LUNDS UNIVERSITET
Lunds Tekniska Högskola

Department of Industrial Management and Logistics
Division of Engineering Logistics

DISTRIBUTION OF SPARE PARTS AT GAMBRO

- Solving the problem with fluctuating demand

Author: Tomasz Doweyko Jurkowski

Supervisors: Stig-Arne Mattsson, Division of Engineering and Logistics

Fredrik Olsson, Gambro SCM Group

PREFACE

This master's thesis constitutes the final element of the author's Master of Science programme in Industrial Engineering and Management at Lunds Institute of Technology, Sweden. The study described and analyzed in this thesis has been carried out at Gambro Lundia AB in Lund, more specifically within the Supply Chain Management Group which is a part of the Gambro Global Supply organization. The work with this thesis started in late August 2009 and ended in early January 2010.

I would like to thank everyone at Gambro that has been involved in the work of realizing the purpose of this thesis. Although I myself have done all the writing, I would not have had that much to write about if it would not have been thanks to the will of many Gambro employees to help and contribute to the final outcome. I am very grateful for having had the pleasure to work with all these individuals and it has been both a fun and instructive experience, two components that should always be present in any work carried out.

Finally, I want to give special thanks to my supervisors, Fredrik Olsson, Global Supply Chain Manager of the Equipment Group at Gambro SCM in Lund and Stig-Arne Mattsson at the Department of Engineering Logistics at Lunds Institute of Technology. Their help and feedback during the work with this thesis has been much appreciated.

January 20th 2010, Lund, Sweden

Tomasz Doweyko Jurkowski

ABSTRACT

Title Distribution of spare parts at Gambro

Author Tomasz Doweyko Jurkowski, Industrial Management and Engineering at Lunds Institute of Technology

Supervisors Fredrik Olsson, Global Supply Chain Manager at Gambro SCM

Stig-Arne Mattsson, Department of Engineering Logistics at Lunds Institute of Technology

Purpose

A general purpose of this thesis can be defined as to examine and evaluate the possibilities to solve the problem with fluctuating demand on spare parts from the local sales subsidiaries in the three big markets in Europe. A secondary, more specific, purpose of this thesis is to investigate what the possibilities are to implement direct distribution of spare parts to these countries and what the implications of such an action would be.

Method

The research approach of this thesis can be described to be one of investigational nature. An in-depth study of the current distribution structure and its relevant correlated aspects was conducted with the aim of getting a full understanding of the situation as it is present today. This was followed by quantitative and qualitative analyses of the gathered data, with the purpose to define possible future distribution structures and discuss the implications of an implementation of these.

Conclusion

This thesis has shown that fluctuating demand, characterized by occasional high demand peeks in the order pattern of the local sales subsidiaries in Germany and France cause problems at the DCs in Sweden and Italy. As a consequence availability issues are generated at the DC level. Two different distribution structures have in this thesis been suggested to deal with these issues: a periodic consumption-based replenishment of the local warehouses and a direct distribution solution comprising spare part deliveries directly to service technicians and customers. The recommendation is that Gambro adopts a two-step implementation plan with the direct delivery solution constituting the second and final step.

Key words

Supply Chain Management, Logistics, Distribution, Spare parts, Gambro, Customer service

SAMMANFATTNING

Titel Distribution of spare parts at Gambro

Författare Tomasz Doweyko Jurkowski, Industriell Ekonomi på Lunds Tekniska Högskola

Handledare Fredrik Olsson, Global Supply Chain Manager på Gambro SCM

Stig-Arne Mattsson, Avdelningen för Teknisk Logistik på Lunds Tekniska Högskola

Syfte

Det övergripande syftet med detta examensarbete har varit att undersöka och utvärdera möjligheterna att lösa problemet med skiftande efterfrågan på reservdelar från de lokala säljbolagen i de tre stora marknaderna i Europa. Ett sekundärt, mer specifikt, syfte har varit att utreda möjligheterna att implementera en lösning med direktleverans av reservdelar till dessa länder samt vilka implikationer detta skulle få.

Metod

Den metod som har använts för detta examensarbete har varit av undersökande typ. En inledande nulägesanalys av den nuvarande distributionsstrukturen och dess relaterade aspekter genomfördes med avsikt att få en full förståelse för den aktuella situationen. Detta följdes upp av kvantitativa och kvalitativa analyser av insamlad data, med syfte att definiera möjliga framtida distributionsstrukturer och diskutera implikationerna av en implementering av dessa.

Slutsats

Detta examensarbete har visat att skiftande efterfrågan, kännetecknad av tillfälliga höga efterfrågekvantiteter i ordermönstret från de lokala säljbolagen i Tyskland och Frankrike orsakar problem i DC Lund och DC Mirandola. Detta leder i sin tur till tillgänglighetsproblem på DC-nivån. Två alternativa distributionsstrukturer har i detta arbete föreslagits för att lösa dessa problem: en periodisk förbrukningsbaserad påfyllnad av de lokala säljlagren samt ett direktdistributionssystem med direktleverans av reservdelar till servicetekniker och kunder. Gambro rekommenderas att implementera dessa i två steg med direktleverans av reservdelar som det andra och slutliga steget.

Nyckelord

Styrning av försörjningskedjan, Logistik, Distribution, Reservdelar, Gambro, Kundservice

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1. INTRODUCTION

The purpose of this chapter is to present the background to as well as the objectives of this thesis. The main issues regarding the management and distribution of spare parts at Gambro will be pointed out. In turn, these issues define the true purpose of the thesis, which will also be presented, together with a definition of the scope and focus of the study and an outline of the following chapters.

1.1 BACKGROUND

Companies are constantly seeking new ways to compete with each other. This is something that is becoming much more evident today than ever before. For a majority of companies, the business environment is becoming more dynamic, more global and more unpredictable, not only from a customer perspective but also from a competitor point of view. The pressure on the single company to achieve competitive advantages with regards to its competitors is increasing in a fast pace. The companies that are not being able to keep up with their competitors in this fierce environment are likely to lose their hard-earned market shares and eventually disappear, leaving only memories behind.

If organisations are to achieve competitive advantage by delivering value to customers, they need to understand how that value is created or lost. One helpful concept concerning the value creating activities that are undertaken by companies is the one of the value chain, described by Michael Porter back in 1985. One of the primary activities of this value chain is the *outbound logistics* activities, comprising activities such as collection, storage and distribution of products to customers. Another of the five primary activities is *service*, which includes all those activities which enhance or maintain the value of a product or service, such as installation, repair, training and spares.[1] Although it is hard to say that these activities have been neglected in the past, it is probably a lot easier however to state that the focus on these both activities has increased with time and today many companies outperform their competitors thanks to their excellence in these areas among others. Because of this it is not possible for a company to treat these areas of value creation in a lesser way than other areas if they aspire to play an important role in the future.

The terms outbound logistics and service can seem pretty straightforward. Logistics as a concept has been given many different definitions in the literature, but it could widely be defined as a term that comprises the supply of materials, materials management and distribution. With this definition, outbound logistics will simply encompass all the activities that concern the distribution of products to the customers. Another definition of logistics is the one given by the

[1] Johnson, Scholes & Whittington (2006)

Council of Supply Chain Management Professionals, who describes logistics as the function that plans, implements and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements'.[2] Whatever definition is used it is certain that the logistic activities in a company constitutes an important part of the value creation process at that company and that it is a source of possible competitive advantage if organized, planned and carried out in a correct and suitable manner.

In today's business environment, the importance of after-sales service is high. Lost revenues due to disservice can be enormous. When customers buy a product they expect a certain quality, that the product will function as promised both in terms of efficiency and life-time and that, in case of breakdown or failure, the responsible company will take care of the problem and make the product functional again in a fast and timely manner. Service therefore becomes an inevitable part of a company's value creation activities if it is going to compete with other companies and the goal is to triumph.

The requirements for planning the logistics of spare parts differ from those of other materials in several ways: service requirements are higher as the effects of stockouts may be financially remarkable, the demand for parts may be extremely sporadic and difficult to forecast, and the prices of individual parts may be very high. On the other hand, material and time buffers in production systems and supply chains are decreasing. These characteristics set pressures for streamlining the logistics systems of spare parts.[3]

1.2 ISSUES

At Gambro Lundia AB, the management of spare parts has for a long time been a problematic process. In the past there have been attempts to solve the main issues regarding spare parts, but the desired results have been absent. These failures have made it clear that there is no easy way to rearrange an existing organisation and change the established processes in a one-step manner. Instead, incremental but carefully prepared changes towards a final goal seem to be the most appropriate solution.

As of today there are a number of main challenges regarding the management of spare parts that have been identified. One of these is the lack of visibility, which is a direct effect of the fact that the management of spare parts is not being managed through an APS (advanced planning system) and there are also no forecasts available for spare parts. While the management of disposables is working in a satisfied manner in this aspect it is important to note that there are some significant differences as to the way these different product groups are managed as well as the special

[2] Waters, (2007)
[3] Huiskonen (2001)

product characteristics they present. When it comes to disposables, there is practically a full visibility of the global inventory through the systems that are being used. They are currently being managed though i2 SCP (Supply Chain Planner), a system which offers a consolidated view of the inventory available as well as providing for advanced planning options, both for the replenishment and production planning of the products. Another application, i2 DM (Demand Manager), is being used as a forecast tool with inputs being made by the sales representatives around the world for the different products. Thanks to these both systems and they way they are being used as well as the well defined routines that are being followed, there is practically a full visibility of the global inventory of disposables available and a high predictability of future demand. This is also a consequence of the product type. Disposables are being used in every dialysis treatment and depend on the number of patients being treated in a certain region. Because of this, it is a somewhat simple procedure to estimate the future demand that will occur for these products. Spare parts on the other hand cannot be predicted in a similar way because of the nature of the products. Spare parts have a tendency to follow very irregular demand patterns and it is very difficult, if not impossible, to forecast the future need for spare parts. This is one of the main reasons why the management of spare parts has not been integrated into the above mentioned systems. Another important reason is the substantial amount of different stock keeping units (SKUs) available, which would make forecasting a very time-consuming and probably an inadequate process. All these issues caused by the lack of visibility result in difficulties to anticipate the future demand, to prioritize and allocate when needed as well as relocating inventory.

Another main challenge is the fact that the order pattern of spare parts is not functioning in a satisfying way. It can be observed that the sales companies replenish their local stocks of certain spare parts in a low frequency manner which, when aggregated, cause occasional high demand peeks at the DC level. These peeks, especially generated by big orders from the big markets, often results in stock-outs at the DC warehouse. This in turn leads to a situation where the DC is no longer able to supply the subsequent orders in a timely manner. Globally the inventory is sufficient to meet the actual demand, however because the majority of the inventory is not located at the DC level the distribution to the needing part is often ineffective and in many cases nonexistent for quite some time.

A third challenge is the vast amount of spare part revisions and re-building orders that occur frequently. These are often announced through the organization in an ineffective way, where Global Supply receives the information about an upcoming revision or re-building at the same time as technical service. These kinds of situations naturally creates sudden increases in demand, increases that the planning department is not able to foresee and therefore the demand is not met with enough inventory. This thesis will however primarily deal with the first two challenges, leaving this issue for future settlement.

These challenges or problem areas are in effect causing low customer service levels and high inventory levels around the world, with the later also resulting in a high percentage of obsolescence as spare parts are withdrawn, outdated, revised or replaced by another spare part.

In order to master these problems as well as other that have arisen in the area of spare parts management, Gambro has launched different projects constituting small steps towards a final goal where the issues regarding spare parts management and distribution are expected to be eliminated or at least brought down to a minimum. One of these steps is the implementation of direct delivery of spare parts to the different markets around the world with the "big markets", more specifically the markets of France, Germany, Italy and the US being prioritized due to their size and their impact on the total demand on spare parts. Recently, direct delivery of spare parts was introduced on the UK market and at the time of this writing, the same process is being carried out in the Benelux countries. Although these examples show that the concept of direct delivery is already in place in some countries, it does not mean that the solution for all countries has already been defined. The UK and the Benelux countries represent, together with some other markets, the "SAP-countries", implying that the local sales representatives are working in the ERP-system SAP, as does the DC in Lund. This is a great benefit when distribution restructurings are carried out, such as direct delivery, because all the information is organized in and is being sent through one and only one system. This is however not the case with the countries of France, Germany and Italy. Each of these countries use their own local ERP-system, different from SAP, and the consequence of this is that the direct delivery solution used in the case of the UK and the Benelux countries cannot be directly applied to these countries. This conclusion brings us to the purpose of this thesis.

1.3 PURPOSE

In order to make a good decision on what the next action steps should be when it comes to improving the management and distribution of spare parts to the big markets, there is a need to examine and define the available possible solutions with respect to the current organisational, administrative, geographical and physical setup. A general purpose of this thesis can therefore be defined as to examine and evaluate the possibilities to solve the problem with fluctuating demands on spare parts from the local sales offices in the three big markets in Europe. It could however be useful to present a more specified purpose definition. Since the desired future scenario of the spare parts distribution at Gambro has already been decided upon, and since this scenario comprises a direct delivery distribution organisation as it has been implemented in the UK, it is implied that this is also the desired future state of the "big markets". The more specified purpose of this thesis can therefore be defined as to investigate what the possibilities are to implement direct distribution of spare parts to these countries and what the implications of such an action would be.

1.4 FOCUS AND SCOPE

Although the “big markets”-countries are four to the number, it goes beyond the scope of this study to examine all these four markets. Instead, since it has been corporately decided that the most prioritized countries regarding the spare parts distribution improvements at the moment are Germany and France, these are the countries that constitute the focus of this study. The scope can further be defined as the distribution of spare parts from the two DCs in Lund, Sweden and Mirandola, Italy to customers in Germany and in France respectively. The word customers is in this respect treated as a general term encompassing private customers such as clinics and hospitals but also the local Gambro sales organisations and the Gambro employed service technicians.

Even though an implementation of some sort will probably be carried out in the future, this thesis will not concentrate on leaving recommendations on how the most appropriate future implementation strategy should be designed. It will however mention and discuss some of the aspects that need to be taken into consideration before the implementation itself is carried out.

As it has already been mentioned, the focus of this thesis will be on the distribution part of the supply chain. However, it is worth to note that a supply chain should be viewed in a wide perspective to fully understand the relationship between the internal parts of the chain as well as the forces of external sources that act upon the supply chain. Aspects that directly affect the distribution step in the supply chain of interest in this thesis will therefore briefly be discussed.

1.5 REPORT DISPOSITION

This thesis has been structured in a way believed to be the most optimal where the aim has been to guide the reader through it as logically as possible. This introduction chapter has therefore been written in an explanatory way so that the reader fully understands the problem that this thesis is aimed to unravel and analyze.

In order to get a feeling of how the work has been conducted and what methods have been used to reach the final result, chapter 2 is all about the methodology of the thesis.

In the following section, chapter 3 presents the theoretical frame of reference. This section contains references to and descriptions of the existing material that has been recognized as relevant to the specific subject of this thesis.

Chapter 4 sets the context for the empirical part of the thesis with a general description of the company of interest, Gambro. The intention of this chapter is only to make the reader familiar with the company’s history, the type of business Gambro is active in as well as giving a brief overview of the organizational structure of the company.

