to FWHs.

When this reasoning is summarized the conclusion is that the preferable scenario proposal is alternative (4), Process proposal, decentralised structure with a few modifications.

How the recommended process is different from the proposal decentralised structure

In the recommended proposal the ECP exists. Everything stocked at the EDC (planned items) is sent to the EDC or to the ECP in case repack is needed. This is different from the proposal decentralised structure where all items ready to be put on stock are sent to the closest availability point, CAP, and all items in need of repack are sent to the location where this can be managed and not to the ECP.

The recommended process in detail

The fundamental idea is that all the LCPs and the ECP are able to take all decisions regarding the returns. All LCPs and the ECP have equal responsibilities, with the exception that ECP handles more repack since more products are stocked at EDC. The ECP will also receive all products in need of repack that are stocked at the EDC even if another LCP also stocks the products (see more information under *in need of repack* below). When a returned item has arrived from a customer, the item should always be inspected at the LCP or the ECP in question. A flowchart picture of the recommended proposal is shown in figure 31 below:

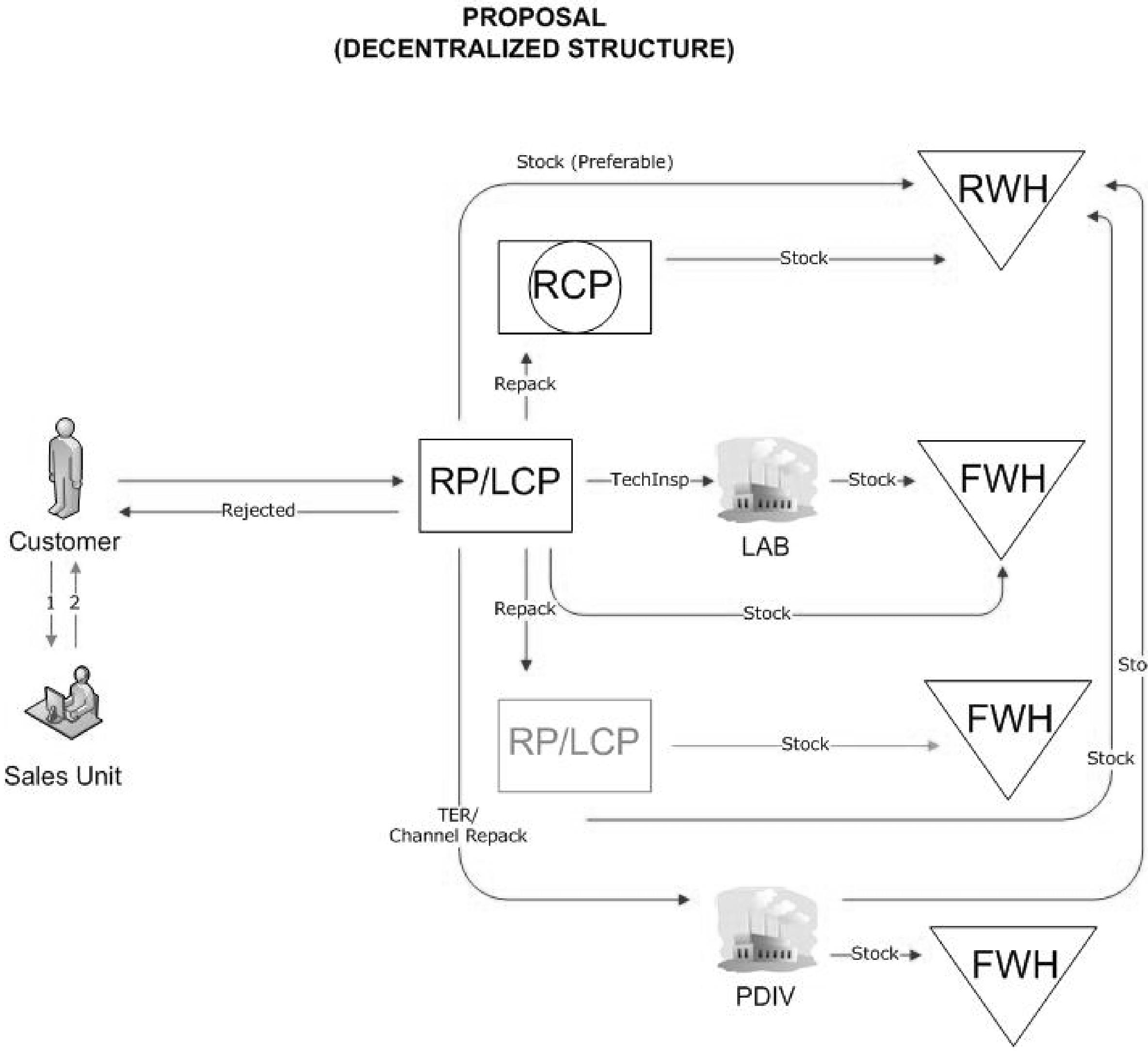


Figure 31, Recommended process (Numbered arrows are information flows)

If the return is marked as a *technical error report, TER,* the return should be sent directly to the location where a technical inspection is possible (PDIV).

If the return is intact and can be *put directly on stock* the question is where to send the item/items. In case it is possible to stock the return at the current location this is done. If this is not possible the return should be sent to the location where the pack code in question can be stocked, preferable to the regional warehouse, EDC, in Tongeren.

If the return is *in need of repack* and can be repacked at the current location this should be done. If this is not possible the return should be sent to the regional collecting point, ECP, in Tongeren if the returned product is stocked at the regional warehouse, EDC. The final possibility is that the product neither can be repacked at the current location nor has a stocking place at the EDC. In this case the returned product should be sent to the location where it can be stocked. The information above is only valid if the PS cost is above a certain amount (1000 SEK). In case the PS cost is below this amount the product should go directly to scrap or be sent back to the customer (if the customer wants the product back and is not already credited).

If the return is *in need of technical inspection* (but not originally marked as TER) the return should be sent to the location where a technical inspection is possible (Lab/PDIV). The information above is only valid if the PS cost is above a certain amount. In case the PS cost is below this amount the product should go directly to scrap or be sent back to the customer (if the customer wants the product back and is not already credited).

Pros and cons with the recommended proposal

+

General

- Shorter total lead time due to fewer stopovers
- Less CO_2 emissions due to fewer transports
- Lower transportation costs
- Good credit lead time circumstances for the customers
- Products from platforms with special requirements can be sorted out at the first entry point

Condition of product

- Scrap is scrapped at the first handling and not forwarded
- Goods in need of channel repack is sent directly to the site where this can be managed
- In case an automatic order list of repack material needed at the ECP can be sent to the PDIV in question time is saved at the ECP (reduced waiting time for packaging material)
- Goods in need of repack (not stocked at the EDC) is sent directly to the site where repack can be executed and the goods can be put on stock
- Goods that can be sent directly to stock (not stocked at the EDC) is sent directly to the location where it can be put on stock
- Goods in need of technical inspection is sent directly to the PDIV/lab where this inspection can be executed

Neither + nor –

General

- To a high degree the same circumstances for the customers (response lead time, credit lead time for TER, one face to the customer) as today
- No difference in the handling costs for the returns

Condition of product

- TER is handled in the same way as today (sent directly to the PDIV)

Product category

- VSM products are sent directly to St Cyr where they can be handled by their personnel, this is a preference given by VSM. This is the same procedure as executed today

-

General

- More uneven workload at the LCPs when STO appear. With this proposal STO can not be directly forwarded to ECP but needs to be inspected before a decision is taken. STO are not lead time sensitive though which means that the LCPs can handle the STO at their own pace

Condition of product

- Goods in need of repack (stocked at the EDC) is inspected at the first entry
- Dependent on if it is possible to send goods to be put on stock at the EDC directly from a LCP to the EDC and not via the ECP. If not, this proposal is a disadvantage for goods to be stocked at the EDC (administrated two times)

How the recommended proposal would affects the LPCs and the ECP

The new proposed structure will imply some shifts in workload and the general conclusion is that some of the responsibilities and work tasks will be moved from the ECP to the new LCPs in Schweinfurt, Airasca, St Cyr, and Gothenburg. Below follows a description of the changes this will cause for the different entities.

The ECP in Tongeren

The ECP will still exist in the recommended proposal and it will keep the name the European collection point. However, the function of the ECP will be the same as for the LCPs. This means that the ECP will have its dedicated market of customers sending goods directly to the ECP. The ECP will take care of the goods that could be stocked at the EDC, and forward the rest to the right location.

The total amount of returns that will arrive at the ECP will be smaller since the LCPs will keep a part of the returns. The personnel at the ECP are today working with other tasks than return handling and during the site visit it was mentioned that temporary employees are used for return handling activities such as repack. The changes in work load should not drastically affect the number of full time employees needed since there are other tasks to be performed as well. However, the need of temporary employees should be eliminated and in the long term, the combination of reduced amount of returns and the possible efficiency improvement can result in a reduced workforce handling returns.

LCPs in general

The other LCPs; Schweinfurt, Airasca, St Cyr, and Gothenburg, will after the structural changes take care of more returns than they do today. One exception is the LCP in Schweinfurt which already goes against the policy and keeps all the returns that is stocked in Schweinfurt. This LCP will more or less handle the same amount of returns as today. The other LCPs, Airasca, St Cyr, and Gothenburg, will handle a larger amount of returns than they do today. The increased amount of returns should be possible to handle for the existing personnel but the time dedicated to return handling might have to be increased. However, much of the additional work could be compensated with a more efficient process based on the proposed improvements.

The new structure would also shift some of the repacking activities from the ECP to the four new LCPs in Schweinfurt, Airasca, St Cyr, and Gothenburg. It was previous argued that there could be economies of scales associated with the repacking activity and there could be disadvantages by moving some of the repacking away from the ECP. But on the contrary, all the LCPs already have a repacking area not associated with returns. It should then be possible to obtain the same economics of scale benefits at the LCPs as at the ECP.

Moreover, in the recommended structure, all the returns will be inspected at the first point of entry. After this many returns will be forwarded to a specific destination for a determined action, and in these cases it is of high importance that the registered information from the first LCP is communicated in a good way to the receiving destination. In other words, one important requirement is that the information is well communicated between the different LCPs.

How the recommended proposal would affect the different divisions and product platforms

In addition to the evaluation based on cost, lead time, CO_2, and the customer's convenience in making a return it is important to analyse how the recommended scenario will affect the different platforms within SKF.

One business unit within the automotive division previously mentioned in chapter 4.1.3 is the vehicle service market, VSM. Today they have their own return handling process and they prefer to keep it in this way. This means that the VSM returns need to be sorted out and sent to their facilities. The recommended return handling structure would serve these requirements well due to the fact that the returns are inspected at the first point of entry and the VSM returns can directly be sorted out and forwarded to the VSM facility.