Chapter 5 contains detailed empirical findings and more comprehensive information about the specific subject situation of the thesis. This chapter underpins the understanding of the problem as well as giving the reader a thorough picture of the reality that the distribution of spare parts at Gambro is a part of.

The next chapter, chapter 6, constitutes the analysis part of the thesis. The empirical findings are analyzed and looked upon from different positions. The different possible final solutions are discussed and evaluated from an organizational, economic, and administrative point of view.

The final chapter presents the conclusions that have been made with regards to the outcome of the preceding chapters. Recommendations concerning a future implementation are given as well as discussions on some of the aspects relevant to the subject that, even though not in the scope of this thesis, should not be neglected.

2. METHODOLOGY

The purpose of this chapter is to discuss some of the common concepts of methodology and present the method that has been used during the writing of this thesis. More precisely the research approach, the research procedure and the data collection techniques selected for the thesis as well as some credibility issues are discussed.

2.1 GENERAL DISCUSSION

Most tasks that are being carried out in our daily life usually have a specific purpose. When someone is doing something without a purpose, this kind of work is often regarded as pointless. The purpose of this thesis has already been pointed out in the preceding chapter and it serves as an indication as to what the reader can expect will be discussed and dealt with in the subsequent chapters. However, defining a purpose is only one part of the preparation one has to do when establishing the route to a certain desired final result. The other important part of this process is to define the procedure of how to reach that future goal in the most optimal way possible or in other terms, define the method. Naturally, the purpose needs to be defined before deciding on the specific method.

When a purpose has been established, one should examine what different methods are available to reach this purpose. If many options are available, a decision needs to be made on which of these represents the most feasible and optimal solution. In practice the chosen option should be the one which will meet the stated purpose most effectively, taking into consideration the scarce resources, time and money, which are always present.[4]

The various methods at hand can be regarded as different methodological approaches to the specific subject that is being treated. Different methodological approaches make different assumptions about their subject areas. In practice this means that when people apply the different approaches, they have to proceed differently when trying to understand, explain and improve the specific situation of interest, depending on the approach being used.[5] Consequently the suitable method is determined by the specific problem at hand. It is important to note however that the view on a certain method or the application of these to a specific problem differs among individuals. This is mainly due to the individual presumptions that each of us is carrying. These kinds of presumptions are affecting the way we look at a certain problem and the knowledge or techniques that we find suitable to use. To make an effective choice of method, the method must

[4] Björklund & Paulsson (2003)
[5] Arbnor & Bjerke (1997)

therefore both “fit” the problem under consideration and the presumptions held by the person conducting the work.[6]

2.2 RESEARCH APPROACH

Researchers are constantly dealing with the problem of creating theories or outcomes which will depict the reality as good as possible. The foundation for this theory creation process is all the data and information, concerning the studied reality, which has been gathered, the empirical foundation. What the researcher usually needs to do is to find a way to relate theory to reality, and vice versa. Three common concepts are widely used to describe the ways that this can be done in: deduction, induction and abduction. The deductive approach is characterized by drawing conclusions of specific circumstances with the aid of general principles and existing theories. Out of the obtainable theories hypothesizes are derived, which are then applied to the specific studied case. The biggest source of risk with this approach lies in the theory selection process. Since all existing theories cannot be included, the credibleness of the drawn conclusions can, and need to, sometimes be questioned. The inductive approach on the other hand works in the opposite way. In this case, the researcher studies the specific situation without establishing beforehand applicable theories, and with the gathered information, he formulates a theory. The main risk with this approach is the fact that the formulated theory in the worst case only is applicable to the studied object or situation, instead of constituting a more general theory, which in most cases is preferred. The third concept, the abductive approach, can be viewed as a combination of the two already mentioned. In the first step, a hypothetical pattern or theory is formulated out of the studied situation. This hypothesis or theory is then tested on new cases and can be expanded during this process to be more general in nature.[7]

Different master’s thesis subjects can however be more or less theoretical by nature. As chapter 1 has made clear, the specific purpose of this master’s thesis is of a quite practical sort. In a way, Gambro has already defined the future desired distribution structure, direct distribution to all customers and service vans, which consequently limit to some extent the possibilities of applying general theories to the problem. Instead, the stated purpose implies that an investigational approach is more suitable for this specific thesis and therefore it is not possible, or useful, to claim that the approach for this thesis is deductive, inductive or abductive in its scientific meaning. There are however other research approach concepts that are more applicable to the specific subject of this thesis. One set of research approaches that are defined differently from the ones mentioned is the one comprising the analytical, the systems and the actors approach.

[6] Arbnor & Bjerke (1997)
[7] Patel & Davidson (1994)

The analytical approach is based on the assumption that reality has a summative character, that is, the whole is the sum of the parts. This implies that once a researcher gets to know the different parts of the whole, these parts can be added together to get the total picture. In addition, the knowledge that is being created is characterized as being independent of the observer. This means that knowledge advances by means of formal logic that is represented by specific judgments that are independent of individual subjective experiences. The goal of the analytical approach is to explain objective reality as fully as possible, where the researchers seek causal relations, that is, necessary and sufficient relations between cause and effect. Because of this, a fundamental issue in the analytical approach is the way in which objective facts and subjective impressions are differentiated between.[8]

The systems approach is characterized by a holistic view and it is the most commonly used approach today. The assumption behind the systems approach is that reality is arranged in such a way that the whole differs from the sum of its parts. This means that not only the parts but also their relations are essential, as the latter will lead to plus or minus effects on the sum. As was the case with the analytical approach, the systems approach also assumes the existence of an objective reality. In this approach however, the systems reality is assumed to consist of components that are often mutually dependent on each other, and can therefore not be summed up in a simple manner. The synergistic effects also need to be taken into consideration. Not only the content of the individual components, but also the way that they are put together, provides information, and what is required for reaching an acceptable understanding of a specific situation is therefore to consider the total picture. Because of this definition, it is of greatest importance to include all the relevant or at least the most relevant parts of the specific situation when constructing the systems reality. Otherwise there is a risk that the total picture will be affected and drawn conclusions will not be credible enough. Another important difference between the systems and the analytical approach is that the systems approach does not deal with causal relations. Instead, the researcher looks for forces that influence the system as a whole.[9]

The actors approach is not interested in explanations; rather, it is interested in understanding social wholes. This is accomplished through the pictures of reality held by the individual actors. The actors approach is directed at reproducing the meanings that various actors associate with their acts and the surrounding context. Reality is therefore taken as a social construction that is intentionally created by processes at different levels of these meaning structures. In this sense it therefore differs clearly from the first two approaches. Knowledge developed by means of the actors approach is dependent on individuals in the sense that it refers to how different actors or groups of actors perceive, interpret, and act in the reality. The actors approach is more about

[8] Arbnor & Bjerke (1997)
[9] ibid.

creating an understanding of the processes that constructs reality, whereas the analytical and systems approach rather seeks to explain these processes.[10]

2.2.1 THE APPROACH OF THIS THESIS

The purpose of this thesis, as mentioned in chapter 1, is to examine and evaluate the possibilities of solving the problem with fluctuating demands on spare parts from the local sales offices in Germany and France, as well as to investigate what the possibilities are to implement direct distribution of spare parts to these countries and what the implications of such an action would be. Based on this purpose and the above discussed research approach concepts, it seems as though a good choice would be the systems approach. In addition to this, the discussion in the relevant literature regarding the objectives of this approach further confirms this belief. The objectives of the systems approach can be described in five levels: to determine the type of system, to describe, to determine relations, to forecast and to guide[11].

These levels are pretty straightforward and self-explanatory. However when it comes to the guiding part, two different types of studies can be identified: goal-means oriented and trial-and-error oriented. The first one of these have the goals of the system stated right at the beginning of the formulation of the problem and looks to the solution of the problem to eliminate any lack of fulfillment of the goals, whereas the second type lets the course of the study provide material for successive continuations and does not focus on a goal stated at the beginning of the study.[12] As for the purpose of this thesis the goal-means oriented study seems as a suitable choice due to the fact that a clear goal was stated in the beginning of the study and this future goal has practically been set in stone. One of the general process plans suggested in the relevant literature when conducting a goal-means oriented systems approach is the one showing below in figure 2.1.

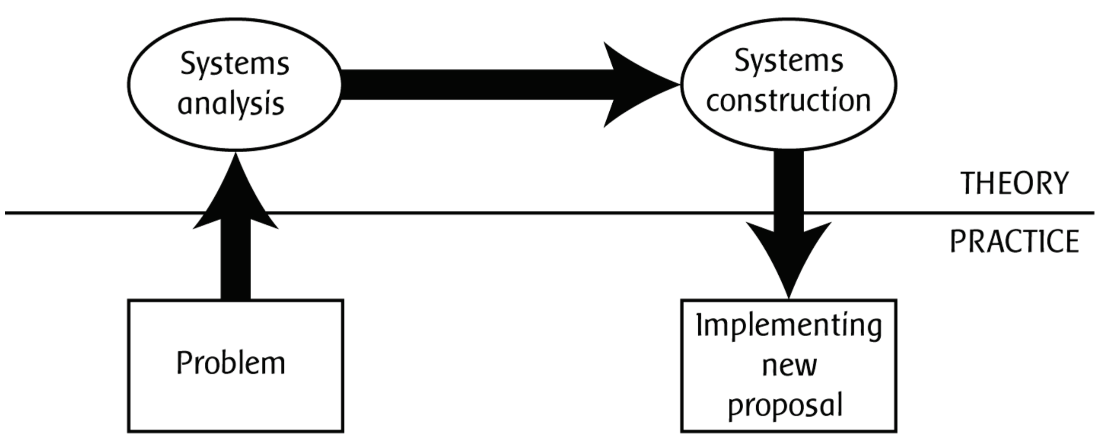

Figure 2.1 The goal-means oriented systems approach research process (Arbnor & Bjerke, 1997)

[10] Arbnor & Bjerke (1997)
[11] ibid.
[12] ibid.

This process plan applies well to the specific nature of the subject of this thesis. The bottom left part of figure 2.1 indicates that there is a problem in the system. This conclusion has also been drawn and stated in general terms in the issues section in chapter 1. In the next step of the process, the system analysis, the problem is formulated and described as it occurs in the existing reality. Simply put, a description of the system is made. In this thesis this part is accomplished primarily through the empirical and analysis part, where the existing distribution system and structure is described and analyzed. After reproducing the problem by means of the systems analysis, a new systems proposal is drawn up, which represents the systems construction part of the process in figure 2.1. In the thesis this part is realized mainly through chapter 6 and 7, in which the existing distribution system is analyzed and conclusions and recommendations based on this analysis are presented. The last part of the suggested process, the implementation of the new proposal, is outside the scope of this thesis and will therefore not be addressed in any detailed manner.

2.2.2 SYSTEMS DEFINITION

Simply put, a system is a set of components and the relations among them. In order to understand an individual component it is not enough to study the component itself or in isolation. Instead, the component must be put in a context or in an environment to be analyzed. The systems environment is supposed to be understood as what lies outside the boundary of a system. This environment is usually defined as the factors that are important to the system but are beyond its control. It is common to talk about open and closed systems when discussing system contexts and environments. Open systems are studied in the context of their environment; closed systems are not.[13] If we look at the specific subject of this thesis we can define the Gambro distribution organization as the system to be studied. The main components of this system are shown in figure 2.2 and described below.

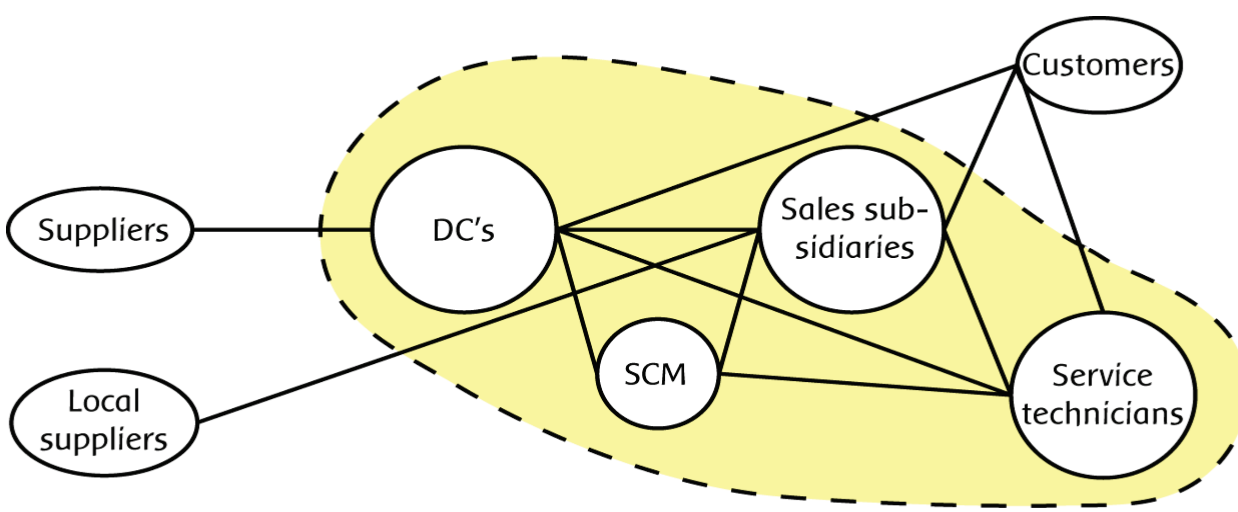

Figure 2.2 The system of this thesis

[13] Arbnor & Bjerke (1997)

Since the focus of the thesis is the distribution of spare parts, only the spare parts related activities in the system components are taken into consideration. The DC's component consists of DC Lund and DC Mirandola, responsible for the distribution, order handling and warehousing of spare parts. The sales subsidiaries refer to the studied sales companies in both France and Germany. They are responsible for spare parts ordering, warehousing and distribution to service technicians and customers. The service technicians are part of the technical service organizations in both France and Germany. They order spare parts from the sales subsidiaries and perform preventive and urgent repair on the machine fleet that they are responsible for in their respective region. The SCM system component is the Supply Chain Management Group in Lund, more precisely the subgroup of this group dealing with spare parts production planning. One of the components outside the defined system are customers, such as hospitals or dialysis clinics, which order spare parts from the sales subsidiaries and in some cases are being visited by the service technicians for repair. The other two outside components are suppliers and local suppliers. Suppliers refer to those suppliers which are supplying spare parts that pass through the DCs, usually the manufacturing entities, whereas the local suppliers are only connected to the local sales subsidiaries. The straight lines in the figure represent those actual or potential links that are of interest to the thesis, such as the physical and informational flow between the different components.

2.3 RESEARCH METHODS

The methods and techniques that are being used when conducting research or studies of different types can usually roughly be classified as either quantitative or qualitative by nature. They define in some way the way that the relevant information has been gathered, processed and analyzed. Quantitative methods are primarily focused on the act of measuring. The result from the measurement can then be used to describe or explain a certain phenomena. Naturally this method is suitable when dealing with large amounts of numerical data. When conducting quantitative studies, the research process can usually be divided into three distinct phases: the planning phase, the data collection phase and the investigating phase. Qualitative methods on the other hand are characterized by a will to understand how a problem or a situation is perceived or interpreted by the relevant persons or groups of persons. As opposed to the quantitative methods, the main underlying questions for the study are rarely set in stone at the beginning of the process. Instead they grow, develop and change during the realization of the study or research.[14] The different methods that have been used during the work of this thesis could fall into both of these two general groups. It could however be discussed if there is a point in making a distinction between these. In order to conduct a study or research, one normally has to choose among some methods that each has its own benefits and drawbacks. It is not unusual to combine quantitative with

[14] Lundahl & Skärvad (2009)

qualitative methods in order to achieve a good compromise. This is what has been done in this thesis. Of course, due to the limited scope of the subject and especially the limitation in time, a need to select the most relevant sources of information has evolved and these choices have in turn affected the methods being used. The different data collection techniques used in this specific thesis will be discussed in the next section.

2.3.1 DATA COLLECTION TECHNIQUES

When gathering the necessary data for the specific subject of a research or study, one can choose several different routes to obtain this kind of information. A typical distinction in this respect is made between primary and secondary data. Primary data is data being collected for the specific purpose of the study or research, while secondary data is previously collected data, not necessarily directly applicable to the study at hand. This is important to keep in mind because the secondary material might have been collected for another purpose. When using this kind of information, one can also not be sure about the extent to which the previously collected data are correct.[15] When it comes to the subject of this thesis, the main sources of primary data have been interviews and discussions with Gambro personnel at different key positions in the organization. A couple of trips to some relevant physical locations have also been carried out. Extracts of relevant and selected data from the relevant systems for the specific purpose of this thesis could also be classified as primary data. The secondary data sources used in the study comprise some internal material, such as presentations, reports as well as general information on the company intranet. The academic literature and articles that have been used also refer to this category.

2.3.2 PRIMARY SOURCES

Initial discussions were carried out with the relevant individuals at the SCM Group in order to get a more detailed feeling for the problem and issues at hand and to define the explicit purpose of the thesis. Interviews were then conducted with key individuals in different parts of the organization to deepen the understanding of the complexity regarding the specific issues. These interviews were of greatest importance and proved to be very useful as some of these presented the view of those individuals that hold some of the strategic positions in the existing spare parts distribution structure. Interviews and discussions with individuals possessing great knowledge concerning those systems and tools which play an important role in the flow of information in the actual structure as well as in the future spare parts distribution scenarios also proved to be of utmost importance. These interviews and discussions were conducted in a semi-structured way with open questions. This proved to be efficient since new questions arose during the conversations and could therefore be dealt with immediately. Apart from these direct oral sources, e-mail correspondence was carried out frequently and through the whole process, often with the purpose to clarify those things that had been discussed orally.

[15] Arbnor & Bjerke (1997)

In order to perform some of the quantitative analysis, there was a need to gather large amounts of relevant data. This was accomplished mainly through extractions from the available business systems used throughout the organization. This proved to be a fast way of obtaining the necessary information in a convenient format. Some of these the author was able to obtain himself thanks to the granted direct access to the systems. When this was not the case, the author was provided with the necessary information by someone else.

The understanding of different processes as well as gaining consensus with relevant counterparts is in many cases impractical, if not impossible, to accomplish with the aid of traditional correspondence media such as telephone or e-mail. Since the subject of this thesis and the purpose that it carries requires an in-depth analysis of the organization, the physical and informational flow and the issues related to the actual as well as the future distribution scenarios, it was decided that an in-person visit to one of the studied sales subsidiaries was the optimal solution to accomplish this in. The discussions with the key individuals at that subsidiary were held on a different level than what would have been the case with the aid of traditional media and this visit proved to be essential and of critical importance to the later presented analysis and recommendations.

2.3.4 SECONDARY SOURCES

Some internal material available on the intranet or on the local server was used during the study. This was either material that had been used in earlier improvements conducted at Gambro or general presentations material both concerning aspects related to the focus of this study as well as other, more distant and general, aspects.

The main part of the secondary sources constituted those academic articles as well as the literature that provided the foundation for the theoretical framework of this thesis. The selection of these was based on the perceived relevance they had to the specific subject of this thesis.

2.4 RESEARCH PROCEDURE

The study on which this thesis is based on was conducted between September and December 2009. The problem and definition of the purpose was presented to the author during the summer and later redefined at the beginning of the study. Later followed the part of the study aimed at getting a full understanding of the distribution structure as it is organized today as well as identifying those individuals that should be involved in the process. Interviews and general discussions were also carried out relatively early to discover those aspects that would need to be taken into consideration in the analysis. Relevant literature and articles were studied during this same time in order to shape the theoretical frame of reference that was to be written.

For the analysis part of the thesis, a large amount of information was extracted and analyzed both numerically and qualitatively. Discussions with key individuals regarding this information and the results from the analysis were carried out and based on these a number of possible future distribution scenarios were constructed. These were then analyzed from different perspectives, with an emphasis on those organizational and administrative implications they would result in if implemented.

Recurring discussions with the thesis supervisor from Gambro were carried out during the whole process with the aim of providing updates on the working progress as well as to decide on the next appropriate steps to be conducted. The supervisor from the university was also updated during the process as to what had been done and what would be carried out in the future.

2.5 CREDIBILITY

When conducting research or studies of any sort, where information and data have been collected, processed or analyzed it is important to reflect on the concept of credibility. A researcher normally wants the results of his work to be trustworthy and neglecting this kind of reflection can therefore have big implications on the usefulness of the presented analysis and conclusions to an outside party. Three terms which are commonly discussed in terms of the concept of credibility are validity, reliability and objectivity.

Validity can be described as of to what extent the study actually measures what is intended to be measured. The validity of a study can be improved by the usage of several perspectives or methods on the same studied situation and thus reducing the risk of accepting a biased view. Reliability is the degree of trustworthiness in the instruments that are being used when measuring things of importance to the study. A high reliability implies that repeated measures of the same measured object or situation will generate the same or very similar results. The reliability of a study can be increased with the aid of control actions when conducting measurements of some sorts, with the relevant aspects being examined a second time. Objectivity refers to the extent that personal values affect the study. By clarifying and motivating the decisions that have been made during the study, the reader is given the opportunity to have an opinion of its own and what conclusions should be drawn from the results, thus increasing objectivity.[16]

The validity of this specific thesis has been increased and secured through the use of different views on the same issue. Several key individuals have been interviewed and individual as well as collective discussions have been carried out in order to examine the issues at hand from different angles. The same reasoning goes for the reliability of the study. In order to avoid misinterpretations and to clarify those aspects that were not fully understood during the initial discussions subsequent questions were also asked. When it comes to the objectivity of this thesis,

[16] Paulsson & Björklund (2003)

the ambition of the author has been to describe, in the most clarifying way possible, what underlying assumptions and decisions have had an impact on the analysis and the results finally presented.

3. THEORETICAL FRAME OF REFERENCE

The purpose of this chapter is to present the theoretical frame of reference of the thesis. Starting with a general discussion on some fundamental concepts of relevance, the chapter continues with a general presentation of, and discussion on, some aspects concerning inventory, distribution, customer service and information technology. The nature of and the special logistical issues concerning spare parts are then presented with some aspects being emphasized because of their importance to the subject of this thesis.

3.1 GENERAL

In the introductory chapter we briefly discussed and defined some logistical terms relevant to the subject of this thesis. Let us review these once again as well as adding some more views on these and other common concepts.

Every organization delivers products to its customers. These products are traditionally described as either goods or services but this distinction is misleading and it is fairer to view every product as a complex package, or offer, that includes both goods and services. At the heart of every organization are the operations that create and deliver its products. We can therefore view an organization as taking a variety of **inputs** (raw material, people, equipment, information, money etc.), doing **operations** (the manufacture, serving, transport, selling etc.) and creating **outputs** (e.g. delivering the product to the customer). This view highlights the flow of materials from suppliers, through operations and on to customers. The materials are everything that the organization uses, both tangible such as raw material, finished goods, spare parts etc. and intangible such as information, money and knowledge. Materials of these sorts generally move through several tiers of suppliers on their journey from initial supplier into an organization and they move through several tiers of customers on their journey out of the organization and on to final customers. All the organizations from the initial supplier to the final customer form a *supply chain*. In practice, there are complex relationships between organizations, so a supply chain is likely to appear as a network of interacting entities. *Logistics* can be described as the function responsible for all movements of material through the supply chain.[17]

The science of logistics has evolved from a purely operation function to a competitive weapon capable of providing goods and services to the farthest regions of the supply chain. Originally, the role of logistics was to provide cost effective warehousing and transportation functions capable of meeting the day-to-day requirements of customer order fulfillment and channel inventory resupply. By the mid 1990s, logistics had risen to such a position of competitive

[17] Waters (2007)

importance that the concept required reformulation. The strategic side of the concept morphed into *supply chain management* and the tactical side focused on logistics operations execution.[18]

Many definitions, other than the one mentioned, of the term logistics can be found in the literature. One of the more popular describes logistics as consisting of the *Seven R's*: that is having the *right product*, in the *right quantity* and the *right condition*, at the *right place*, at the *right time*, for the *right customer*, at the *right price*. This definition covers most of the value-added functions performed by the logistic operations in an organization. The most often quoted formal definition of logistics is the one composed by the Council of Logistics Management where it is defined as *"the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements"*. All definitions characterize logistics as serving three central functions. First of all, logistics is concerned with the **storage** of inventory. Activities occurring in this function are inventory control, replenishment and procurement as well as the number, design, type, and location of storage areas and warehouses. The second function focuses on the **movement** of inventory from the supplier through the manufacturing and distribution channel, ending with delivery to the end user. Essential to this function is the effective selection and use of modes of transportation. The final, and most important, function is capability of logistics to satisfy **customer requirements**.[19]

There is however no "true" definition that should be pedantically used because products differ, companies differ and systems differ. Logistics is a diverse and dynamic function that has to be flexible and has to change according to the various constraints and demands imposed upon it and with respect to the environment in which it works. Another very straightforward widely accepted view of logistics shows the relationship as follows:[20]

Logistics = Supply + Materials management + Distribution

Logistics is thus concerned with both physical and information flows and storage from raw material through to the final distribution of the finished product. *Supply* and *materials management* represents the storage and flows into and through the production process, while *distribution* represents the storage and flows from the final production point through to the customer or end user.[21]

When the logistics function started to gain more and more strategic importance among companies, new concepts such as logistics management and supply chain management evolved.

[18] Ross (2004)
[19] ibid.
[20] Rushton et al. (2006)
[21] ibid.

Logistics management can essentially be seen as an integrative process that seeks to optimize the flows of materials and supplies through the organization and its operations to the customer. It is essentially a planning process and an information-based activity. Requirements from the marketplace are translated into production requirements and then into materials requirements through this planning process. It has however been recognized, that for the real benefits of the logistics concept to be realized, there is a need to extend the logic of logistics upstream to suppliers and downstream to customers. This is widely known as the concept of supply chain management. Supply chain management is a fundamentally different philosophy of business organization and is based upon the idea of partnership in the marketing channel and a high degree of linkage between entities in that channel. The new model of competition suggests that individual companies compete not as company against company but rather as supply chain against supply chain. Thus the successful companies will be those whose supply chains are more cost-effective than those of their competitors.[22]

As an aid in the on-going supply chain management process of organizations, the Supply-Chain Council has developed a process reference model known as the Supply Chain Operations Reference model (SCOR), a management tool to describe the business activities associated with all phases of satisfying a customer's demand. The model can however also be used in order to get a high level understanding of the operations that a supply chain normally consists of. SCOR is based on five distinct management processes that are all central to the supply chain: Plan, Source, Make, Deliver, and Return. Figure 3.1 depicts how these processes are organized in and a part of the supply chain.[23]

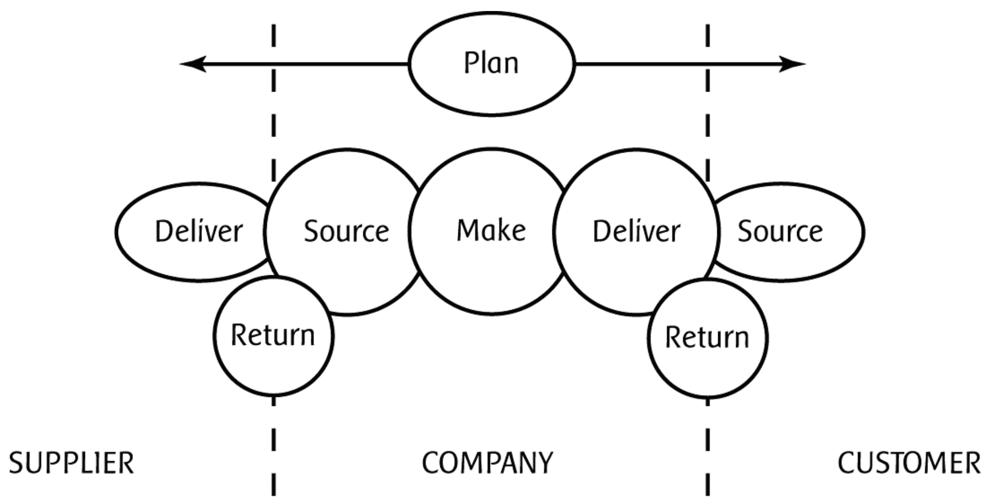

Figure 3.1 The Supply Chain Operations Reference (SCOR) Model[24]

[22] Waters (2007)
[23] Hugos (2006)
[24] Ibid.

The Plan process refers to all the operations needed to plan and organize the operations in the other categories, for example demand forecasting, supply planning and inventory management. The Source process includes the activities necessary to acquire the inputs to create products or services, such as procurement and acquisition of cash. The operations required to develop and build the products and services that a supply chain provides, e.g. product design, production management and facility management, are brought under the Make process. The Deliver process encompasses the activities that are part of receiving customer orders and delivering products to customers, while the Return process comprises those activities related to returning or receiving returned products for any reason. All these operations constitute the core connections between companies in a supply chain. [25] Since this thesis is primarily focused on inventory and distribution, we will concentrate on the Plan and Deliver process aspects of the supply chain in the rest of this chapter.

3.2 INVENTORY

In order to discuss the concept of inventory in general terms, one could talk about inventory systems. In an inventory system, every inventory lies between two activities or processes, which can be seen as the supply process and the demand process. The supply process comprises the production, transportation and other activities that add new stock to the inventory, while the demand process describes the various activities that use and thus subtract material from the inventory.[26]

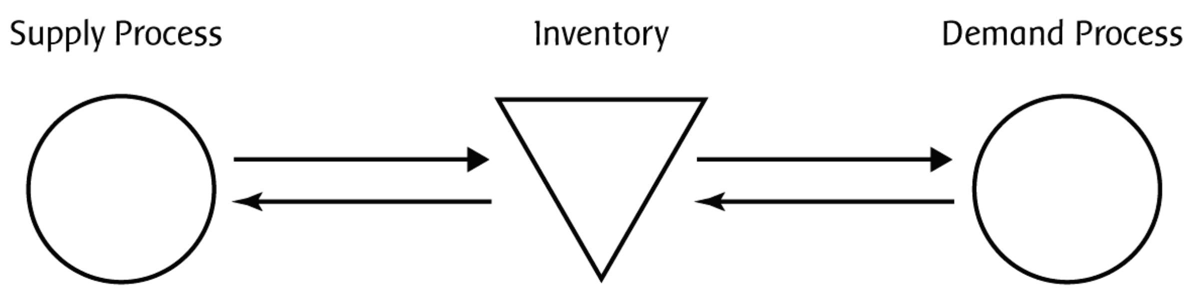

Figure 3.2 Inventory system[27]

Although the concept of what an inventory is as well as the context that it is a part of seems pretty straightforward, the real world implications and consequences of inventory systems are far more complex and complicated than one would imagine.