Other product platforms consist of large products that usually are sent back to the PDIV. These returns can also be sorted out at the first point of entry and forwarded to the corresponding PDIV.

The different platforms' requirements favour the recommended decentralised structure over a centralised structure since the products can be sorted out at the first point of entry. Moreover, it means that the customers can send all their returns to the same LCP and that the LCP can sort the returns and forward them to the correct destination.

5.6 Possible general improvements

This chapter will present possible improvements that could be implemented in the return handling process. The majority of the improvements are concerning the general return handling process regardless of which return handling structure that is chosen.

In the frame of reference (chapter 2.1.3) the five following possibilities to reduce the cost of reversed logistics is presented:

- Improved gate keeping technology
- Partial returns credit
- Earlier disposition decisions
- Faster processing / shorter cycle times
- Better data management

The aspects *Improved gate keeping technology* and *Earlier disposition decisions* have already been considered and covered in the recommendation of a decentralised structure. The returns will be sorted and inspected at the first point of entry and non-approved returns can be sorted out directly before they enter the return handling system. Moreover, the aspect *Partial returns credit* is already implemented at SKF. Different credits are given to the customer based on the condition of the product etc. The remaining aspects *Faster processing and shorter cycle times* and *Better data management* will be investigated further in the sections 5.6.1 and 5.6.2 below. Moreover, section 5.6.3 about waiting time reduction is added as a result from the performed value stream mapping.

5.6.1 Faster processing and shorter cycle times

Making the processing faster and reducing the cycle times would have a positive impact on both the total lead time and the costs associated with return handling. Below follows various areas with possible improvements.

One important part of the cycle time is the time spent on administration of the returns and this will be considered in the next section, chapter 5.6.2.

Policies and procedures

One observation from all the visited LCPs and the ECP is the lack of clear policies and procedures. At all the sites where the process mapping where conducted, the task of mapping the processes and activities became complex and time consuming. The mapping was mainly performed by questioning the personnel working with the return handling and the answers were almost only given based on experience. There were in no cases any references to a policy or to procedures. At one of the LCPs, the personnel even stated the lack of policies and procedures as a problem.

The activities performed by the return handling personnel are based on experiences but also on personal logic. During the site visits, it became evident that these logics are different for the different LCPs but also different for different people within the same LCP. In other words, there is no established best practice of the return handling activities.

One apparent drawback with this lack of common working procedures is that the process and the activities are not carried out in the most efficient way. Moreover, the variations cause inefficiencies when one employee's tasks are dependent on several other employees with different working standards. One example of this is the communications between the LCPs and the ECP. If each LCP uses their own standards, the ECP has to deal with several different standards.

It is obvious from the previous reasoning that there are efficiency advantages and improvements that are possible to obtain with a set of standardised working procedures. Moreover, most of the personnel working with return handling are not only dedicated to return handling but are working on other tasks as well which also promote clear working procedures. In addition, clear working procedures would also facilitate the use of extra personnel (which is frequently used today).

The working procedures should for example include a short description of all the types of returns that are handled at the specific location, step by step working instructions, guidance and screenshots from all systems in use, and contact persons for the other involved units.

Reduced handling when forwarding goods

The goal is to reduce the time spent on return handling in each activity but also to eliminate activities that are not necessary. Examples of these activities are some of the activities associated with forwarding goods.

For example goods that should be forwarded to the ECP is in most cases brought into the return handling area of the LCP, opened in order for the personnel to identify and sort out goods that should be forwarded, administrated on the computer, closed, and scheduled on a transport and sent away. If the boxes could be marked in a better way with the address to the ECP, many of these steps could be eliminated. One question that needs to be analysed further is if it is possible to just cross dock the goods and put it on a truck without the administrative work. (This example is applicable for the centralised structure where everything should be forwarded to the ECP but in the given decentralised recommendation this problem and related improvement would not be relevant).

Eliminate low value returns

One way to reduce the costs for return handling would be to set a limit for the lowest value to handle as a return. One example of this is what the VSM business unit calls "No quibble complaints". With this concept items under a specific value are not taken back from the customer, instead the customer is asked to keep the return for two months and they are told that SKF might do a random inspection during this time period. The customer is credited right away and can scrap the goods after the two months period. This concept would reduce the costs associated with the handling of low value returns, shorten the credit lead time for the customer, and also reflect that

SKF put confidence in the customer. The exact value limit needs to be investigated further though.

5.6.2 Data management

Better data management is already mentioned in chapter 2.1.3 as a tool to reduce cost. One importation observation during the site visits and the process mapping was the excessive amount of manual work associated with administration of the returns. The manual work consisted of looking up information such as PS cost, stock location, and corresponding PDIV in different databases. Moreover, a lot of time was spent on communicating with other units. Examples of this are when repackaging material at the ECP needed to be ordered from a LCP or when a PDIV needed to be asked for approval to return non planned items. These activities were automated with an access database to automatically send out e-mails regarding these issues but the overall return handling process was not efficient.

Decision making

One problem identified with the decision making was that many decisions regarding the returns were taken for each specific return leading to the same decision being taken several times. After the returned product is inspected and the condition of the product is determined, there is additional information affecting the decision about what action to take with the return. Necessary information regards if it is a planned or a non planned product, where it is stocked, the PS cost, and where it is produced (at which PDIV). For one product designation, these attributes will remain the same if not considering long term changes and cost variations. In other words, the decision that is taken manually for each return and for each condition of the product should always be the same for each designation.

After the returned product is inspected the condition is set to one of the four following states; intact (to put on stock), in need of repack, in need of technical inspection, or scrap. For each one of these decisions, the necessary information is specified in table 13 below:

Condition of product	Necessary information
Intact (to put on stock)	Where can it be put on stock?
In need of repack	Does the value of the item exceed the repack limit? Where can it be put on stock after repack? Where does the packaging material exist?
In need of technical inspection	Where can the product be technically inspected/where is the PDIV?
Scrap	Where should it be scrapped? (Or should it be sent back to the customer?)

Table 13, Information needed for each condition

In addition to the information in the table above, there might in some case be necessary to know what type of error the return is classified as. For example, for the error type TER a technical inspection might be conducted even if the value of the product is below the limit for technical inspections for other types of errors.

One exception that needs to be considered is when the condition of the product is set to “scrap” but when the customer will not be credited. In this case, the customer should have the option to receive the products in return. This is valid when the error is made by the customer, in other words when the return is classified as a CER or STO.

Another exception is for non planned items that are produced to orders and therefore don’t have a stocking location. For these products, the corresponding PDIV needs to be asked if it can take the products back. The decision is based on if the PDIV believes that there is a second market for the product or not.

Product database

Based on the assumptions and conclusions above, it would be possible to establish a database where, for each designation and condition of the product, the required action and destination would be determined.

The information that is needed is: PDIV (which could be found in Prodmast), Stock category (which could be found in ICSS for each designation and pack code), PS cost (which could be found in COH or Prodmast and also in the return database), and the type of error (which is provided by the sales unit and could be found in the return database).

One alternative would be to set up a separate database containing all designations (and for all designations the different pack codes) and the corresponding action and destination for each condition decision. This database could be used to look up each returned product. However, this would also imply manual work and one new database in additional to the Customer Return Processing database.

Another alternative would be to use the already existing Customer Return Processing database and add information about the PDIV and Stock location (Stock category exists but does not specify all stocking locations). The PS cost and the error type is already in the database. The return handling personnel should then only need to enter the quantity of each product that arrived and the condition of these. The database should then automatically determine the action and destination of the returns. In case a return is forwarded to another LCP for some action, this information should be registered in the database and available for the receiving LCP. It should be evaluated further if these modifications of the database would be feasible.

One field that should be added in the database in the case of CER and STO returns is weather the customer wants the product back in case of scrap without given credit note. This should be asked by the sales unit representative when registering the return. By adding this information in an early stage, there is no need to wait for a customer decision later in the process.

For the non planned products where the PDIV is asked for approval of the return, it might also be possible to establish a fixed list of which products that can be taken back. It should be possible for all PDIVs to continuously make changes to this list.

Information transparency

In addition to the identified problems with manual decisions, there is also a communication problem between the different actors and units involved in the return handling and there is no information transparency.

One way of increasing the transparency could be to implement one common information system. As it is today, there is a common database where all returns should be registered, the Customer Return Processing database. But due to the current structure where the policy is not followed, many returns are not registered in the database. An example of this is in Germany where only the returns that are sent to the ECP are registered in the database. At some of the LCPs and at the ECP there are also local databases which are not accessible for the other units.

The Customer Return Processing database is set up for a centralised structure and today only the personnel at the ECP can modify the returns registered by the sales units. The recommended decentralised structure would therefore also require some system support for the LCPs.

Improved return handling
If the data management could be improved with the previous proposals it would have significant impact on the return handling administration activities. When the return arrives at either a LCP or at the ECP, the return handling personnel would be able to use the return number to view the information about the return. The only decision needed to take is to determine the condition of the product. The condition of the product for each designation (if more than one) would be filled in and information about the next actions and destinations for the products will be given by the system. In case the products needs to be forwarded somewhere, the system should be able to automatically print transport labels with the correct destination based on the predefined course of action for the product and for the condition of the product.

Technical improvements
To improve the return handling further, one suggestion is to automate the process with scanning equipment that could scan the return label and open the return case in the database. The actual product could also be scanned to automatically control that it corresponds to the stated product.

5.6.3 Waiting time reduction

According to the results from the value stream mapping the by far biggest part of the lead times is represented by waiting times.

Prioritisation
One observable reason for the long waiting times is that the return handling process is of low priority. This is reflected in many different areas, for example in the information systems, number of personnel, and transportation. The information system part was discussed in the previous chapter (5.6.2) and the other two parts will be discussed here.

The major fraction of the waiting time for the returns is when the returns are waiting for action by the personnel. It was concluded during the sites visits that the majority of the personnel were not dedicated to return handling and that the other tasks in general were prioritized. It would be possible to shorten the lead times significantly by adding more resources and there is in this case a clear cost / lead time trade off.

The same logic applies to the transportations of the returns. The returns are scheduled for transportation when there is available space in the trucks. The returns are also here given a lower priority than the goods in the forward supply chain. However, by sending the returns when there is available space in the trucks, the fill rates can be improved and there might not be reasonable to add more resources for transportations in order to reduce the lead time. The general waiting time for transportation is a couple of days.

Waiting for decision
Another significant contribution to the overall lead times is the time the returned goods are waiting for decision. One example of this is when the PDIV is asked for approval before the return handling personnel are returning non-planned products. This waiting time could be reduced with the proposed improvement in chapter 5.6.2 where the idea is to determine what products that can be returned beforehand.

Yet one further waiting time contribution is returned products that are waiting for packaging material. This waiting time could also possible be reduced by ordering the material in advance (these improvements are valid for the decentralised recommendation).