In the ideal world, no inventory would be required because manufacturers would exactly forecast demand and produce only that much. Unfortunately the world is not perfect, at least from a

[25] Hugos (2006)
[26] Zipkin (2000)
[27] Ibid.

logistical point of view, and forecasts are not accurate. Firms must produce and store additional stock just in case to meet changing demand patterns. If firms could forecast accurately, many logistics activities would be unnecessary or have little effect on logistics costs.[28] Indeed, most of the important functions of inventories can be understood in terms of the various types of mismatches that arise between supply and demand processes. In other words, inventory serves as a buffer between supply and demand processes that do not fit neatly together, to mitigate the costly disruptions that would otherwise occur.[29] The function of inventory is thus to decouple the organization from the discontinuousness of customer demand on one hand and limitations in supplier delivery capacities on the other.[30]

A firm's different functional areas usually disagree over inventory. Marketing and sales want high inventories over a broad range of products to allow quick response to customer demand. Manufacturing wants high inventories to support long production runs and to realize economies of scale through the reduction of per unit fixed costs. Also, lack of inventory may shut down the production line. Finance normally prefers low inventories to increase inventory turns, reduce current assets, and increase return on assets. The planning, warehousing and shipping departments usually agree with finance. High inventory increases inventory carrying costs, warehousing costs, packaging costs, and material handling costs. Everyone recognize the need for some inventory but the question is how much should optimally be kept. The solution discussions regarding this question, together with other similar questions, are usually grouped under the concept known as *inventory management*.[31]

3.2.1 INVENTORY MANAGEMENT

In simplest terms, inventory management deals with the issues of how much to keep on hand and how much and how frequently to reorder. The objective of inventory management is to meet customer needs while keeping inventory costs at a reasonably level to produce profit for the firm. The objective is not simply to reduce costs of ordering and holding inventory, nor is it just meeting customer demand. These two objectives are clearly opposed to each other when considered by themselves. To reduce inventory costs, the simplest solution would be to hold no stock at all and reorder only when customers place an order. Although this will certainly lead to low inventory costs, the probability is high that it will also result in dissatisfied customers and, in the longer term, lost sales. On the other hand, if a high level of inventory would be kept in anticipation of customer needs, this could be incurring huge costs that may eventually put the

[28] Bloomberg et al. (2002)
[29] Zipkin (2000)
[30] Ross (2004)
[31] Bloomberg et al. (2002)

company out of business. It is thus clear that a delicate balancing act is needed to achieve these two objectives simultaneously.[32]

The reasons for keeping inventory are many. One, already mentioned, reason is the one concerning market demand. When demand can be envisioned as a continuous stream, drawing down inventory at some rate, either constant or variable, then we say that demand is smooth. The opposite of this is lumpy demand, where the demand occurs in large, discrete chunks. These are however the two extremes of demand; real demands often have both smooth and lumpy components. Those products or parts that have a tendency of generating more lumpy demands are generally harder to manage as the mismatch between the supply and demand processes are bigger and more difficult to predict, thus implying a need to keep more inventory. Seasonal changes and other temporal variations in the demand level also often lead to mismatches, especially when the capacity of the supply process is limited. Then, inventory must be built up during slack periods to have sufficient stock to meet later, heavier demands. On the supply side of the inventory system one factor leading to mismatches between supply and demand is the economies of scale; in many situations the technology and economics of the supply process favor long production runs or large deliveries, relative to short-term demand. Another one is the aspect of capacity limits. Every real supply process has limited capacity, and so has limited ability to respond to changes or lumps in demand, whether anticipated or not. Thus, inventories are required to compensate for this inflexibility. A third influencing factor is the delay in response, defined by the different lead-times present in the supply process. These kinds of random fluctuations in demand, in conjunction with supply lead-times and capacity limits, are among the major reasons for maintaining inventories. In these cases, the supply process is unable to respond quickly to unanticipated demand surges and declines, so inventory is needed in order to fill demands in a timely manner.[33]

Focusing on the distribution of finished goods, the primary reason to hold inventory is to offset uncertainties in end customer demand. If customer orders outstrip the finished goods supply, the resulting stock-outs could lead to lost customers. Product stock-outs leave customers with a variety of options. The customer can wait, substitute, buy elsewhere this time or buy elsewhere permanently. The frequency of stock-outs and the existence of competition will influence this choice. If the stock-outs are infrequent, the customer will probably wait or backorder. Repeated stock-outs may however cause the customer to substitute or seek another supplier. The major problem in avoiding stock-outs is how much inventory to carry. Unless the costs of inventory are known, a firm may add inventory to eliminate stock-outs, increasing customer service but increasing inventory carrying costs even more. A logistics manager’s constant dilemma is

[32] Mercado (2008)
[33] Zipkin (2000)

therefore to find the optimal inventory level that will guarantee an adequate customer service level and at the same time keeping the inventory carrying costs at an acceptable level.[34]

3.2.2 INVENTORY COSTS

No matter the type of inventory carried, it is expensive. Some experts estimate that total inventory costs run from 14 percent to more than 50 percent of the value of the product on an annual basis. On a general level, two types of costs are associated with inventory: carrying costs and ordering costs. The relationship between these are inverse, as shown in figure 3.3.[35]

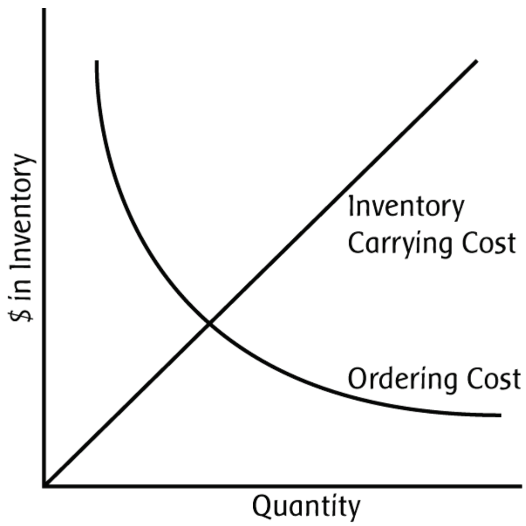

Figure 3.3 Inventory costs[36]

The carrying costs are related to the physical storing of goods. These costs can be divided into four subgroups: capital, storage space, service and risk. Capital costs compares inventory investment to what the firm could earn from other capital investments. Storage space costs cover the cost of moving goods into and out of inventory. This includes only the variable costs of rent, utilities, and space. However, if the company owns its own warehouse and pays no identifiable premium in cost for additional inventory, then the cost is not a storage space cost or carrying cost, instead it is a warehousing cost. Inventory service costs include insurance and taxes. The last carrying cost is the inventory risk cost, which includes the cost of obsolescence, damage, relocation, or theft. Obsolescence means the goods can no longer be sold for the original price or for the original cost. Better products may be available, or the product may be out-of-date. The ordering costs, on the other hand, consist of order costs, setup costs, or both. Order costs could include preparing and processing the order request, selecting a supplier, checking stock, preparing the payment, and reviewing inventory levels. Setup costs refer to modifying the

[34] Bloomberg et al. (2002)
[35] Ibid.
[36] Ibid.

manufacturing process to make different goods. They include personnel costs, as well as capital equipment costs.[37]

Another cost aspect that is important to keep in mind when discussing inventories is the shortage cost. When a customer needs an item that is not in stock, there is a cost incurred since activities have to be performed that would not have otherwise been necessary. For example, if the customer decides on putting his order as a backorder, this backorder has to be created and then monitored until its fulfillment. If the customer is not willing to wait, the company loses the opportunity to gain profit on the lost sale. Last but not least, the customer normally becomes very unhappy. Although it is difficult to estimate the cost of an unhappy customer, there is universal agreement that the cost of an unhappy customer is not an insignificant amount.[38]

3.3 DISTRIBUTION

Distribution is all about making products available to the customer in the most cost efficient way possible, while maintaining a certain specified service level. A company can choose to produce a product when the order has been received ("make-to-order") or produce it and put it on stock ("make-to-stock"). From a distribution point of view, this choice is of highest significance.

A very common problem related to this is described by the question: where to position inventory in a distribution system, at a retail facility next to the customer or at a warehouse closer to the factory? The importance of this question has grown as distribution managers are increasingly caught between the pressures of the market and the high cost of inventories. Global competition and the growing emphasis on customer satisfaction have underscored the need to improve customer service levels. At the same time the capital, space and obsolescence costs of carrying inventories have increased, necessitating prudent management of the inventory resource. There are several methods of improving customer service levels in the face of uncertain demand. The traditional method, increasing inventories, may not be sensible given the costs outlined above. Decreasing uncertainty can work in those markets where customer alliances that allow sharing of information can be developed, but this is difficult in the customer market. Increased shipment frequency can improve service levels, but at increased cost. Finally, distribution managers can invest in better inventory control systems, again at some cost. All of these alternatives can be expensive and some, as indicated, may not even be feasible. So, in general, the issue reduces to one of how to use existing resources better.[39]

In the extreme, distribution managers can position their entire inventory at the local retail stores. Having some inventory positioned at the central warehouse, however, enables them to send it out

[37] Bloomberg et al. (2002)
[38] Mercado (2008)
[39] Whybark & Yang (1996)

to the retail stores later. Intuitively, the idea of positioning some portion of the inventory at the central warehouse is attractive since it provides an ability to react to changing conditions at the retail level. On the other hand, inventory held at the central warehouse is not available to meet the demand at the retail stores where it occurs.[40] An illustration of two common ways of organizing the distribution is shown in figure 3.4.

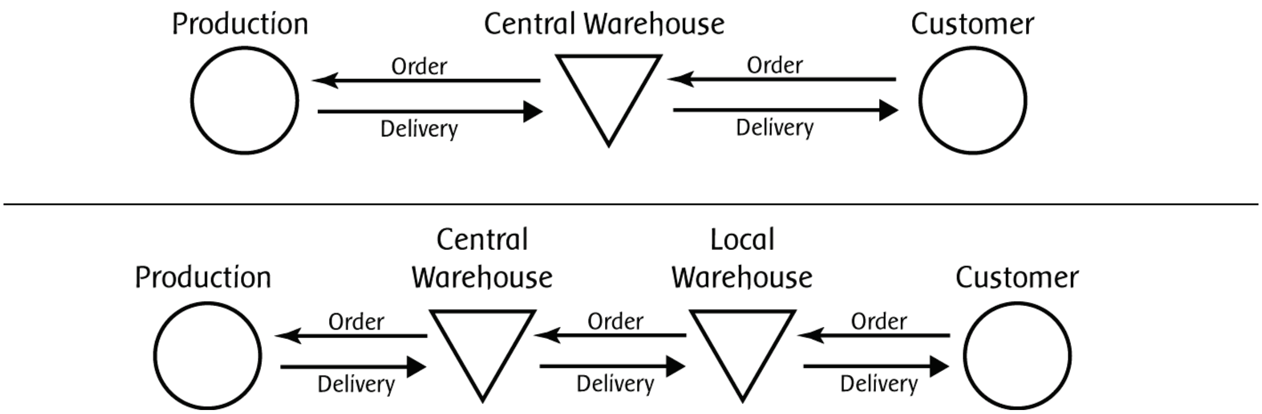

Figure 3.4 Different ways to organize the distribution[41]

In the first example only one central warehouse is used which distributes products directly to the customer. In the second example there is also a local warehouse which order products from the central warehouse and supplies the customers located in the local region. The second example illustrates the structure that has been most common for a long time historically. A shift towards a more centralized distribution structure has however been observed in Europe during the last three decades.[42] In the literature, this change of physical distribution structures that has been taking place has also been analyzed and discussed, where the traditional way of reasoning has been confronted with this new way of organizing the distribution.

3.3.1 DISTRIBUTION THEORIES

The traditional distribution theories, which have influenced the design of distribution systems during the last decades, are based on well known theories in marketing (the marketing channel theory) and logistics. According to the marketing channels theory, the design of a distribution structure is based on the geographical distance between the producer and its customers. The marketing channels theories focus on functions performed in the distribution channel, gaps between the producer and customers and the use of intermediaries in the channel. Because of the gaps in the channel (time gap, geographical gap, quantity gap and variety gap), the producer and

[40] Whybark & Yang (1996)
[41] Aronsson et al. (2006)
[42] Ibid.

the customers operate almost independently. The producer's large production batches do not match the customer demand for small quantities and specific assortment. Similarly the time and place of production does not match the time and place of the customer demand. Therefore the middlemen are expected to create utilities in place, time, quantity, assortment and possession.[43]

The distribution functions are considered as indispensable and must be performed. They are also considered as mutually independent. The question is which institution or middlemen within the system are taking responsibility for the function. If one institution is eliminated, its functions will be shifted either forward or backward in the channel, because you can eliminate the middlemen but you cannot eliminate his function. According to the marketing channels theories, the distribution channel will contain many warehouses if, among other things, the number of customers is large, the customer-structure is geographically spread out, the customers purchase small volumes and if there are many competent middlemen available.[44]

The logistics theories differ from the marketing channel theories in two ways. First, the logistic channel is separated from the transaction channel. The logistic channel focuses the materials flow from the point-of-origin (supplier) to the point-of-consumption (the customer). It implies that the physical distribution must be coordinated with the in-process flow and the materials management. Coordinating functions is important and considered as necessary to reduce costs by trade-offs. Increased costs in one function can result in decreased costs in other functions and thereby reduced total distribution costs. Second, in the logistics theories the number of warehouses is a result of a total cost analysis, as shown in figure 3.5, where the total physical distribution cost is a function of inventory cost, warehousing cost, transportation cost and cost of sales.

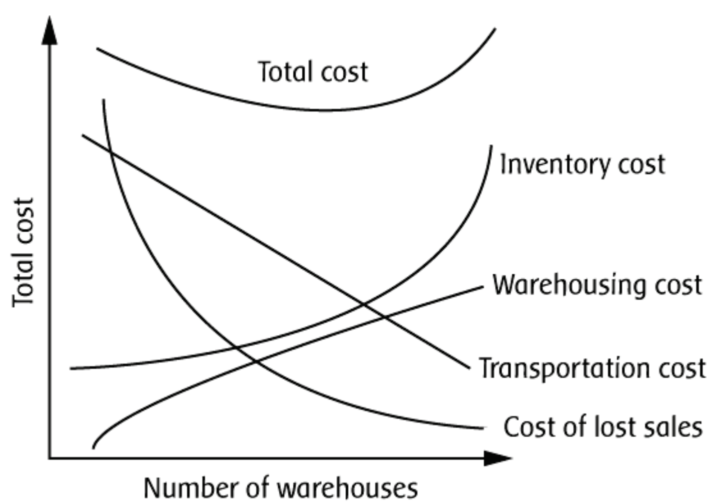

Figure 3.5 Total distribution cost[45]

[43] Abrahamsson (1993)
[44] Ibid.
[45] Ibid.