6 Discussion

In this chapter the results of the analysis are discussed from both a theoretical and a practical perspective. The chapter is divided in five sub sections: *Reverse logistics, The chosen method, The model, The result* and *Contradictions in the result.*

6.1 Reverse logistics

Compared to other logistics issues not much is written about reverse logistcs. In addition, parts of what is written are analyses of why not much is written about reverse logistics. Even this thesis contributes to this area. Both by having a frame of reference where it is clearly stated, for example "traditionally reverse logistics has attracted little attention as companies have focused on the forward moving supply chain" (Retzlaff-Roberts 1998) and by coming to the same conclusion when trying to find and receive answers from possible benchmark companies. So even though several years have passed since Retzlaff-Roberts stated the citation above this still seam to be a pressing issue: both the fact that it is difficult to find newly written material about the subject, and the fact that companies do not pay as much attention to the subject as they could have done. There are no easy solutions to this question since the forward supply chain always will remain both bigger and straighter forward than the reverse chain. It is easier to set up theoretical structures for the forward supply chain where, to put it simple, goods are moving from one destination to many, instead of the opposite where goods are moving from many destinations to one.

6.2 The chosen method

The actual strategies used to answer the research questions in this study were site visits, value stream maps, database studies, SKF interviews, workshops and benchmark studies.

The *site visits* were important to get a general picture over the return handling, and in addition the visits clearly served as evidence of the fact that the return handling was carried out differently at different sites. This had already been mentioned by SKF, but during the site visits it also became clear how the return handling was carried out differently. This new knowledge might not have been a major contribution to the return handling scenario analysis as such, but it served as a base when describing SKF's current return handling process. During the site visits input to the *value stream maps* were also gathered. As already stated this input was not collected through time studies, but through estimations done by the personnel. In case the same questions were to be asked again, by someone else or later by the same team, it is not only possible but also probable that slightly different answers would have been given. It is difficult to estimate average times, especially when the time span ranges from minutes up to several days, weeks or even months. However, the impact this uncertainty has on the final results of the thesis is low due to the fact that the estimated times were only used to roughly see tendencies and differences.

To collect all the necessary data to the *database studies* was one of the greatest challenges with this thesis. A general problem was that not all the returns were registered, and the calculations could only include the data available. The results are therefore based on a number of assumptions. Consequently they are also, to a certain extent, subjective and influenced by the individual's approach to the problem. However, even if all returns would have been registered uncertainties would not completely have been avoided since the amount of data is so large. Even if the results are not based on information about every single return, it is important to remember that a significant amount of time has been devoted to the database studies. By putting information from several sources together it was possible to see trends and draw conclusions from the existing material. This is something SKF was interested in, and no such thorough return handling data study had been executed by the company lately.

Yet one troublesome area was to receive answers to some of the questions asked during the *SKF interviews* or, even more accurate, to get in contact with some of the people intended to be interviewees. Sometimes it was difficult, or not possible, to receive answers and sometimes the answers received later turned out to be erroneous. One example concerns the CO_2 issue where it was not possible to receive as much information as wanted from the company due to the fact that the person intended to be interviewed changed job position. Sometimes it was also difficult to get in contact through e-mail and telephone. In the end, a couple of the questions remained unanswered, but these questions where not affecting the overall results as such.

The *workshop* in Airasca was perceived as a good way of gathering knowledge at an early stage of the thesis work. This workshop, as well as the follow-up web-ex meetings, were seen as important milestones during the work. Preparations and priorities on what to work on needed to be done before the meetings, and during the meetings additional input were given by the attendees.

Finally, the *benchmark studies* have already briefly been discussed in the previous section. Maybe it would have been possible to contact more companies, but priorities had to be made. It was not possible to thoroughly both search and go through return handling material from other companies during the time frame given.

6.3 The model

When thinking about straight off applying existing reverse logistics models to SKF it was early stated that this could not be done. It is important to remember that the models described in the theory are extremes. For some companies, one of these extremes may be the best solution, but for SKF the extremes somehow needed to be evaluated to each other both in terms of the objectives already set up by the company and in terms of other important company specific parameters. Due to the reasoning above about the fact that not much is written about return handling no such evaluating model were found. Therefore, a model had to be invented. However, without the extremes described in the theory this would not have been achievable. Much influence derived from the centralised structure on the one hand, and from the decentralised structure on the other.

The final recommended proposal for SKF's return handling is in line with what was compiled in the matrixes during the workshop in Airasca, especially since the ECP in Tongeren still exists with this proposal. This means that customers located close to the ECP still send their returns directly to the ECP. If the ECP should have been removed, the results from the matrixes would not have fit the recommended proposal as good as it does now. Hence, the final recommendation is valid and in line with what was stated by the working group in Airasca. This is important.

It is also possible to see that the working procedures during this thesis follow the supply chain network design for forward logistics presented in chapter 4.2. The Spinnaker Management Group LLC's (2011) network design divides the process into three phases; *Strategy Development, Scenario Evaluation, and Operational Planning*. In this thesis, first critical issues were identified and the model was set up to recognize different scenario proposals. Afterwards these scenarios were evaluated to each other, and a recommended proposal was presented. Finally, both general improvements and the impact the recommended proposal would have on the different units were described.

6.4 The result

When drawing conclusions it is important not to forget the set up limitations and to analyze how these limitations could have affected the outcome. Four limitations were set up in the beginning of this thesis (see chapter 1.3). These limitations were to only consider *external returns, the physical flow, the product return part* and the *European market*.

If not only the *external returns* but also the internal returns were to be considered this thesis would have a different character. The internal returns are products which SKF for some reason are moving from one SKF site to another. First of all, these returns are already in the system and the daily transport system, DTS, can be used from start. The same transport system is also used for the external returns once they enter the SKF system and no changes to the DTS network have been considered. Second, there is no customer since these products have not been purchased. And as a consequence of the second statement, the condition of these returns is also already known. The external returns and the internal returns may travel with the same transport between the different SKF sites, but still they come from different sources and therefore need to be handled differently.

Concerning the second limitation, not only *the physical flow* has been considered. Also the information flow (not least in chapter 5.6) and the financial flow (matters concerning the credit lead time) have been discussed. Both the information flow and the financial flow are important parts of the return handling, but the structure have not been set up with these flows primarily in mind. Instead the physical flow has been the primary flow and consideration has been taken to the information flow and the financial flow when evaluating the different return handling scenarios. This feels like the natural way of tackling the problem, since it is the physical products that are being returned.

Concerning the third limitation, *the product return part*, this limitation roughly follows the reasoning of the first limitation: the product return part and the empty package material and the end-of-life products are different things and can not be handled in the same way. If this thesis would consider them all, less attention would have been given to the product return part and different handling procedures would probably have been presented.

Finally, this thesis has been focusing on the *European market* but SKF also has markets in America and Asia, with regional collecting points in Crossville (US) and Singapore City (Singapore). No information has been collected from these regions and therefore it is not possible for the authors of this thesis to describe or draw any conclusions from SKF's American or Asian return handling. What is possible for the company though is to use the set up model in this thesis even for these markets. In this case the parameters in the matrixes would need to be discussed, but the scenarios and the objectives would still be the same. It would have been interesting to do this research and to see the results, but it is not possible within the time frame for this thesis.

6.5 Contradictions in the result

When comparing the result with the originally identified problems and the presented theory there are some contradictions that need to be discussed further.

The first contradiction regards the identified problem of non system compliance for the recommended decentralised structure. One well known problem related to decentralised systems in general is the risk of non system compliance and local variations. However, in this case the proposed changes to the system are in line with the procedures already executed by the LCPs. It could therefore be assumed that the transition to the new system will be easier and that the personnel at the LCPs will feel that they have been involved in the decision and that it makes sense to follow the new system. But still, it is of high importance to be aware of this risk during and after the implementation.

The second contradiction regards the presented theory which state that there are cost benefits with a centralised system, but the cost evaluation performed in this thesis favours a decentralised structure. However, this contradiction can first of all be explained by the assumptions drawn from the site visits saying that there are no economies of scale in the administration and handling of returns, and that the personnel are not dedicated to return handling only but will also have other tasks to balance their time with. Second, the decision regarding the action of the return is taken almost immediately by only a visual inspection and it is therefore better to do this visual inspection early and sort out scrap and send the remaining goods to their final destination. Third, SKF's products are produced at many different locations and due to the fact that only the producing unit can perform the technical inspection, the products are usually forwarded from the central collecting point to many different locations. In the decentralised structure the products can be sent straight to the corresponding producing unit. Finally, the high variety in SKF's product portfolio makes it necessary to sort out some of the returned products and send them to a separate return handling facility immediately. It is more efficient to sort them out at the first point of entry than to first send them to a central collecting point and then sort them out.

7 Conclusion

This chapter consists of the three subsections: *Conclusions from the work*, *Contributions from the work,* and *Prospect of future research*.

7.1 Conclusions from the work

Most research in the field of logistics has been focused on the delivery of products to the market and there has been limited research on the reverse logistics process. However, companies paying attention to their reverse logistics processes can add value through reduced cost, reduced cycle time, improved environmentalism and improved customer service. SKF did not only realize this, but they had also noticed that their current return handling policy was not executed in the way it was set up to be. When the sites that handles returns had been visited this was also clear to the authors of this thesis. Every site handled the returns differently and they had all set up their own procedures. By handling the returns in a more structured and non exception-driven way, it will be possible to keep track of the returns, both for SKF and for the customers. There are also many benefits in terms of cost, lead times and CO_2 emission to gain and sub-optimisations could be avoided.

By developing a model for how the return handling structure could be set up based on reversed logistics strategies from the theory and on different company specific parameters, a couple of return handling scenario proposals for SKF could be presented. Together with data from different databases both the site visits and these proposals were needed in order to answer the research questions addressed in this thesis. Here, short answers to these questions (presented in chapter 1.2.3) will be given:

1. *What is the scale and nature of returns at SKF?*
   - Due to reasons of confidentiality, the scale of returns at SKF will not be presented in this thesis. The nature of the returns was given by analysing the data from different return databases. Given by the data, for various reasons, only a small share of the registered returns arrived at the ECP. It was concluded that of the returns that arrived at the ECP, the majority was of the error type STO (about 78%). The rest of the returns had an even share of DER and SER. Moreover, when considering the condition of the returned products, the majority (about 73%) were intact and ready to be put back on stock. The rest of the products were scrapped (about 12%), repacked or technical inspected (about 15%).

2. *How does SKF's current return handling process look and work like?*
   - The current return handling structure is complicated and carried out differently at the different sites handling returns. One site might follow the policy, another will not, and a third might follow the policy in some cases but not in all. The personnel working with returns are asking for directions on how the return handling could be organised in a more structured way. The total lead times for the returns are long, and the return handling is not prioritized.

3. *How could different scenarios for SKF's return handling look like and function? How are they compared to each other in terms of:*

   a. *Cost?*
   b. *Lead time?*
   c. *CO_2?*
   d. *Customer's convenience of making a return?*

   - Four different return handling scenarios where discussed: the current process "as is", the policy, a proposal with separated flows, and a proposal with a decentralised structure.