As in the marketing channel theories the geographical distance to the customer is important. The number of warehouses is considered to effect the customer service. That is why the cost of lost sales is expected to increase when the number of warehouses is reduced. Another factor that effects the number of warehouses in the logistic theories are lead-times (the time from received order to a complete delivery to the customer). If the demand for short lead-times is high, or if the customer's orders are hard to predict, then another warehouse in a closer location to the customers is recommended.[46]

As has been mentioned, there have been several examples of companies changing their distribution from a decentralized structure with one or more warehouses in each country, corresponding to the traditional theories, to a centralized distribution structure known as *time based direct distribution*. The customers now instead get their deliveries from one central warehouse. In time based direct distribution it is more important to deliver the goods to the customers within a specified time, e.g. 48 hours, than it is to have warehouses geographically close to the customers.

3.3.2 TIME BASED DIRECT DISTRIBUTION – A CASE EXAMPLE

One good example of how time based direct distribution has been implemented is the case of Atlas Copco Tools AB (ACT). In the beginning of the 80s ACT had seven manufacturing plants in Europe, each with a warehouse for finished goods. They had two central warehouses, one in Sweden and one in Finland. In each country there was a sales company with a warehouse. The local warehouses were refilled from one of the central warehouses, which in turn were refilled from the factories stock of finished goods. The former distribution strategy was influenced by the traditional theories. It was designed to be geographically close to the customers. The aim was to have a complete assortment in the local warehouses. However, the delivery performance (number of items ordered available in stock) was only 70%. If the item could be delivered from stock the lead time was 2 days, but the average lead time over all orders was about two weeks. In 1986 inventory was 29 % of the sales, and the value of the sales companies stock was $ 9,000,000. The DDD-system (Daily Direct Distribution) started in 1987. The aim was to reduce inventory and to increase delivery performance. With DDD, ACT delivered all their products from one central warehouse, located in Sweden, direct to customers in Europe. At first, most of the shipments from the central warehouse in Sweden to customers in Europe were by air freight, in order to be sure of the delivery performance and to convince the local sales companies that they did not need stock of their own. In 1993, 95 % of the shipments were carried out by truck. The identified effects of this centralization were:[47]

- Reduced inventory by 1/3
- Reduced variable distribution costs by $ 4,000,000 annually

[46] Abrahamsson (1993)
[47] Ibid.

- Reduced average lead time to customers, from 2 weeks to 24-72 hours
- Increased delivery performance, from 70% to 93%
- Reduced number of employees in the central warehouse, from 40 to 23

3.3.3 THE NEW DISTRIBUTION STRUCTURE?

Effects of centralization could be described as cost advantages for the selling company and added values for the buyer. Abrahamsson uses the terms logistics cost leadership and logistics buyer values to express the results of the changes to a centralized distribution structure. Logistics cost leadership, in terms of increased profitability and possibilities for price competition, can be identified in four variables: reduced fixed distribution costs, reduced variable distribution costs, integration/separation advantages and reduced learning costs for the organization. In the same way logistics buyer values can be described by four variables: shorter lead-times, increased delivery precision, differentiation of physical distribution and increased information to customers. These are all effects that were experienced by Abrahamsson during the case studies of three Swedish companies during their switch towards a centralized direct distribution structure during the 80s and early 90s, with ACT as described above being one of these companies.[48]

According to the traditional logistics theories, the transportation costs for the selling company were expected to increase considerably. Yet the transportation costs did not increase in any of the three cases. The reason was a complete assortment in the central warehouse in combination with a smooth flow of deliveries from the warehouse, which made stock control much easier. The complete connection between the centralized distribution and inventory and transportation costs is shown in the figure below.[49]

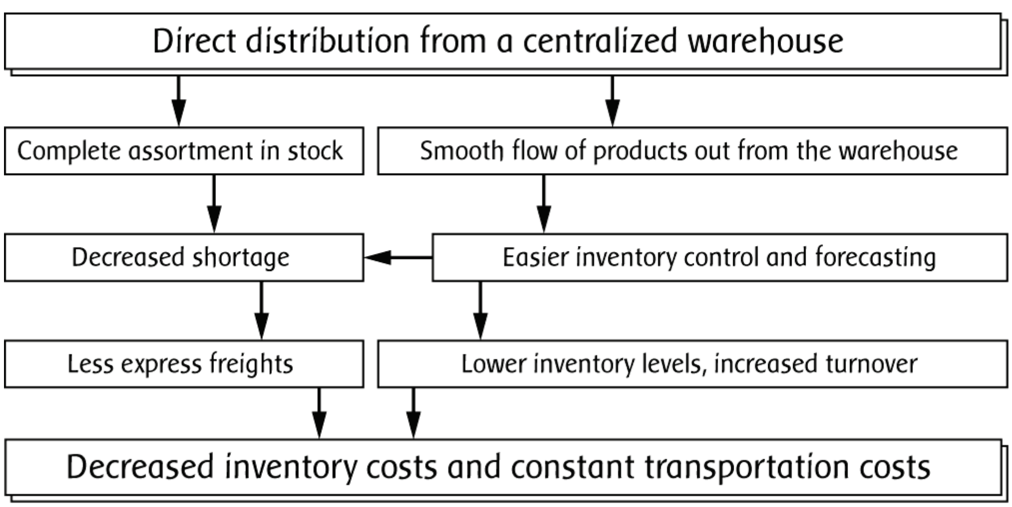

Figure 3.6 Connections between centralized distribution and inventory/transportation costs[50]

[48] Abrahamsson (1993)
[49] Ibid.
[50] Ibid.

A computerized information system was absolutely necessary to implement time based distribution, which made it possible to integrate, for example, the order handling system with production planning. Another important effect of centralization was the separation of the sales function from physical distribution. Physical distribution is centralized to achieve economies of scale in materials handling and transportation and the sales function is still local for best customer service and support. Because the personnel in the sales companies did not have to handle and control their warehouse, they had more time for marketing and sales activities.[51]

On the buyer value side, the effects on lead time and delivery performance were most obvious. Again the key was complete assortment and the smooth flow of deliveries from the warehouse, making it easier to control the availability of products. Figure 3.7 shows the full connections.[52]

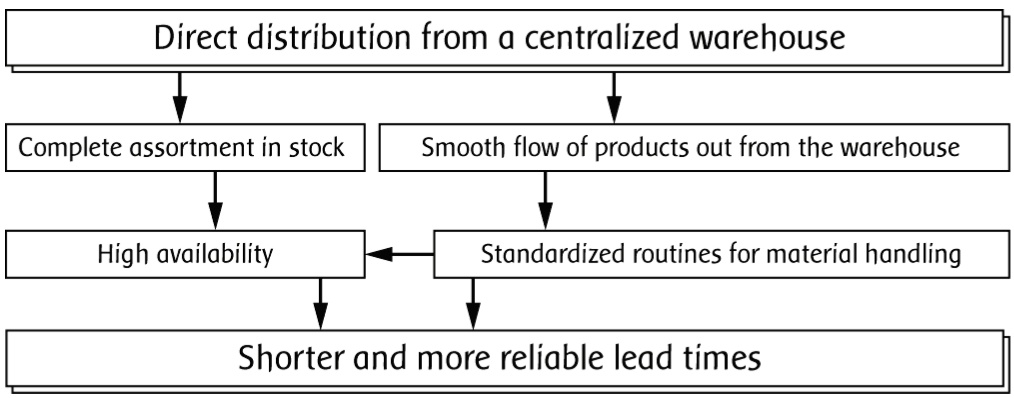

Figure 3.7 Connections between centralized distributions and leadtimes[53]

Opposed to the traditional theories, the companies found their best distribution system with only one or two warehouses in the system. They focused on delivery time instead of the geographical distance to the customers, a factor which is not considered as significant in the traditional theories. The clear effects of a change in distribution to a system with deliveries from one, or a few, central warehouses direct to the customers also indicate deficiencies in the traditional total distribution cost model. In the three case studies the total distribution costs decreased with a reduction of the number of warehouses in the distribution structure. The inventory costs decreased, the transportation costs were constant and the sales increased rather than decreased. It is the opposite to what was expected in the traditional total distribution costs model in figure 3.5. Figures 3.6 and 3.7 show the key to these effects. A complete assortment in stock, which is possible with only one warehouse and a smoother flow of products out from the warehouse, because of the large number of small deliveries to a large number of customers. The traditional models do not consider the importance of these variables to the design of a distribution system.

[51] Abrahamsson (1993)
[52] Ibid.
[53] Ibid.

The variables have an impact on two of the curves in the total distribution costs model, the transportation costs and, because of shorter and more reliable lead-times, the curve of lost sales. It shows that the total distribution costs will increase by the number of warehouses. The importance of lead time in the distribution structure and because the companies studied decreased their distribution costs, indicate that the lowest total distribution costs will be reached with as few warehouses as possible and requested lead time as a prerequisite. The clear effects of the change to time based distribution, both in logistics costs leadership and logistics buyer values, show its potential to increase competitive advantages of the companies.[54]

3.4 CUSTOMER SERVICE

The term logistics is usually not directly associated with the more non-tangible notion of customer service. And yet customer service represents the output of a firm's business logistics system and the physical distribution or place component of its marketing mix. Thus, customer service can be seen as the interface between logistics activities and the demand creation process of marketing and it measures how well a logistics system functions in creating time and place utility for customers.[55]

There are hundreds of definitions for customer service. One simple definition is "*doing what you say you're going to do, when you say you're going to do it*". There are however more textbook definitions: "*customer service is the complete activity of identifying customer needs in all their complexity, satisfying customers fully and keeping them satisfied*" or "*customer service is a function of how well an organization meets the needs of its customers*".[56] In the context of logistics, one definition of logistics customer service could be viewed as "*a process which takes place between buyer, seller and third party. The process results in a value added to the product or service exchanged... the value added is also shared, in that each of the parties to the transaction is better off at the completion of the transaction that they were before the transaction took place. Thus, in a process view, customer service is a process for providing significant value-added benefits to the supply chain in a cost effective way*".[57]

The logistics components of customer service can be classified in different ways. They may be seen as transaction-related elements, where the emphasis is on the specific service provided, such as on-time delivery, or they may be seen as functional attributes that are related to the overall aspects of order fulfillment, such as the ease of order taking. Transaction elements are usually

[54] Abrahamsson (1993)
[55] Waters (2007)
[56] Vass (2006)
[57] Waters (2007)

divided into three categories. These reflect the nature and timing of the particular service requirements (before, during and after delivery of the product):[58]

1. *Pre-transaction elements*: these are customer service factors that arise prior to the actual transaction taking place. They include:
   - Written customer service policy
   - Accessibility of order personnel
   - Single order contact point
   - Organizational structure
   - Method of ordering
   - Order size constraints
   - System flexibility
   - Transaction elements
2. *Transaction elements*: these are the elements directly related to the physical transaction and are those that are most commonly concerned with distribution and logistics. Under this heading would be included:
   - Order cycle time
   - Order preparation
   - Inventory availability
   - Delivery alternatives
   - Delivery time
   - Delivery reliability
   - Delivery of complete order
   - Condition of goods
   - Order status information
3. *Post-transaction elements*: these involve those elements that occur after the delivery has taken place, such as:
   - Availability of spares
   - Call-out time
   - Invoicing procedures
   - Invoicing accuracy
   - Product tracing/warranty
   - Returns policy
   - Customer complaints and procedures
   - Claims procedures

Customer service elements can also be classified by multifunctional dimensions. The intention is to assess the different components of customer service across the whole range of company

[58] Rushton et al. (2006)

functions, to try to enable a seamless service provision. Time, for example, constitutes a single requirement that covers the entire span from order placement to the actual delivery of the order – the order cycle time. One of the main consequences of this approach is that it enables some very relevant overall logistics measures to be derived. The four main multifunctional dimensions are:[59]

1. *Time* – usually order fulfillment cycle time
2. *Dependability* – guaranteed fixed delivery times of accurate, undamaged orders
3. *Communications* – ease of order taking and queries response
4. *Flexibility* – the ability to recognize and respond to a customer's changing needs

3.4.1 CUSTOMER SERVICE AND SPARE PARTS

The spare parts supply as a part of the after-sales service for capital goods has an increasing importance as a competition tool in this industry. Its effect for winning new customers and binding existing ones depends on the recognition and the fulfillment of customer requirements. Customer requirements can be distinguished into requirements on delivery service, on spare parts quality, on customer communication and on spare parts supply costs. These factors are described in a detailed way below.[60]

Customer requirements on delivery service

Delivery time has an effect on the customer's inventory level and a longer delivery time normally causes more supply uncertainty and a higher inventory level. Delivery time itself depends on the stock availability of the supplier and on the implemented distribution system. The reliability of delivery has an additional influence on the customer's inventory level. A high reliability means meeting the promised delivery date. Possible changes in the delivery data and a timely confirmation of order must be communicated to the customer. High quality delivery means also a delivery:[61]

- Without any damaged goods
- Of the right kind and amount of products according to the customer's order

The avoidance of wrong deliveries demands high reliability within the entire order cycle process, especially order taking and order picking. Moreover, packaging has to provide a reliable protection against possible damages during transport. Expectations from the customer concerning the supply flexibility should be met by a corresponding capability of the supplier to adapt to different customer requests. The adaptation could take place during the processes of order

[59] Rushton et al. (2006)
[60] Pfohl & Ester (1999)
[61] Ibid.

processing, delivery procedure and customer information processing. The flexibility of order procedure can be accomplished by not using:[62]

- Minimum order quantity
- Fixed order quantities
- Fixed dates of order placing

Moreover, a free choice of the way the order is transmitted should be realized. A flexible procedure of delivery includes the consideration of the customer's requests on packaging, shipment choice and the offer for a delivery "on call". Customer information must refer to delivery alternatives, state-of-the-order process and possible delays in delivery. Although measurement of flexibility is limited to only qualitative criteria, an evaluation is still necessary and useful. Since every kind of flexibility in the order management process has an influence on the customer's value chain, flexibility is an important tool to fulfill customer requirements. Delivery service also includes dealing with customer queries. Dealing with customer queries should be done quickly and must be very reliable because of possible failing costs for machine breakdowns on the customer's side.[63]

Customer requirements on communication

Concerning the technical side of communication, the EDP (electronic data processing) systems of customers and suppliers have to be directly connected to one another to reduce transmission time and to avoid errors in data input and data transmission. Customers need consulting for placing their orders (e.g. article number of the requested spare part, technical advice for the installation). Therefore telephone consulting should be offered to the customer and be on duty as long as possible. Customer information requests are also connected with the forecasting of spare part demands and recommendations for the maintenance of machines and spare parts. In this context, the appearance and personality of the sales force and the consulting staff are quite important. That means they have to meet high standards regarding their technical qualification, which comprises the understanding of the customer's technical and organizational problems. Furthermore, they are expected to show politeness and understanding towards the customer. An important prerequisite for a reliable order consulting and a correct order management is a clear and correct numbering and labeling of spare parts. This allows a quick identification, a clear order placement and an easy storage at the customer's facility. A careful documentation of all offered spare parts is also an important condition for customer consulting, in particular if the period of storage is very long.[64]

[62] Pfohl & Ester (1999)
[63] Ibid.
[64] Ibid.