Since the current process "as is" was not considered as an alternative for the future only three return handling scenarios where compared to each other in the terms stated above in research question 3. For the terms a, b and c the decentralised structure were considered to be the best alternative and for the term d all the alternatives were considered to be equal. Hence, the best alternative was the alternative with the decentralised structure. With a few improvements the decentralised structure turned into the recommended proposal.

7.2 Contributions from the work

As stated earlier reverse logistics have not been a prioritized subject neither in theory nor for companies in general. In this thesis a frame of reference in the subject has been compiled, and in addition companies have been contacted for benchmark. By doing this, and not least by analysing SKF's return handling process, the subject has gained attention.

One important breakthrough in this work was the development of the model. The model was used to analyse how the return handling structure could be set up depending on different company specific parameters, and this model was not specific for SKF – only the parameters where. The model combines theory and company specific needs for return handling. By setting up its own important parameters, any company with return handling could use the model for improving the return handling process.

The contributions to SKF can be divided into contributions that immediately will affect SKF and contributions that will affect SKF in the future. The immediate contributions are mainly the given understanding of the scale and nature of the returns at SKF but also the presented theory regarding reversed logistics and return handling in general. Moreover, the thesis has highlighted many exceptions from the policy in the return handling that were not previously known. The contributions for the future are depending on how the recommendation is handled and followed at SKF. If the proposed return handling structure and the proposed improvements are implemented there are great benefits to obtain in terms of the objectives cost, lead time, CO_2, and the customer's convenience of making a return. The recommendation could also serve a base for further analysis if more information is needed in order to restructure the return handling process.

7.3 Prospect of future research

This thesis can serve as the starting point for future research, both in general and for SKF in particular. Some ideas are presented:

In general:

- How could the model set up to analyse how different return handling scenarios could look like be improved?

For SKF:

- Are the parameters set up in the model the same for Asia and America as for Europe? Would the parameters' ranking be similar? What would be the outcome when analysing the matrixes with these other markets in mind?
- With inspiration from this thesis, could the return handling for empty packaging material be improved?

8 Recommendations to the company

The primary aim given by SKF was to evaluate the current return handling process in Europe and to decide upon an optimal process for the future. The objectives given by SKF were *Cost*, *Lead time* and *CO_2 emissions* and in addition to these, the additional objective *Customer's convenience of making a return* was added. Based on observations of the return handling requirements at SKF and different return handling strategies given by the theory, four different scenarios were identified and evaluated in terms of the stated objectives. Here, the final recommendations to the company are presented. This chapter consists of the sections *European return handling structure*, *Possible efficiency improvements* and *Aspects for further evaluation*.

8.1 European return handling structure

The evaluation showed that for all objectives the preferable scenario was the scenario called the decentralised structure. The recommendation to SKF is therefore to restructure the current European return handling process and to implement the proposed decentralised structure described more in detail in chapter 5.4.5. This means leaving the implemented centralised policy and change to the decentralised structure that has already been partly practiced at the local units.

The recommended structure would result in five local collecting points located in Tongeren, Schweinfurt, Airasca, St Cyr, and Gothenburg. The collecting points will have equal responsibilities and all have their dedicated area of customers. All returns should be inspected at the local collecting point where they arrive and the products which cannot be taken care of at the location in question should be forwarded to the right location.

8.2 Possible efficiency improvements

In addition to the overall structural change, there are many areas where efficiency improvements can be achieved. Below follows three different areas of improvements and the recommended course of actions for each one of them:

The first area of improvement is the administration and handling of forwarded goods. Today goods in need of technical inspection and returns that are to be put on stock at another location are sent through a local collection point. For example goods sent for technical inspection at the PDIV in Gothenburg are first sent to the return handling in Gothenburg which in turn sends the goods to the technical inspection. In order to reduce the amount of handling and administration, the forwarded returns should instead be sent directly to the final destination. One other improvement that would decrease the amount of handling and administration is to allow the customer to scrap products of low value instead of sending them back to SKF. However, this should be done with the constraint that the customer needs to keep the products for a set time limit and that SKF might do a random inspection of the goods during this time. This would be in line with the "No quibble complaint" concept used by the business unit VSM.

The second area of improvement is the data management. When a return is administrated at a collecting point, several different sources of data are used to collect the information necessary to take a decision about the return, and the decision is taken manually on a one off basis. This activity could be improved by a better data system containing all necessary information and also predetermined courses of action for the different products and for the different conditions of the products. For example, product X in need of technical inspection should always be sent to the same unit for inspection and this information could be given by the system. This would reduce the data collection from different sources and simplify the activity.

The third area of improvement is the policies and procedures. A set of standardized working procedures would make it possible to implement a best practice for the return handling activities. It would also facilitate the training of new personnel and temporary employees. Moreover, a clear return handling policy well communicated to all the return handling units would assure that decisions are taken on the same basis and according to a general agreement. One example where this can be improved today is when the ECP forwards returns for technical inspection and the returns are scrapped by the receiving unit because the value of the product is not high enough for technical inspection.

8.3 Aspects for further evaluation

The recommended course of action requires an implementation of a new return handling process. Before this new process is implemented it is important to investigate the implementation of the current process and to analyse why this process was not followed. It should also be thoroughly investigated how the new process should be implemented in the best way and what people that should be involved in the process. It is also important to be aware of the fact that one of the risks with implementing a decentralised structure is that there might be hard to get system compliance from all the units.

Another aspect which needs to be investigated further is the customer areas belonging to each local collecting point. The information collected in this thesis provides some contradictions in how they are structured today and in some cases it might be more appropriate to send the returns to another LCP than the current LCP today.

9 References

Every citation made in the body of the thesis appears here. The list is in alphabetical order and written in Harvard reference style.

Amini, M.M., and Retzlaff-Roberts, D., 1999. Reverse Logistics Process Reengineering: Improving Customer Service Quality. The University of Memphis.

Autry, C.W., 2005. Formalization of reverse logistics programs: a strategy for managing liberalized returns. *Idust.Marketing Mgmnt,* 34, pp.749-757.

Bernon, M., and Cullen, J., 2007. An integrated approach t managing reverse logistics. *International Journal of Logistics: Research and Applications,* 10(1), pp.41-56.

Blackburn, J.D., Guide Jr, V.D.R., Souza, G.C., and Van Wassenhove, L.N., 2004. Reverse supply chains for commercial returns. *California management review*, 46(2), pp.6-22.

De Brito, M.P., and Dekker, R., 2002. *Reverse logistics – a framework.* Econometric Institute Report EI 2002-38, Erasmus University.

Guide, J., V.D.R. and Van Wassenhove, L.N., 2003. *Business Aspects of Closed-Loop Supply Chains.* Pittsburgh, Carnegie Mellon University Press.

De Koster, R.B.M., de Brito, M.P., and van de Vendel, M.A., 2001. *How to organise return handling: an exploratory study with nine retailer warehouses.* Rotterdam School of Managenent, Rotterdam School of Economics, Erasmus University Rotterdam, magazjin ‘De Bijenkorf BV.

Krumwiede, D.K., and Chwen, S., 2001. *A model for reverse logistics entry by third-party providers.* College of Business, Idaho State University and Kansas State University, USA.

Lambert, D.M., and Stock, J.R., 1981. *Strategic Physical Distribution Management*, Homewood, IL: Irwin, pp.19.

Li, X., and Olorunniwo, F., 2007. *Current Practice in Reverse Logistics: Findings from Three Case Studies.* Ph.D. Department of Business Administration, Tennessee State University.

Raimer, G., 1997. In reverse. *Mater Mgmnt Distrib.,* 42, pp.12-13.

Reece, J., and Norman, L., 2006. *The Hidden Costs of Reverse Logistics, Part 1.* [online] Multichannel Merchant. Available at: <http://multichannelmerchant.com/opsandfulfillment/advisor/hidden_reverse1/> [Accessed 10 March 2011].

Rogers, D.S., and Tibben-Lembke, R.S., 1999. *Going Backwards: Reverse Logistics Trends and Practices*. Reverse Logistics Executive Council Press, Pittsburgh, USA.

Rogers, D.S., and Tibben-Lembke, R.S., 2002. *Differences between Forward and Reverse Logistics in a Retail Environment.* Supply Chain Management: An International Journal. 7(5), pp.271-282.

Rother, M., and Shook, J., 1999. *Learning to See: value-stream mapping to create value and eliminate muda.* Lean enterprise institute.

SKF (2010) *Annual report 2010 including sustainability report*. AB SKF and Admarco.

Subramaniam, U., 2004. Reverse logistics strategies and implementation: a pedagogical survey. *Journal of Academy of Business and Economics*.

SKF intranet (2011). SKF Group. www.skf.se (2011-05-09).

The greenhouse gas protocol initiative. The foundation for sound and sustainable climate strategies. www.ghgprotocol.org (2011-05-09).

The Spinnaker Management Group LLC (2011)

Volvo Parts and Volvo Parts Logistics, Volvo Group. www.volvogroup.com (2011-05-11)

10 Appendices

This chapter consists of material that would interrupt the flow of the thesis writing if placed in any other chapter. This can be lengthy data tables, complex charts and graphs, extensive listings of any kind, etc.

10.1 List of abbreviations

SKF – Svenska Kullager Fabriken

SER – Sales Error Report
DER – Delivery Error Report
TER – Technical Error Report
CER – Customer Error Report
STO – Stock cleanse
ADM – Administrative Returns (all returns except TER)

CS – Customer Service
SU – Sales Unit
RP – Return Point
LCP – Local Collecting Point
RCP – Regional Collecting Point (In Europe ECP in Tongeren, Belgium)
ECP – European Collecting Point (Tongeren, Belgium)
EDC – European Distribution Centre
PDIV – Product Division
FWH – Factory Warehouse
IWH – International Warehouse (some of the FWHs)
RWH – Regional Warehouse (In Europe EDC in Tongeren, Belgium)

MVT – Marginal Value of Time
OEM – Original Equipment Manufacturer
3PL – Third Part Logistics

COH – Customer Order Handling

PS – Performance Standard cost
DTS – Daily Transport System
SLS – SKF Logistic Services

10.2 Interviews

Person	Working area	Person located	Answered questions about	Interview form
SKF Supervisor John Öhrvall*	Group Demand Chain, Business Development	Gothenburg	Return handling	Face-to-face, Group interview, Electronic, E-mail, Telephone
Karin Hulten	Group Demand Chain, Business Development	Gothenburg	Databases	Face-to-face
Monica Udvarhelyi	Group Demand Chain, Business Development	Gothenburg	Databases	Face-to-face
Torbjörn Sedin	Group Demand Chain, Supply Chain	Gothenburg	Databases	Face-to-face, E-mail
Jonas Dahlqvist	Group Demand Chain, Logistics Services	Gothenburg	Logistics	Face-to-face, E-mail
Maria Niemi	Group Demand Chain, Logistics Services	Gothenburg	Logistics	E-mail
Claes Kristenson	Group Demand Chain, Logistics Services	Gothenburg	Product data	Face-to-face
Jonny Hillbert	Group Demand Chain, Logistics Services	Gothenburg	Return handling Gothenburg	Group interview
Annica Kjos	Group Demand Chain, Logistics Services	Gothenburg	Return handling Gothenburg	Group interview, E-mail
Maria Ydkvist	Industrial Division, Business Development	Gothenburg	CO_2	Face-to-face
Lars-Erik Ericson	Service Division, Sales & Marketing	Gothenburg	Customer perspective	Face-to-face
Mats B Petersson	Automotive Division, Supply Chain	Gothenburg	Return handling St Cyr	E-mail
Johan Appermont	Group Demand Chain, Logistics Services	Tongeren	Databases	E-mail
Johan Verdin	Group Demand Chain, Logistics Services	Tongeren	Return handling Tongeren	Group interview, Electronic, E-mail
Martine Peetersem	Group Demand Chain, Logistics Services	Tongeren	Return handling Tongeren	Group interview
Jenny Claes	Group Demand Chain, Logistics Services	Brussels	Scenarios	Electronic, E-mail

Michael Eckart	Group Demand Chain, Supply Chain	Schweinfurt	Scenarios, Return handling Schweinfurt	Face-to-face, Group interview, Electronic, E-mail
Thomas Winkler*	Group Demand Chain, Logistics Services	Schweinfurt	Scenarios, Return handling Schweinfurt	Group interview, Electronic, E-mail
Armin Roesner*	Industrial Division, Information Technology	Schweinfurt	Scenarios, Return handling Schweinfurt, Databases	Face-to-face, Group interview, Electronic, E-mail
Birgit Streng	Industrial Division, Finance	Schweinfurt	Return handling Schweinfurt	E-mail
Cornelia Roessner	Industrial Division, Finance	Schweinfurt	Return handling Schweinfurt	E-mail
Emanuela Abate*	Group Demand Chain, Supply Chain	Airasca	Scenarios, Return handling Airasca	Face-to-face, Group interview, Electronic, E-mail, Telephone
Sandro Carminati	Group Demand Chain, Logistics Services	Airasca	Return handling Airasca	Group interview, Electronic
Carlo Roccati	Group Demand Chain, Logistics Services	Airasca	Return handling Airasca	Group interview, Electronic
Patrizia Mana	Service Division, Sales & Marketing	Airasca	Return handling Airasca	Face-to-face
Delphine Baujard	Group Demand Chain, Logistics Services	St Cyr	Return handling St Cyr	E-mail
Kjell Nilsson	Scania Parts	Södertälje	Benchmark	E-mail, Telephone
Bart van Sande	Volvo Parts	Gent	Benchmark	E-mail, Telephone

In addition e-mails with questions have been sent to representatives within each sales unit in Europe.

10.3 Matrixes

10.3.1 Matrix 1 - Cost

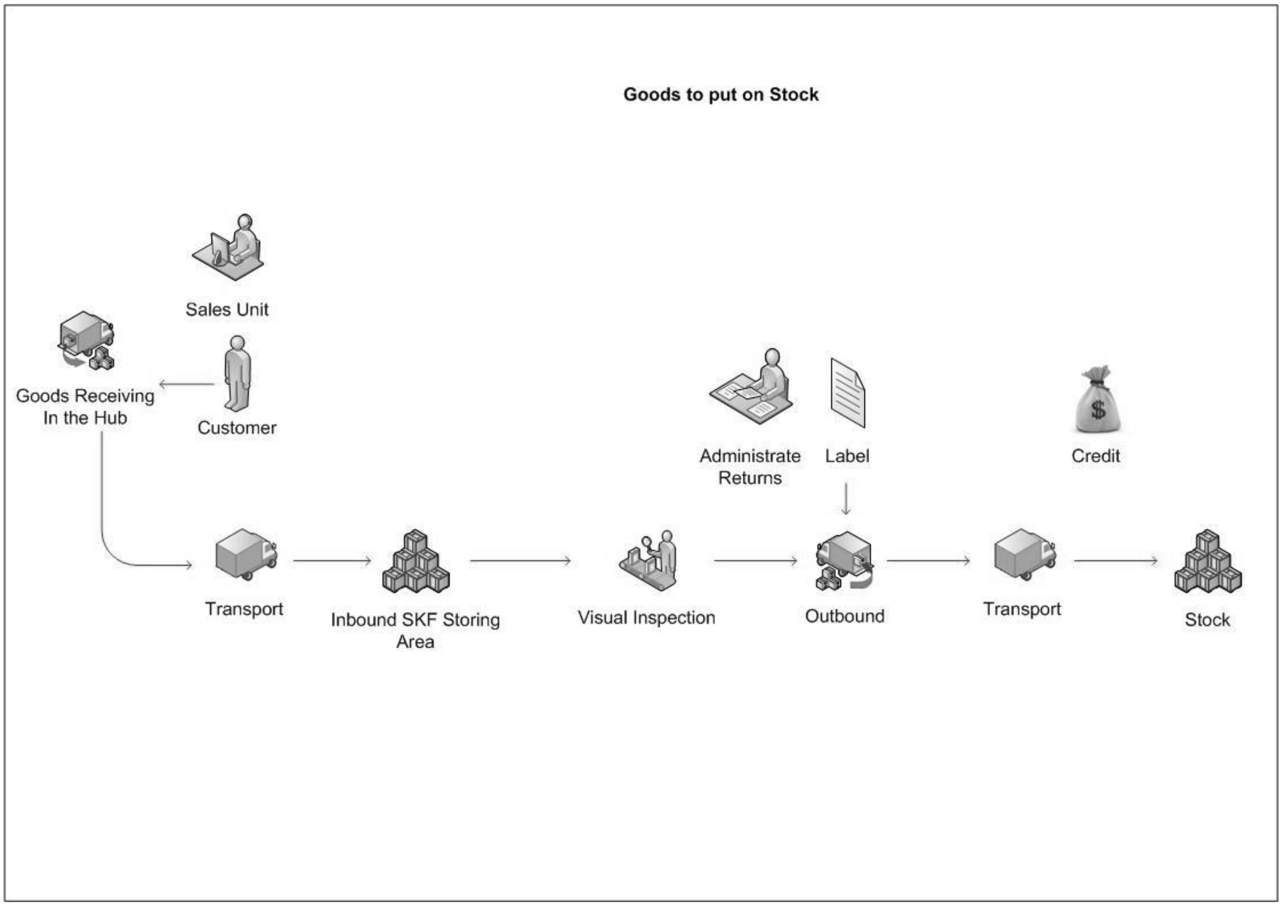
Scenarios evaluated for Cost				
Design parameters	**Same structure as forward logistics**	**Outsource to 3PL**	**Centralised structure**	**Decentralised structure**
Stock category				
Planned Items			x	
Non Planned Item	x			x
Type of error				
Sales Error, SER			x	
Delivery Error, DER			x	
Technical Error, TER				x
Customer Error, CER			x	
Stock Cleansing, STO			x	
Location of customer				
Close to RCP			x	
Far from RCP				x
Located in Strong Market				x
Located in Weak Market			x	
Product value				
High Value				x
Low Value			x	
Value decrease of time				
High Decrease				x
Low Decrease				
Product dimensions				
Large Products				x
Small Products			x	

10.3.2 Matrix 2 – Lead time

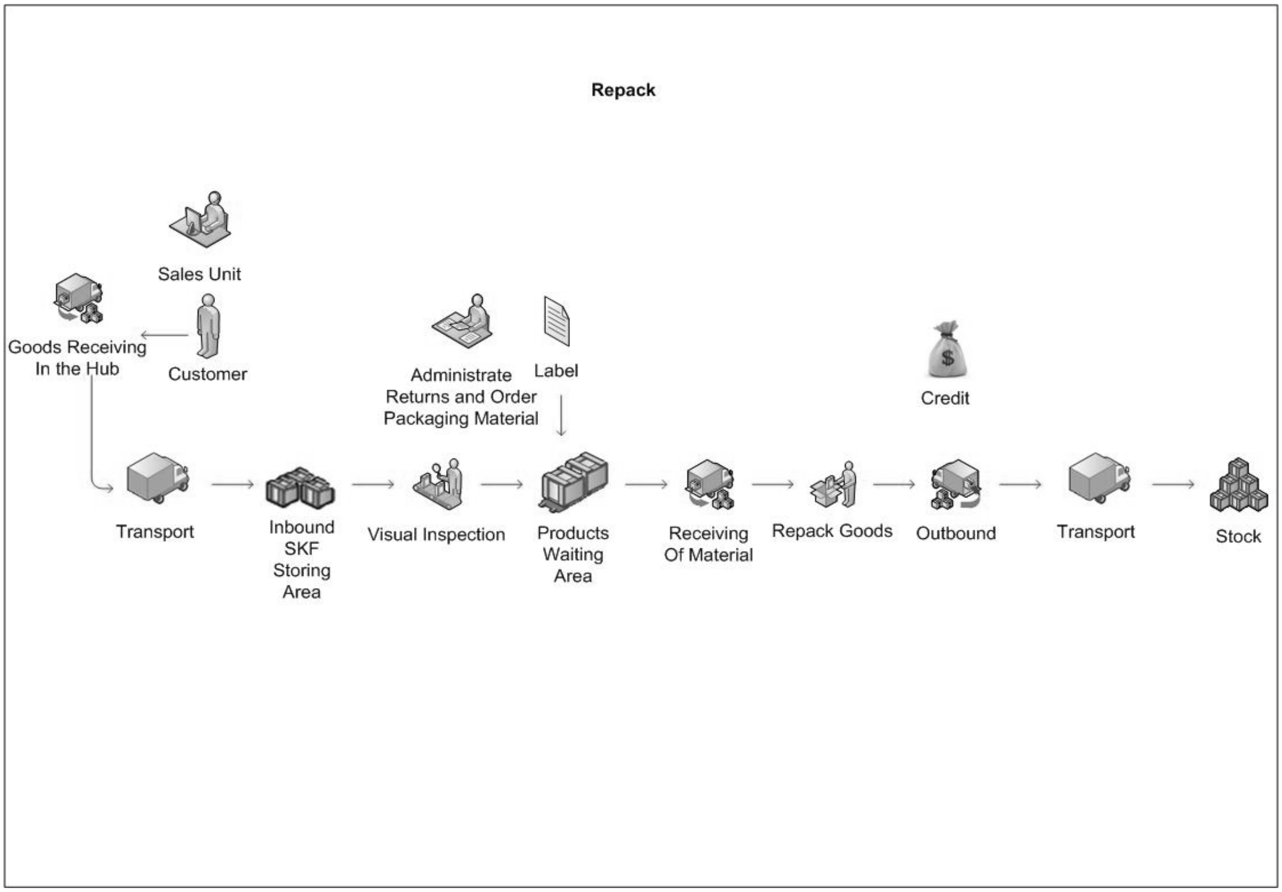
Scenarios evaluated for Lead time				
Design parameters	**Same structure as forward logistics**	**Outsource to 3PL**	**Centralised structure**	**Decentralised structure**
Stock category				
Planned Items			x	x
Non Planned Item				x
Type of error				
Sales Error, SER				x
Delivery Error, DER				x
Technical Error, TER				x
Customer Error, CER				x
Stock Cleansing, STO			x	
Location of customer				
Close to RCP			x	
Far from RCP				x
Located in Strong Market				x
Located in Weak Market		x		
Product value				
High Value				x
Low Value				x
Value decrease of time				
High Decrease				x
Low Decrease				x
Product dimensions				
Large Products				x
Small Products				x