Customer requirements on quality of spare parts

The quality of spare parts, the possibility of their repair and an easy assembling and reassembling have a high effect on the customer's value chain. Particularly, the quality of spare parts is an argument of prime importance for the customer's choice of the supplier for capital goods.[65]

Customer requirements on the costs of spare parts supply

The two components of supply costs are the prices of spare parts and the supply costs (deliver or procurement cost). Both components are affected by the spare parts logistics. Prices of spare parts depend on the costs of production and storage, whereas the costs for supplying depend on the structure of the distribution system.[66]

3.5 INFORMATION TECHNOLOGY

As the importance of timely, accurate and complete information increases in the supply chain environment, information technologies have progressively become the key enabler integrating the supply network environment. What this means is that today's marketplace leaders must view computerized technologies not only as a tool to accelerate the speed and productivity of business through automation, but also as a key driver that enhances the opportunity for supply chains to continually activate new relationships and operating structures that change the way they compete in the marketplace.[67]

Internally, information technologies enable companies to develop databases and implement applications that provide for the efficient management of transactions and the timely collection, analysis and generation of information about customers, processes, products, services and markets necessary for effective decision making. Externally, information technologies enable supply chain strategists to architect channel networks that are collaborative, agile, scalable, fast flow and Web-enabled. The goal is to present customers anywhere in the supply chain a single, integrated response to their wants and needs by creating a unique network of value-creating relationships. Connectivity and synchronization at this level require the elimination of channel information silos and the construction of collaborative, channel-wide communication and information enablers directed at a single point: total customer satisfaction.[68]

3.5.1 INFORMATION SYSTEMS

Data, information and knowledge are critical assets to the performance of logistics and supply chain management because they provide the basis upon which management can plan logistics

[65] Pfohl & Ester (1999)
[66] Ibid.
[67] Ross (2004)
[68] Ibid.

operations, organize logistics and supply chain processes, coordinate and communicate with business partners, conduct functional logistics activities and perform managerial control of physical flow of goods, information exchange and sharing among the supply chain partners. Information systems (IS) are the effective and efficient means to manage those critical assets, and to provide sustainable competitive advantages.[69]

From an information management perspective, information systems are conventionally utilized in the application of efficiency-oriented SCM to increase productivity and reduce operational costs. Specifically they are used to:[70]

- Capture and collect data on each product and service at a specific logistics activity to provide accurate, reliable and real-time raw facts.
- Store collected data in a specific information system in predetermined categories and formats.
- Analyze stored data to generate meaningful information for management decision making in response to SCM events and to evaluate SCM performance for cost reduction and productivity enhancement.
- Collaborate and communicate with supply chain partners to reduce information time lag and misunderstanding and make data resources available and visible to all SC partners.
- Standardize logistics operations and data retrieval procedure and develop generalized and rigorous information management policies, regulations and control measures.

Nowadays, information systems are widely applied in the areas of effectiveness-oriented SCM to enhance supply chain competitive advantages, value-added SCM and globalized operations. In particular they are deployed to:[71]

- Enhance core competence and positioning of a focal supply chain organization through designing and controlling the information sharing and flows.
- Re-engineer supply chain operations and eliminate duplicated facilities or activities.
- Manage marketing, customer, product and service knowledge or expertise developed in SCM and share this with suppliers and partners.
- Manage partner and customer relationships through resource-based and relational views to stabilize supply chain structure and enhance relations with adjacent upstream and downstream partners.
- Deploy supply chain resources and capabilities to compete with other supply chains at worldwide level and through international sourcing and offshore manufacturing.

An important development for many major companies has been the introduction of enterprise-wide information systems, often known as ERP or enterprise resource planning systems. These

[69] Waters (2007)
[70] Ibid.
[71] Ibid.

are transaction-based information systems that are integrated across the whole business.[72] ERP systems gather data from across multiple functions in a company and they monitor orders, production schedules, raw material purchases and finished goods inventory. They support a process-oriented view of business that cuts across different functional departments. For instance, an ERP system can view the entire order fulfillment process and track an order from the procurement of material to fill the order to delivery of the finished product to the customer.[73]

Advanced Planning and Scheduling systems, also known as ASP systems, are highly analytical applications whose purpose is to assess plant capacity, material availability and customer demand.[74] They enable a company to plan and manage its logistics operations through the use of an integrated system-wide package. Such tools will use information such as real-time demand and/or forecasting, linked to production capacities and run rates, inventory holding levels and locations, supplier lead times, associated costs etc. to help determine operational production and inventory requirements. To be effective, these systems rely on the accuracy and real-time nature of the data that are fed into the system.[75] APS systems base their calculations on the input transaction level data that is extracted from ERP or other transaction processing systems. They can use linear techniques and other sophisticated algorithms to create their recommended schedule.[76]

Two other widely used systems are Demand Planning (DP) and Inventory Management (IM) systems. DP systems use special techniques and algorithms to help a company forecast their demand. These systems take historical sales data and information about planned promotions and other events that can affect customer demand, such as seasonality and market trends, and use this data to create models that help predict future sales. IM systems support activities such as tracking historical demand, patterns for products, monitoring inventory levels for different products and calculating economic order quantities and the levels of safety inventory that should be held for each product. These systems are used to find the right balance for a company between the cost of carrying inventory and the cost of running out of inventory and losing sales revenue because of that.[77]

3.5.2 STRATEGIC ASPECTS OF IT & IS IN SCM

It must be remembered that the installation of information systems will entail widespread change within the organization and must not be entered into lightly. It will have implications in terms of organizational structure as well as of the way in which individuals work. It is not a question of simply computerizing an existing paper-based system, but rather a matter of installing a

[72] Rushton et al. (2006)
[73] Hugos (2006)
[74] Ibid.
[75] Rushton et al.(2006)
[76] Hugos (2006)
[77] Ibid.

completely new system. It must be thoroughly planned and executed, which will require significant extra resources to achieve a successful outcome. Many companies have benefited from these systems, whilst some have experienced severe problems with their application. Generally, they are very expensive to purchase, require a lot of tailoring for each user company, and take a lot of expensive consultancy time to implement and a high degree of training for use at the operative level. It is a logical extension of the principles of supply chain management to have overarching computerized system that allows for the organization and support of the planning of the planning of the whole enterprise, and they are becoming more and more commonplace.[78]

Some strategic aspects of implementation and development of new or existing information systems that every organization needs to take into consideration are:[79]

- Does IS/IT fit organizational SCM strategies and core competences?
- Is IS/IT adoption compatible with current philosophies and practices?
- What business process and SC structure change will take place?
- How will existing suppliers and relationships be affected by the new IS/IT?
- What costs will be incurred during and after IS/IT adoption?
- How does the developed IS/IT impact on our current SC operations?
- What will happen to existing long-term and arm's-length relationships with key customers?
- How do we integrate our ERP or other functional systems with SCM systems?
- What internal and external IT infrastructure has to be developed with our suppliers/users?
- What are the system and data compatibility issues in interacting with nonstandardized systems?

SCM attempts to achieve cycle time reduction and faster inventory turnover by establishing tight linkages with suppliers and to move from pure efficiency orientation to greater coordination and integration of business processes in functional areas including product design and development, market research, production planning etc. A high level of trust and extensive information sharing are required for successful implementation of these initiatives. A critical SCM decision is how to develop and introduce IS and still maintain trustworthy, long-term relationships with key supply chain partners. While long-term relationships and contracts provide stability, they reduce the flexibility of exploring alternative markets and the possibility of faster growth or increasing profits in some markets. The focal organization needs clear objectives and strategic planning and collaboration with other supply chain partners to share the risks and benefits and a careful analysis of the impact of new IS/IT. Since the adoption of new IS/IT takes significant effort and time, organizations should check that there is alignment with current SCM strategies. Change

[78] Rushton et al. (2006)
[79] Waters (2007)

management, both internal and external, is critical, as there are many instances of good IS/IT not producing the desired results owing to faulty implementation.[80]

When evaluating different systems that can be used to support the supply chain it is important to keep in mind the goal and the reason for using any system at all. Customers desire good service and good prices. That is what guides them when they select companies to do business with. Technology is not an end in itself. It is only a means to enable a company to be of service to its customers. Technology can be impressive, but in business, technology is only important insofar as it enables a company or an entire supply chain to profitably deliver valuable products and services to its customers. Success in supply chain management comes from delivering the highest levels of service at the lowest cost. Technology is expensive and it can quickly add a lot of cost to business operations. It is a far better thing to use simple technology well than to use sophisticated technology in a clumsy manner.[81]

3.6 SPARE PARTS

Technical installations may fail so that repair is needed. They are usually also subject to planned maintenance. In most cases maintenance and repair require pieces of equipment to replace defective parts. Common names for these parts are spare parts or service parts.[82]

Spare part inventory management is often considered as a special case of general inventory management with some special characteristics, such as very low demand volumes. The principal objective of any inventory management system is to achieve sufficient service levels with minimum inventory investments and administrative costs. For this purpose and for numerous specific operational conditions, a vast number of inventory models have been developed during the past decades. Mathematical models are usually aimed at optimizing the problem of inventory investment and service levels, while considerations of administrative efficiency have led to different types of classifications of inventory items. In practice, spare part inventories are often managed by applying general inventory management principles, if any, and not enough attention is paid to control characteristics specific to spare parts only. Furthermore, the control is usually focused on local inventories and not so much on the supply chain as a whole.[83]

The control of spare parts is a complex matter. Stock-out of spare parts may often have serious consequences for the system in which it is to replace a defective part. Consequently, this may cause the necessity to keep a spare part in stock, or to increase stock levels in order to compensate for long lead-times. Another difficulty arises if demand is low and very lumpy,

[80] Waters (2007)
[81] Hugos (2006)
[82] Fortuin & Martin (1999)
[83] Huiskonen (2001)

which is very common for spare parts, so that standard forecasting techniques of the demand process produce inaccurate results, and consequently, invalidate stock control models that rely on accurate demand forecasts. Moreover, the shorter life cycles of products and better product quality further reduce the possibility of collecting historical demand figures. Topping off uncertainty in demand forecasts by putting extra parts into stock is unacceptable in many situations, as parts may be very expensive. The fact that suppliers do not guarantee spare parts supply for all time may lead to additional problems. Due to the limited life span of parts in production, users of these parts are forced to order service parts once to cover the demand for long periods of time. The ultimate example is the so-called final order or last-time buy. The client has to forecast the total demand for this item for the entire remaining economic lifetime of the technical system. It is the combination of these factors that makes spare parts control a tricky business.[84]

When looking at the demand and delivery process, much depends on the context that is being considered. The delivery process starts when a customer order spare parts from a supplier, after which it takes a lead-time until the order is processed and the parts are received at the user's site. If spare part providers prove to be unreliable, both in terms of delivery quantity and delivery time, the lead-time cannot be considered deterministic. Unreliable supply of spare parts may be caused by multiple factors. These can include unreliable shipment times, unreliable provision of resources to the supplier of spare parts, inadequate management procedures at the supplier's side, a lumpy demand pattern for spare parts etc. If demand forecasting is difficult and inaccurate, compensation for unreliable lead-times has to be dealt with every time a part is needed. This can and often will be done via additional safety stocks.[85]

The requirements for planning the logistics of spare parts differ from those of other materials in several ways: service requirements are higher as the effects of stock-outs may be financially remarkable, the demand for spare parts may be extremely sporadic and difficult to forecast, and the prices of individual parts may be very high. On the other hand, material and time buffers in production systems and supply chains are decreasing. These characteristics set pressures for streamlining the logistic systems of spare parts.[86]

3.6.1 SPARE PARTS LOGISTICS SYSTEM

The main process of spare parts logistics can be divided into two components: customer-driven processes and support processes. Customer-driven processes cover all activities in direct connection with the customer's order fulfillment, whereas support processes have no direct

[84] Fortuin & Martin (1999)
[85] Ibid.
[86] Huiskonen (2001)

connection to the customer's order but they support the customer-driven processes. A detailed picture of some elements of these processes is shown in the list below:[87]

Customer-driven processes

- Order processing
- Order transmission of the purchasing order data from the customer to the supplier
- Order adaptation of the order data to the company's own order processing system
- Order conversion of the controlled and completed data into picking data
- Order picking
- Order dispatch
- Distribution

Support processes

- Procurement
- Storekeeping
- Documentation

The process of designing a logistics system cannot however be done in isolation, without taking into account the numerous links with the other processes of a company or with the other parties in the supply chain. There are several possible ways of describing the logistics system design process and different approaches may be used. Huiskonen suggest one general approach, illustrated in figure 3.8.[88]

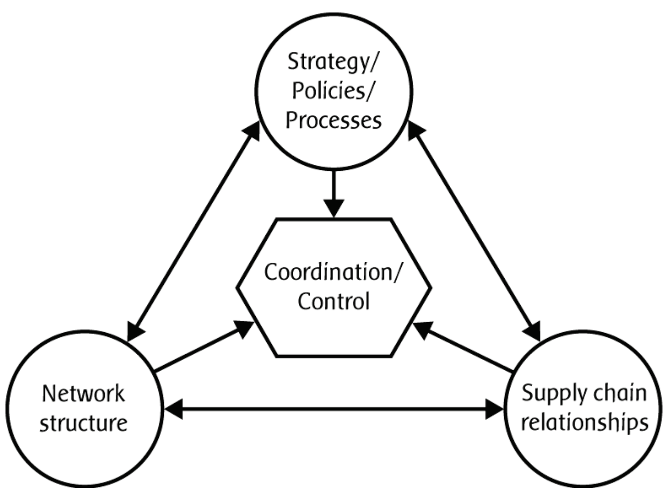

Figure 3.8 The logistics system design process[89]

[87] Pfohl & Ester (1999)
[88] Huiskonen (2001)
[89] Ibid.