10.4 Process maps Tongeren

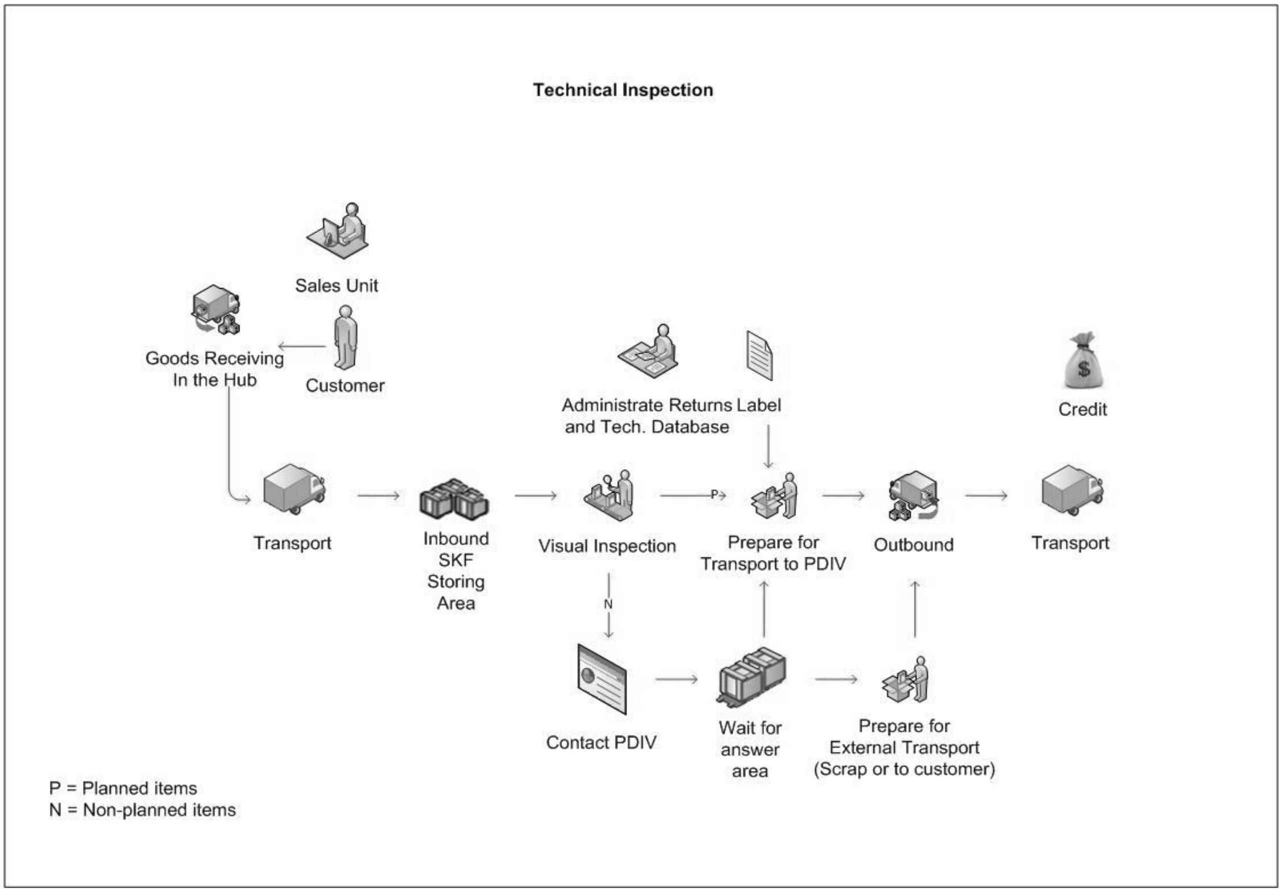
10.4.1 Goods to put on stock



10.4.2 Goods to repack

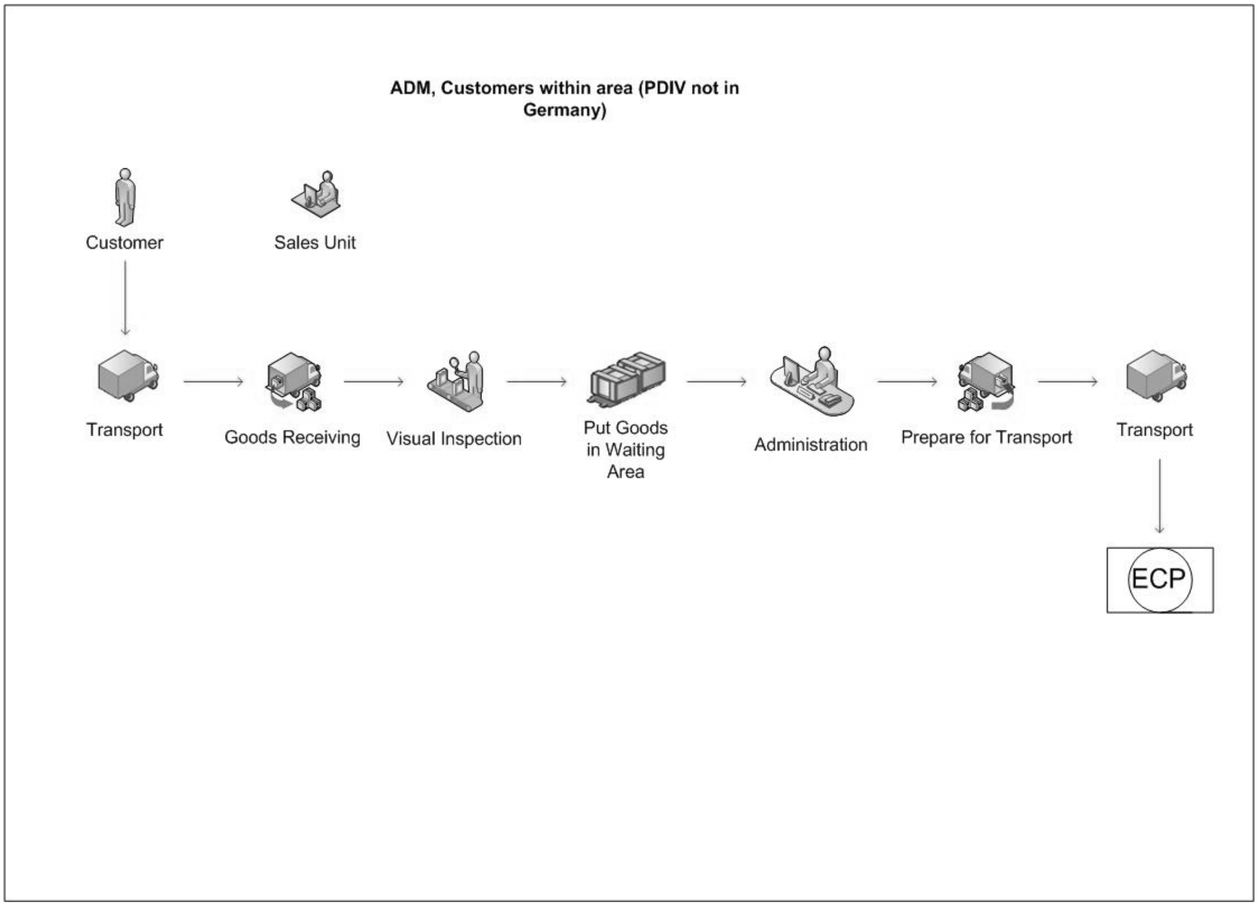


10.4.3 Goods to send to technical inspection

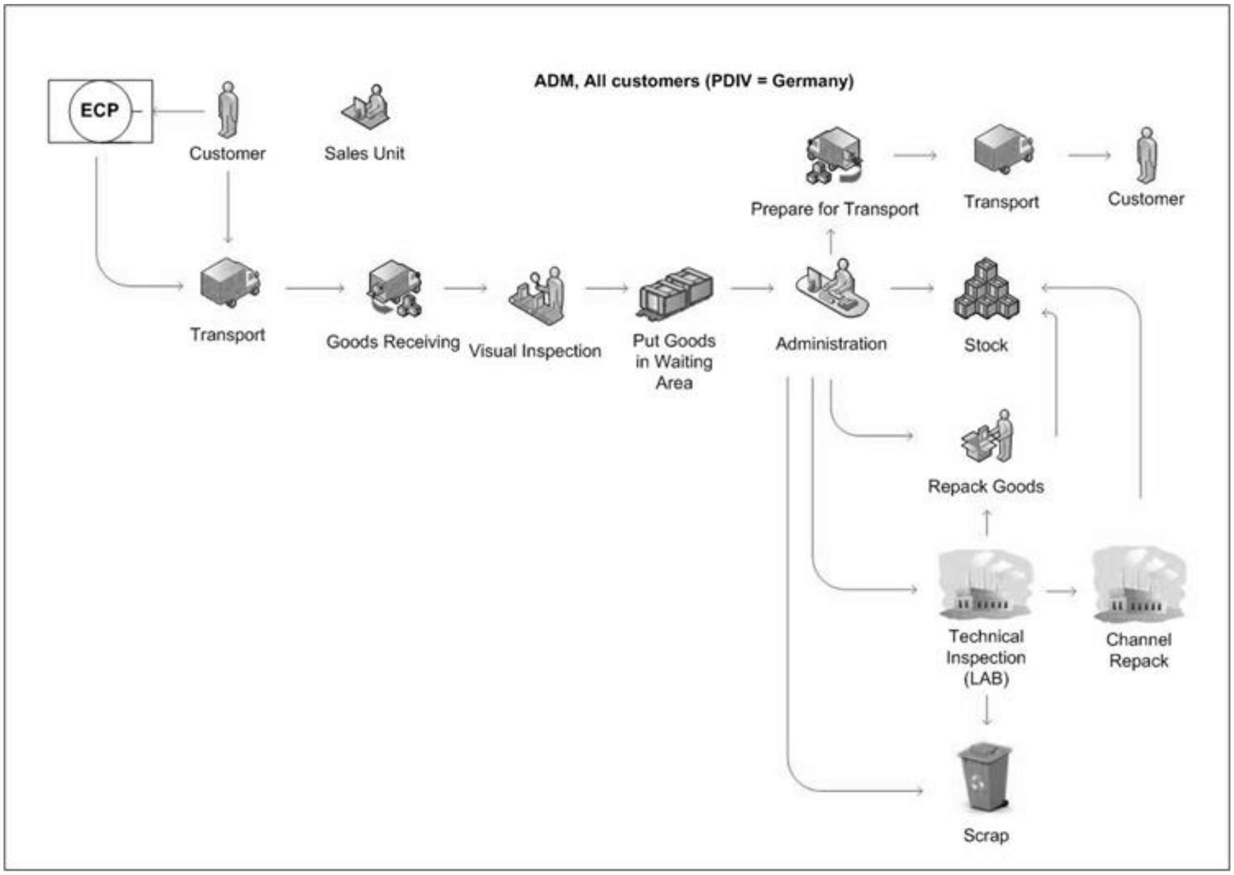


10.5 Process maps Schweinfurt

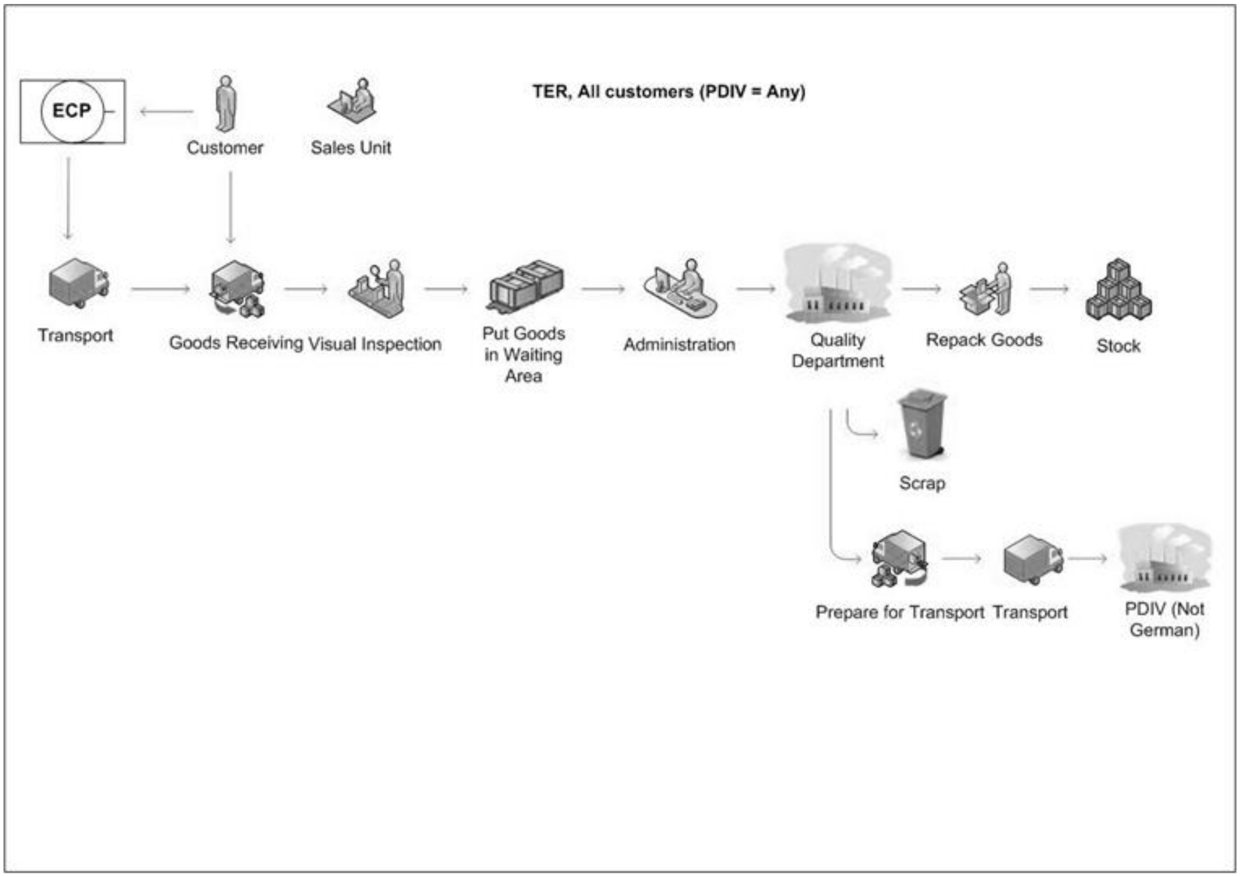
10.5.1 ADM from customers within area. PDIV outside area. (Flow 1B)



10.5.2 ADM from all customers. PDIV within area. (Flow 1A and 2)

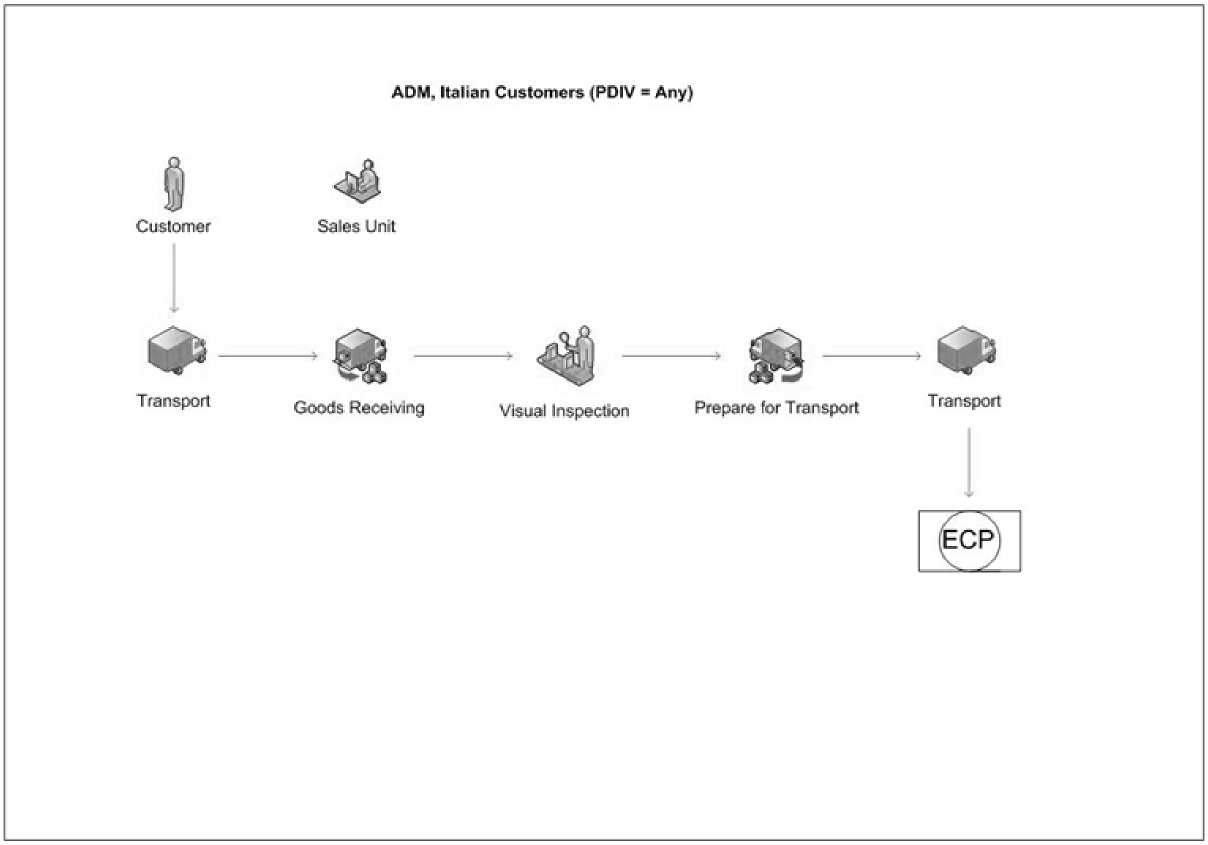


10.5.3 TER from any customer. Any PDIV. (Flow 3 and 4)

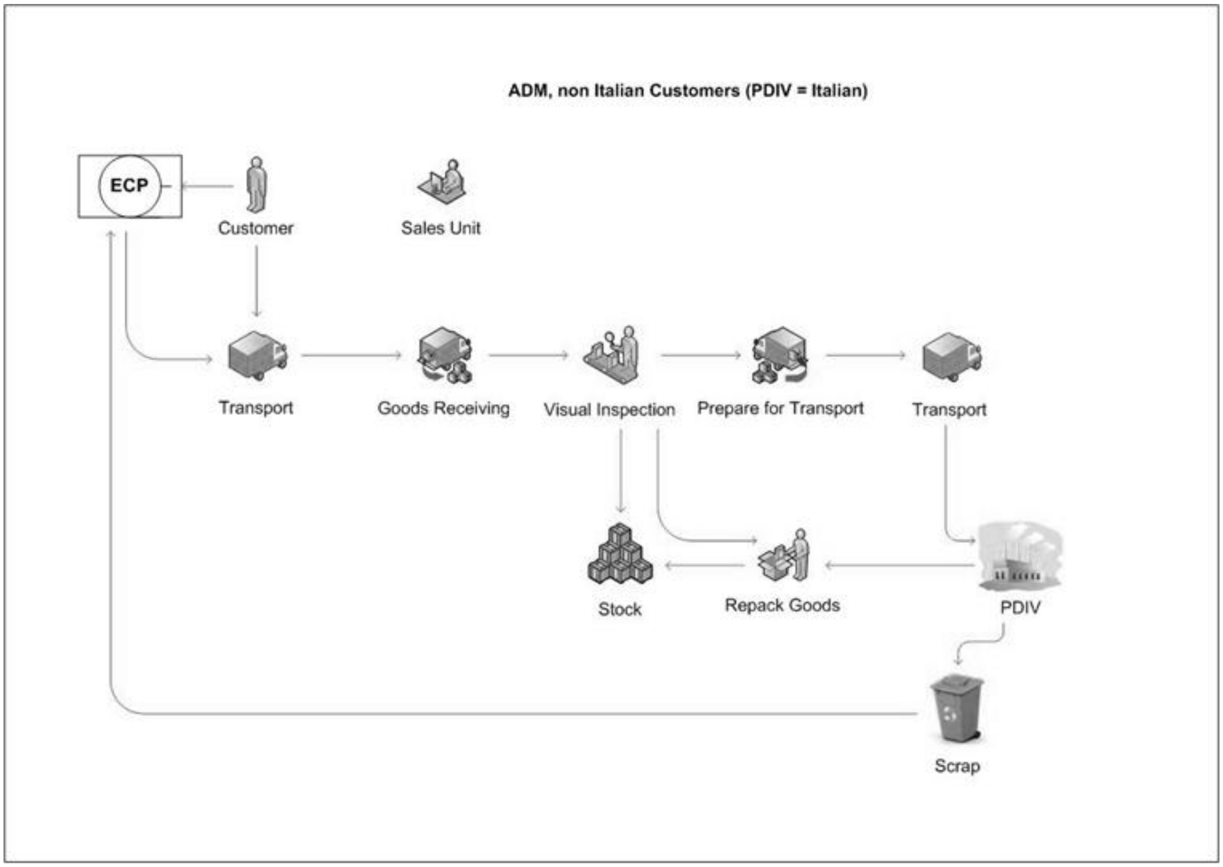


10.6 Process maps Airasca

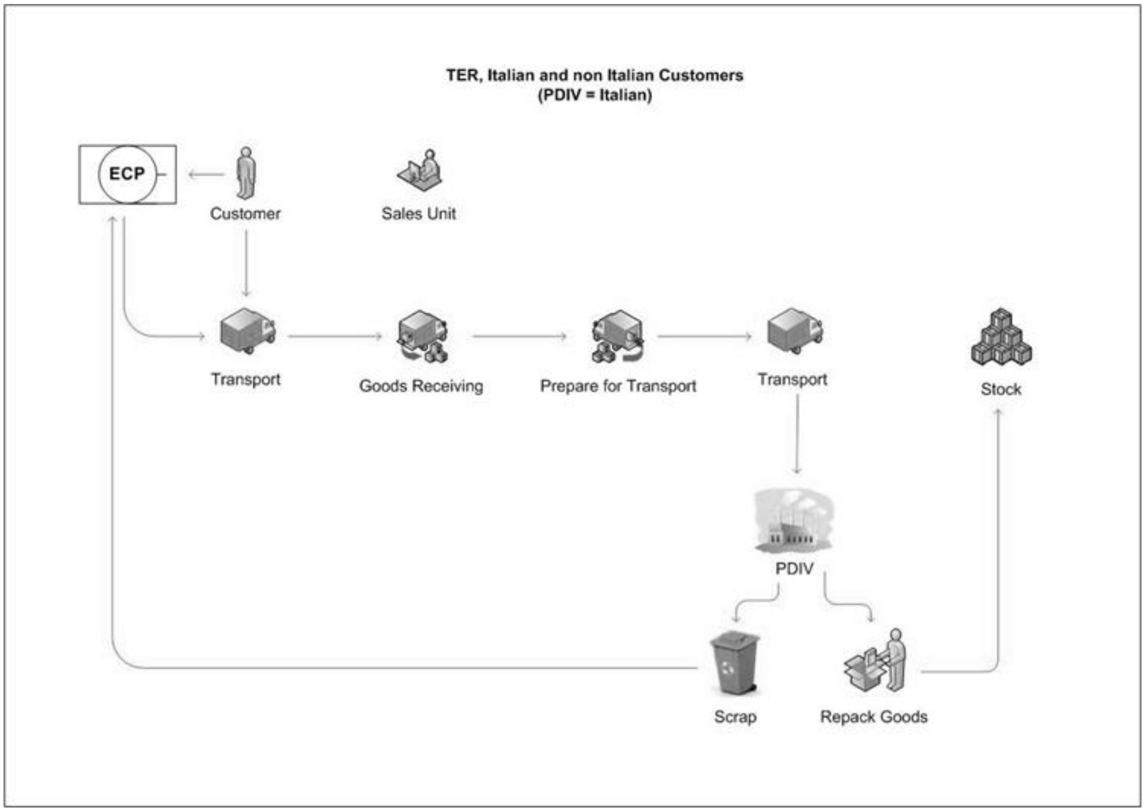
10.6.1 ADM from Italian customers. Any PDIV. (Flow 1)



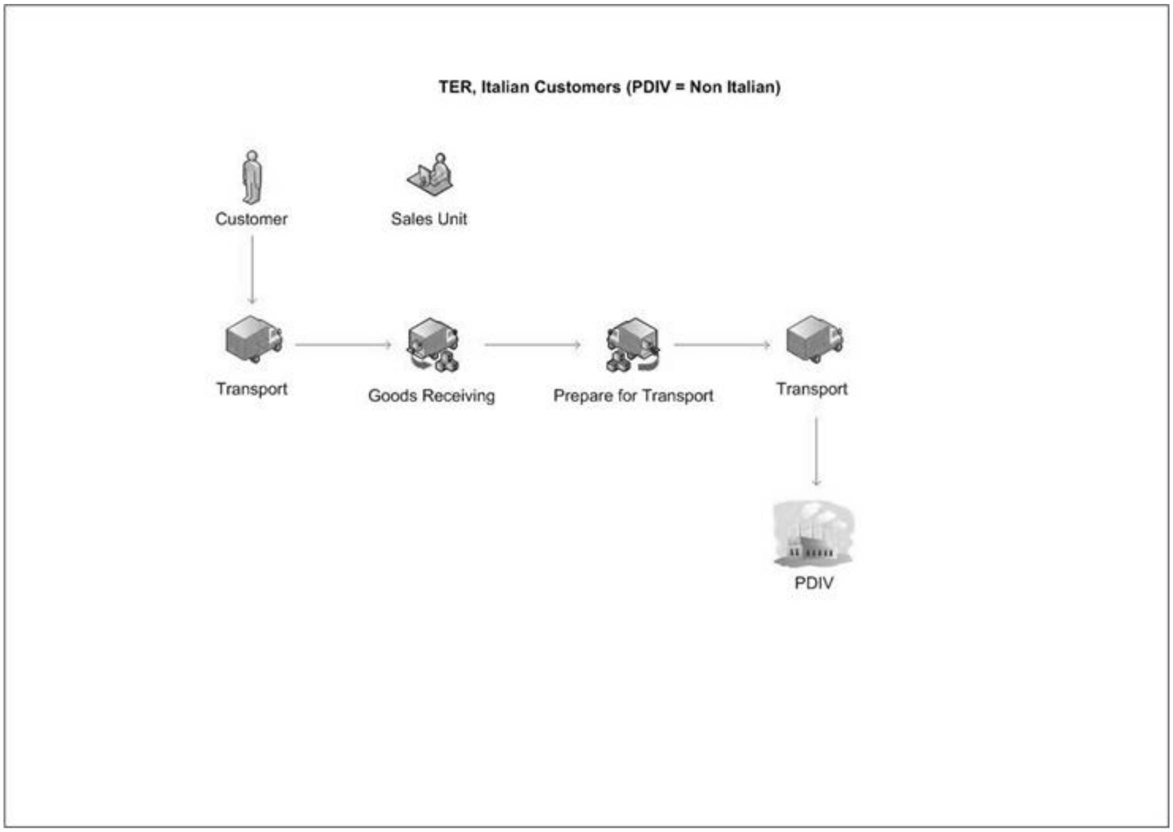