The four elements: strategy, policies, processes; structure; relationships; coordination and control have to be considered during the analysis, and decisions about them have to be made as a result of planning. Traditionally, customers' and suppliers' views of the desirable logistics system have been very different.[90]

From the supplier's point of view the *strategy, policies and processes* element describes for example what levels of service are to be offered, and whether customers are segmented and prioritized in terms of service. For example, promising deliveries within 24 hours or providing emergency services could be considered. Hence, the question is about the role of the distribution system to support the possible strategies, such as differentiation of service to each customer segment. The customer's main concern in maintenance is assured availability of parts and the quality service reasonable costs. This includes the processes of comparing and selecting the suppliers and deciding on the supply strategies.[91]

The *network structure* element defines the number of inventory echelons and locations used in the system. Structural issues are typically considered only by one party of the chain (usually the supplier). However, as the locations concerned may be owned, managed or controlled by either the customer or the supplier, a collaborative planning of their use should be done.[92]

Management of relationships between the parties in the supply chain is becoming a more and more important aspect of supply chain planning. It considers such aspects as degree of co-operation, responsibility of control, as well as sharing the risks between the parties. Instead of distant arm's length relations, a variety of cooperative relationships can be employed.[93]

Finally, all three elements have an effect on what types of *coordination and control mechanisms* would best support the ultimate objectives of the logistics system. The coordination and control element includes decisions about inventory control principles, performance measurement and incentive systems and also information systems used to implement the control procedures.[94]

These elements are strongly interrelated with each other and should be considered simultaneously in strategic logistics planning. Collaboration between the customer and the supplier (and possible other parties) is needed while designing the system, and the importance of open information sharing is crucial for managing the inter-company supply chain effectively. While designing a logistics system, some factors have to be considered, for example product-specific characteristics,

[90] Huiskonen (2001)
[91] Ibid.
[92] Ibid.
[93] Ibid.
[94] Ibid.

competitive situation in the market, customers' special requirements, and supplier's resources and commitments.[95]

3.6.2 Strategic Aspect of Spare Parts

For many companies faced with world-wide competition, customer satisfaction has become crucial. An important means to keep customers satisfied is quick repair of a product or system that has failed. To this end, enough spare parts have to be stocked at appropriate points in the supply chain to guarantee a high service level. As most of these parts are expensive, this requires large amounts of money to be invested. As in any inventory control situation, some basic questions have to be answered. For example:[96]

- Which spare parts should be stocked?
- Where are the spare parts to be stocked?
- How many units have to be kept in stock for each of these spare parts (reorder level and reorder quantity)?

Spare part management means finding feasible and efficient answers to these basic questions.[97] Spare parts can become an integral part of a manufacturer's marketing mix: price, quality and performance of a product are about the same, but one company may increase its market share or open an entire new market at the expense of competitors. Various elements play a role in this context. One is the concept of value added logistics. Service management of high quality can increase the value of an initial product, and thereby increase the image of the company.[98]

Fortuin and Martin concludes in their analysis on spare parts that the logistics of spare parts is difficult as demand is hard to predict, the consequences of stock out may be disastrous, and the prices of parts hare high. At the same time the logistics of spare parts is important as the image of the company may be at stake and there is a lot of money involved. They further claim that it is fruitful to classify spare parts, in order to concentrate on parts that really matter and control the rest by means of some simple rule. Much depends on the maintenance concept at the basis of spare parts demand. For planned maintenance in principle no stock keeping of parts is needed, whereas for corrective maintenance parts are required in stock as soon as the delivery time exceeds the acceptable waiting time. Another remark they make is the one that developments in the field of IT increasingly make central spare parts control a feasible option. Ready-made solutions do not exist. Managers tend to avoid the problems inherent to spare parts logistics by establishing better relationships with their suppliers and setting up new kinds of arrangements

[95] Huiskonen (2001)
[96] Botter & Fortuin (2000)
[97] Ibid.
[98] Fortuin & Martin (1999)

with competitors and colleagues. While doing so, service parts logistics gradually changes into service management.[99]

Syntetos, Keyes and Babai have, based on a spare parts case analysis, made the following strategic and operational-level observations concerning factors that have an impact on the performance of relevant inventory management systems with regards to spare parts:[100]

- Inventory planning needs to be carefully linked to the information infrastructure of the company under concern. ERP systems preclude the utilization of well-established forecasting and stock control methods and although manual intervention is often desirable at the operational level, excessive involvement obviously defies the very purpose of moving towards automated holistic systems.

- Managing spare parts requirements necessitates a considerable amount of expertise and familiarization with demand mechanisms that differ significantly from those associated with typical (fast moving) SKUs. That renders effective inventory management an even more difficult task than what already is in other contexts of application. One of the most important lessons learned for the studied company at the strategic level was to focus on core competences. The company's offices in Europe were primarily sales offices; they were running warehouses and managing inventories without the necessary know-how and allocated resources to efficiently achieve high service levels. It was also important that although as part of the project the company was able to outsource the picking/packing/delivery of the spare parts, the ownership of the inventory process and management of the inventory levels was kept in house. Thus, the company released the local offices to concentrate on the sales, whilst having the expertise at the head office to look after the stock etc.

- Intermittent demand structures prevail in a spare parts context. Given the frequency with which such patterns are encountered in practice and given the difficulties associated with their effective management, further quantitative and qualitative research into the area of intermittent demand management would appear to be merited.

[99] Fortuin & Martin (1999)
[100] Syntetos, Keyes & Babai (2008)

4. COMPANY PRESENTATION

The purpose of this chapter is to make the reader familiar with the company of interest to this study, Gambro, and the industry that it is a part of. This will help setting the base when it comes to getting a full understanding of the subsequent chapters. Although not necessary for the understanding of the specific subject of this thesis, it is recommended.

4.1 HISTORY

Gambro was founded in 1964 in Lund by the entrepreneur Holger Crafoord, an industrialist who decided to develop and market an artificial kidney, invented by Nils Alwall. The latter had been working on artificial kidneys for more than 20 years and his studies and experiments gained historical status and importance in 1946 when the first dialysis treatment was carried out at Lunds hospital. Alwall was able to make this happen thanks to the work of many predecessors. The term *dialysis* was coined way back in 1861 when Thomas Graham, a Scottish chemist, found out that he could use a membrane to separate a fluid from particles. Dialysis is commonly referred to as "selective diffusion", where the word diffusion is to be understood as the movement of material from higher concentration to lower concentration through a given membrane. Selective diffusion is therefore diffusion but, depending on the membrane, some material will move across the membrane and some material will not. It was this principle, among others, that was used by Alwall when he constructed his artificial kidney.[101] However, as has been and still is the concern for the majority of inventors, Alwall did not possess the necessary funding that was needed in order to commercialize his invention and start a mass-production of the artificial kidney. Luckily he got acquainted with Holger Crafoord and he was able to convince him of the clinical and commercial significance of the disposable filter needed for dialysis treatments. The artificial kidney is today regarded as one of the biggest medical successes of modern time.[102]

With the success of its first dialysis machine, Gambro was able to step up its research and development efforts. In the beginning of the 1970s, the company had presented a new product, which became the world's first automatic dialysis machine. The success of this product led the company to expand its manufacturing base, with the opening of a production facility in Hechingen, Germany. The company also moved into France, establishing its subsidiary "Gambro SA" in 1972. Another breakthrough came in 1977 when Gambro introduced the first computer-controlled dialysis machine. All these efforts and market successes made the company grow and

[101] http://www3.lu.se/info/lum/LUM_06_97/LUM6_36_njure.html (2009-11-01)
[102] http://www.med.lu.se/english/about_the_faculty/faculty_milestones/nils_alwall (2009-11-01)

in 1983 the Gambro stock was introduced for the first time at the Stockholm and New York stock exchange and the company became Gambro AB.[103]

Since the stock exchange entry up to today Gambro has undergone several structural changes with mergers, acquisitions and hiving-offs becoming everyday food for the corporate directors. Gambro continued to expand its operations, introducing dialysis services by opening its own treatment centers, in addition to manufacturing dialysis machines and equipment. After some tough years in the beginning of the 1980s, Gambro continued its expansion and began searching for acquisitions. In 1987 Gambro acquired the French-based company Hospal, one of its main European rivals and the company behind many breakthrough developments on the membrane side. In 1988, Gambro found itself a new owner when the Swedish investment company Cardo bought out the Crafoord family and other Gambro shareholders.[104]

At the start of the 1990s Gambro was ready for a new expansion drive and acquired its US-based rival Cobe in 1990. Gambro kept the Cobe brand name as it targeted the United States for its 1990s growth. Gambro had already begun opening its own dialysis clinics in the United States and in 1992 the company acquired majority control of the REN Corporation, the leading operator of dialysis clinics in the United States. In 1994 a new investment company, Incentive AB, acquired the Cardo stock in Gambro and it took full control of Gambro in 1996. With this financial backing Gambro continued its acquisition spree, primarily acquiring dialysis clinics around the world and by the year of 1996 the total clinics owned by Gambro were 125 to the number. By 1998, Incentive had succeeded in streamlining itself into a focused healthcare company and changed its name to Gambro AB. However, Gambro's nearly decade-long growth drive had left the company burdened with dept. By 1999 the company was forced to restructure its operations, a reorganization which also included the elimination of the company's multiple brand names. The company's product lines and operations were now brought under either the Gambro or the Hospal name, while the company was reformed into three primary business units: Gambro Healthcare, which took over operation of the company's more than 600 dialysis clinics; Gambro Renal Products, which provided the umbrella for its dialysis systems; and GambroBCT, provider of the technology, products and services in the blood component and separation area. At the same time the company also closed down two of its US production sites, moving manufacturing to its facilities in Italy, France and Mexico. Gambro continued to launch new products as well as doing some minor additional acquirements and rumors began to circulate that Gambro would merge with either Fresenius or Baxter International, two of its main competitors. These rumors proved however to be wrong and no mergers occurred.[105]

[103] http://www.answers.com/topic/gambro-ab (2009-11-01)
[104] ibid.
[105] ibid.

After a number of major US fraud settlements in the US and in order to improve the profitability, Gambro sold its 565 US clinics to the company DaVita in 2005. As part of the purchase agreement, Gambro became the preferred supplier of dialysis products to DaVita for at least 10 years. The same deal also included an alliance between Gambro and DaVita in the research and development of dialysis products and quality of care. During the same year, Gambro entered into an agreement with Baxter Healthcare Corp. to distribute and promote Gambro's dialysis instruments around the world.[106]

The year of 2006 proved to be a milestone in the company's history. Investor AB, a holding company, together with the venture capital company EQT established a joint venture, Indap AB, which then acquired all Gambro stocks making it a privately owned company and taking it off the stock exchange. The previous three business areas became stand-alone companies. In July 2007 Indap decided to sell all the 155 remaining clinics of Gambro Healthcare to the private equity firm Bridgepoint. The next year after that, GambroBCT was renamed CaridianBCT. The third company, Gambro Renal Products, was named Gambro and this is the name that is still being used today for this part of the original company constellation.[107]

4.2 GAMBRO TODAY

Gambro is today the only *clinic-independent* company with a complete product range, covering all kidney treatments including Peritoneal Dialysis, In-center Care and Self Care Hemodialysis, Renal Intensive Care as well as Hepatic Care. Gambro designs and delivers complete solutions for dialysis clinics and intensive care units. The company has about 8 200 employees with 14 manufacturing facilities in 9 countries, sales subsidiaries in approximately 40 countries and sales activities in more than 100 countries as well as an annual revenue of 11 300 MSEK. The purpose of the company is to be the *"leading innovator and the preferred partner for dialysis providers worldwide"*.[108]

Dialysis, as has already been mentioned, works on the principles of the diffusion of solutes and ultrafiltration of fluid across a semi-permeable membrane. Dialysis treatment replaces the function of the kidneys, which normally serve as the body's natural filtration system. Through the use of a blood filter and a chemical solution known as dialysate, the treatment removes waste products and excess fluids from the bloodstream, while maintaining the proper chemical balance of the blood.[109] In hemodialysis, which accounts for approximately 88 % of all dialysis treatments performed worldwide, the blood is purified outside the body and waste products and excess fluids are removed directly from the blood by pumping it through a filter, the artificial

[106] http://www.denverpost.com/healthcare/ci_12454996 (2009-11-02)
[107] http://www.bmartin.cc/dissent/documents/health/dial_gambro.html (2009-11-02)
[108] www.gambro.com (2009-11-02)
[109] http://www.answers.com/topic/kidney-dialysis (2009-11-02)

kidney, also known as a dialyzer. A small amount of blood is continuously removed from the body, pumped through the dialyzer and returned. Only a small amount of blood is outside the body at any time. The blood is returned to the body at the same speed as it is removed. Hemodialysis can be performed either in a hospital, a satellite dialysis unit ("In-center") or at home ("Selfcare"). Peritoneal dialysis differs from hemodialysis in that the blood is treated without being removed from the body. Instead the dialysis fluid is introduced to the patient's abdominal cavity through a catheter placed in the lower part of the abdomen. These both types of dialysis treatment are aimed at patients with chronic kidney diseases. When a patient needs to be treated for acute kidney injuries the use of the Renal Intensive Care-equipment is the optimal treatment solution.[110]

In order to be able to provide for complete solutions concerning the above mentioned treatment options, Gambro needs to produce and possess all the necessary products that the customers will possibly need. One of the central parts in a dialysis treatment is naturally the dialysis machine itself. Gambro offers many models suitable for different kinds of treatments. There are also constant developments and improvements being made to these in order to keep up with the competition as well as using the new technology being made available in the field of dialysis treatment equipments. As with any manufacturer of equipment of some sort, Gambro is obliged to be able to supply customers with technical support for these machines, among other things with spare parts. Gambro's policy is being able to support a machine, comprising a continuous supply of spare parts, for a period of ten years after the manufacturing of the specific machine or model has ceased. Taking into consideration the many different models that have been released during the last years as well as the constant development and releases of new machines, it's not hard to imagine what great amount of spare parts need to be supported and supplied when required.

4.3 BUSINESS SURROUNDING

By the end of 2008, the number of patients undergoing dialysis treatment had reached 1,77 millions worldwide. Of these patients, approximately 21 % were treated in the U.S., 17 % in the EU and 16 % in Japan. The remaining 46 % of all dialysis patients were distributed among 120 countries around the world (see Appendix A for more details). The projected growth rates are 3-4 % for the U.S., Europe and Japan and 8-10 % for the rest of the world.[111]

The overall dialysis market is dominated by three big players: Gambro, German Fresenius Medical Care and the American company Baxter. There are however several smaller companies competing in the different dialysis market segments, which on an aggregated level posses quite a

[110] www.gambro.com (2009-11-02)
[111] http://reports.fmc-ag.com/reports/fmc/annual/2008/gb/English/401040/dialysis-market.html (2009-11-02)

significant market share. The specific market shares for the overall, renal intensive care, hemodialysis and peritoneal dialysis segments for the year of 2008 are shown in figure 4.1.