10.6.2 ADM from non Italian customers. PDIV Italy. (Flow 2)



10.6.3 TER from all customers. PDIV Italy. (Flow 3)

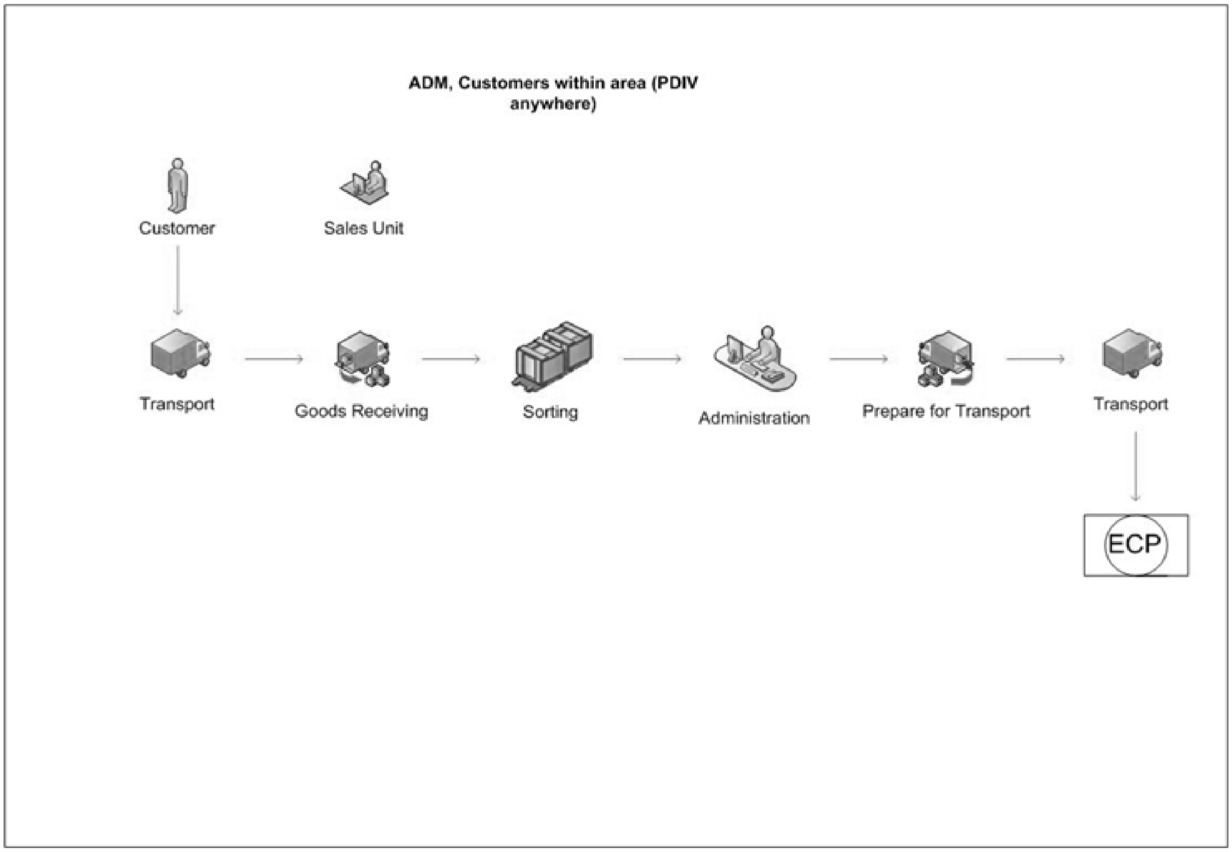


10.6.4 TER from Italian customers. PDIV not Italy. (Flow 4)



10.7 Process maps Gothenburg

10.7.1 ADM from customers within area. PDIV anywhere. (Flow 1)



10.7.2 ADM from customers outside area. PDIV within area. (Flow 2)