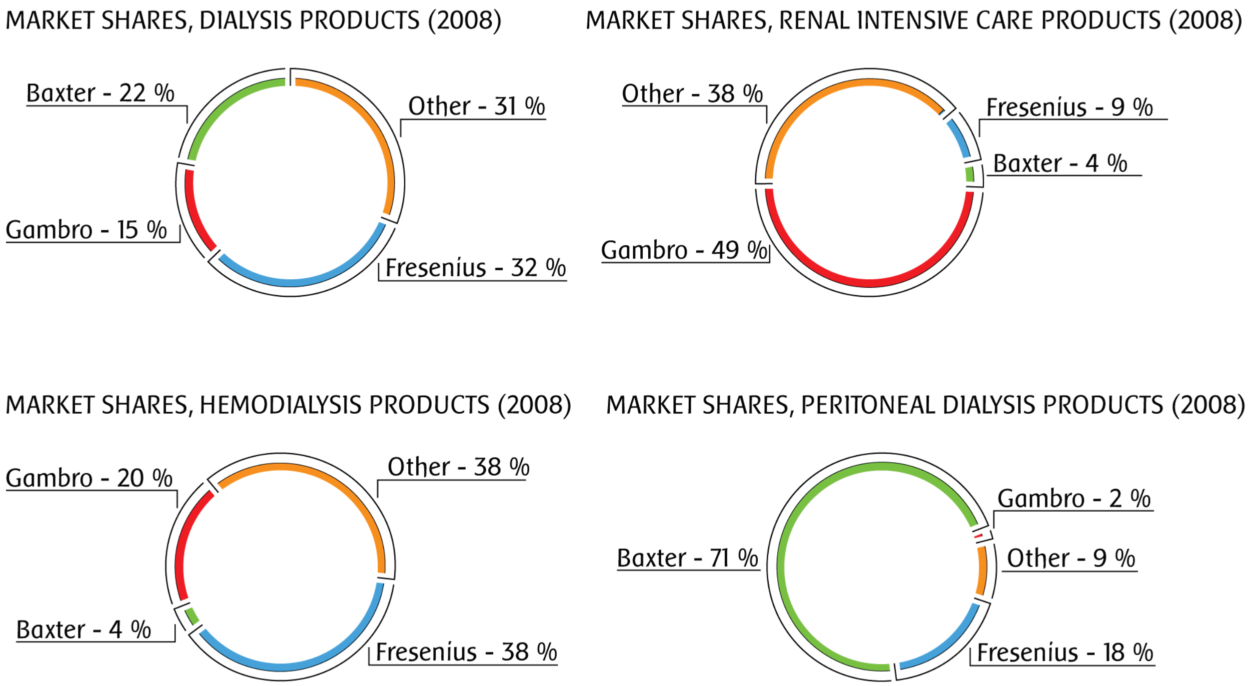

Figure 4.1 Market shares for different market segments[112]

As these figures show, Gambro has a very strong position in the Renal Intensive Care segment as well as a pretty solid position in the Hemodialysis segment but a small market share in the peritoneal dialysis segment. There is however no reason to feel comfortable with this position, especially when there are big players interested in obtaining more market shares as well as smaller companies wishing to play a more important part in their focused market segment.

4.3 ORGANIZATION

It could be worth to mention the different organizational entities that are of interest to and that play a significant part in the areas relevant to the specific subject of this thesis. At the top level we have what is called the Global Supply Division, with about 350 people over three regions responsible for the distribution of all products offered by Gambro. One of the groups under this division is the Supply Chain Management (SCM) Group which is situated in Lund, Sweden and the place where the author of this thesis was based during the study and writing months of the thesis. This SCM group, consisting of 21 persons, is further divided into subgroups: three groups

[112] http://reports.fmc-ag.com/reports/fmc/annual/2008/gb/English/401040/dialysis-market.html (2009-11-02)

responsible for the production planning of bloodlines, solutions and filters; one replenishment group responsible for the global replenishment of these products to distribution centers and satellites around the world; one equipment group doing the production planning of machines and spare parts produced in both Lund and Dasco, Italy; and finally, one development group responsible for the continuing improvements of the supply chain. Other main groups of relevance under the Global Supply Division are the DC (distribution central) Lund and DC Mirandola Groups, handling incoming orders, warehousing and shipping of products produced in Lund and Dasco respectively. On the same organizational level as the Global Supply Division there is also a Sales Division responsible for all selling activities in the appointed markets. For example, once again taking into consideration the scope and focus of this study, there are local sales subsidiaries in both France and Germany, which are selling products to customers in these specific market as well as providing for the technical service needed. All these organizational aspects will be dealt with in more detail in the next chapter.

5. EMPIRICAL FINDINGS

The purpose of this chapter is to present the empirical findings relevant to the main objectives of the thesis. The different organizational entities involved in the supply of spare parts will be mentioned as well as the relationship between these. Most importantly, this chapter will outline the spare parts distribution structure in the German and French market with a detailed description of the flow of information, goods and capital. Some aspects concerning information technology as well as other relevant areas will be touched upon. The findings presented in this chapter will constitute the starting point for the subsequent analysis chapter.

5.1 SPARE PARTS AT GAMBRO

As has already been mentioned, spare parts at Gambro constitute an important part of the overall business. Gambro has, due to its policy, made an obligation to its customers to be able to support a machine, comprising among other things a continuous supply of spare parts, for a period of ten years after the manufacturing of the specific machine or model has ceased. There are in principle two ways that spare parts reach the end customer. The first is the situation where the end customer, such as a clinic or hospital, orders the necessary spare part by contacting the technical service organization for the relevant market. This is usually done by the clinics' or hospitals' own technician, responsible for maintaining and repairing the sites' machines. The second way is that a Gambro service technician is called upon by the clinic or hospital due to a failure on a machine or that the service technician visits the customer to perform regular maintenance activities, usually once per year, on a machine.

The general physical flow of spare parts at Gambro is illustrated in figure 5.1 and will be discussed below.

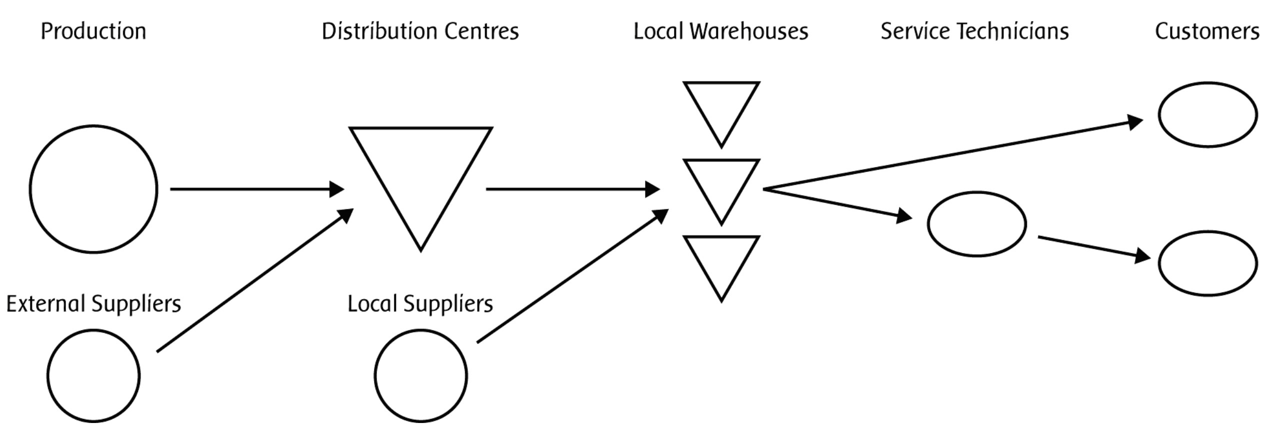

Figure 5.1 The general physical flow of spare parts at Gambro

5.1.1 PRODUCTION AND SOURCING

At the moment, Gambro has two machine production facilities. One is situated in Lund, Sweden ("Gambro Lundia") and one is located near Mirandola, Italy ("Gambro Dasco"). Both production facilities are, apart from producing the machines, also responsible for the production and sourcing of spare parts. Spare parts can be either sourced externally or produced at the production site. Furthermore, these parts can also be classified as parts used in production and parts not used in production. Planning personnel at the production facility are responsible for the planning of production of spare parts required in production as well as the external sourcing of parts needed in production.

5.1.2 SCM

One organizational entity of relevance not depicted in the figure above is the earlier mentioned Supply Chain Management Group, more precisely the equipment subgroup, located in Lund. This equipment group is a strictly administrative function and is therefore not a part of the physical flow of goods. The administrative work conducted by this group relates however to the flow of goods between the production facilities and the distribution centers and can thus be viewed as the controlling entity of the first two arrows to the left in the figure above. When it comes to spare parts, the members of this group are responsible for the planning of the spare part production concerning those parts that are to be supplied to the distribution centers. In Lund, this group also source products from external suppliers directly to the distribution centre. This production planning is usually carried out a couple of times per week with a production lead time varying from 2 weeks to a couple of months, depending on the type of spare part as well as supplier issues.

5.1.3 DISTRIBUTION CENTERS

There are two distribution centers for spare parts. One is DC Lund, which is the name of the organizational entity, whereas the physical spare parts warehouse is located in Malmö. This warehouse keeps those spare parts that are sourced from external suppliers or produced or sourced by the production facility in Lund. Only spare parts that are aimed at supplying subsequent entities in the supply chain are being kept here, thus excluding those parts that are to be used in the production. The other distribution center is DC Mirandola, which keeps those spare parts that are produced by and sourced from the Italian production facility. Both distribution centers are responsible for order handling, warehousing and shipping of spare parts from the DC to the local warehouses around the world.

5.1.4 LOCAL SUPPLIERS

Not all spare parts that the sales subsidiaries in the different markets need are sourced or supplied from the two distribution centers. As we shall see later in this and the subsequent chapter, the sales subsidiaries buy certain products locally. There can be several reasons for doing this. Some products that a local sales subsidiary has decided to offer their customers may for example not be produced or sourced at a global level. Other products may be sourced cheaper locally and some locally sourced products may perhaps better fit the portfolio that the local sales subsidiary offers its customers.

5.1.4 LOCAL WAREHOUSES

The local warehouses are usually located in a close geographical proximity to the local sales subsidiaries. In most cases there is one sales subsidiary for each country. The sales subsidiary is responsible for all the selling activities performed in their respective market as well as providing for the necessary technical service. This part is usually the responsibility of a dedicated technical service organization, one of the sales subsidiary's branches, responsible for the supply of spare parts as well as providing for the repair and maintenance needed in each market.

5.1.5 SERVICE TECHNICIANS

Service technicians are Gambro employed personnel and part of the technical service organizations in each market. They are responsible for maintenance and repair of all Gambro products. They are equipped with a car where they keep the most usual needed spare parts and they are geographically stationed in a strategical way related to the geographical distribution of the machine fleet in the respective market.

5.1.6 CUSTOMERS

Customers are those clinics and hospitals, but also individuals in the case of home patients, that own a Gambro machine which needs maintenance and repair. As was stated in the beginning of this chapter, these customers can have their machines maintained and repaired in two general ways. They can have their own service technician, which is usually the case when the hospital or clinic has many machines, who is then responsible for the maintenance and repair of the machines. This technician orders spare parts directly from the sales subsidiary. In most cases these orders have the purpose to fill up the safety stock that is being kept at the clinic or at the hospital, especially if the machine fleet is big. If the clinic or hospital does not have its own technician, or if the customer is a home patient, the normal case is that all maintenance and repair is conducted by a service technicians employed by Gambro. Based on the different service contracts that are being entered between the customers and the technical service organization, the service technicians are directly contacted by the customer when repair is needed. All spare parts needed for these kinds of maintenances and repairs are ordered by the service technician from the local warehouse.

5.2 TECHNICAL SERVICE

As was mentioned above, the typical scenario is that each sales subsidiary has its own branch organization dealing with technical service. Parallel to this part of the organization, other branches may for example consist of sales forces responsible for different product types. The sales subsidiaries in Germany and France, as well as in Italy, act as profit centers. They are registered companies in their respective markets and separate legal entities. They are therefore fully responsible for all sales activities, pricing policies, technical service etc. in their markets. The term technical service can in broad terms be said to constitute repair and maintenance of monitors. The importance of this function needs no emphasis, as it should be obvious that the quality of the service that technical service is providing has an immediate effect on the value perceived by the customers. In one sense, technical service and the people working in that part of the organization are representing Gambro throughout the whole lifetime of the monitor and the time that the customer remains a customer to Gambro. Taking into consideration the competitive market that Gambro is a part of, it is evident that a well functioning technical service organization is one of the many key prerequisites to gain success.

When a customer buys a Gambro machine, he also decides whether he wants to enter a service contract agreement with the Gambro technical service organization in the respective market. The terms for the service contract are usually negotiated with every customer and then shaped accordingly to their demands and expectations and, of course, priced accordingly. The various kinds of agreements vary both between different markets as well as between different customers in the same market. One service contract may for example involve a full repair and maintenance responsibility for Gambro with a promised obligation as to when the machine will be up and running again. The customer then pays an annual fee for this service contract per each machine. The annual fee can of course vary, but a price of 2000 Euros per machine and year is not uncommon. The customer is not debited with any other costs during this year as Gambro pays for the full spare part and technician hours costs that have been incurred. Other service contracts may be partial ones and can for example consist of an obligation by Gambro to send a technician when needed and have the machine up and running again within an agreed time frame, but with the customer paying for the spare parts and the working hours. A third type of contract is what is known as a PPT-agreement (price per treatment). In this situation, the customer pays Gambro per each treatment carried out on the machine, keeping Gambro responsible for all costs including spare parts and service hours. As has already been mentioned, some clinics and hospital own many machines and often have their own dedicated service technician responsible for repair and maintenance of these. In these cases, no service contract with the Gambro technical service organization is needed. The clinic or hospital employed service technician orders the spare parts that he needs from the local warehouse and carries out the repair by himself. The only obligation that is being made from Gambro in such a case is the promised time of delivery of the ordered spare parts, usually measured in hours from the moment or ordering. Clinics and hospitals usually have one or a number of machines working as backup so that they do not have to wait for new spare parts to continue the treatment of patients. It is also very common that the hospitals and clinics keep their own safety stock of spare parts that are frequently being used, thus making them less dependent on the fast supply of ordered parts from the local warehouse. On an average, a service technician needs to check on a machine 2-3 times a year. One of these is for regular maintenance that is always being carried out once per year on every machine. The other one or two visit(s) are for repair of some sort. Back in the days when the quality of today had not been achieved, a machine could require 5-8 visits per year.

5.2.1 GERMANY

The technical service organization in Germany consists of approximately 51 people. The administrative and management functions of this group are located at the Germany Sales office in Munich. This is also where the German local warehouse is situated. There are currently 38 field service technicians employed in the organization, spread out across the whole country with a higher concentration in the big city areas. The distribution of the service technicians across the country naturally depends on where the clinics and hospitals with which Gambro has entered service contract agreements are located. As big customers are usually found close to or in big cities such as Berlin, Hannover or Hamburg, this is also where many of the technicians are stationed. The total machine fleet in Germany is approximately 8 800 machines as of 2010. Roughly 50 %, 4 400 machines, fall under a service contract and the responsibility of the German technical service organization. This yields an average of 115 machines per technician. Out of these, 60-70 % of the machines are on full contract and the rest are on partial contracts. The standard reaction time for these contracts is 48 hours, meaning a guarantee that the machine will be back in operation within 48 hours. The typical scenario, however, is that a service technician receives a call from a customer about a machine breakdown during the day and in 80 % of the cases the machine will be up and running on the next day. Although a 24 h guarantee is normally given by competitors and many times achieved by Gambro as well, technical service in Germany feel that it is better to give a guarantee of 48 h and be sure to deliver. It is better to be reliable when giving guarantees, instead of making big promises and fail occasionally. As with any situations, there are exceptions to this rule. When water treatment installations need repair or when a clinic that does not have any backup machines experience machine breakdowns, the time frame is immediately narrowed and action needs to be taken fast. In Germany every machine under a service contract is dedicated to one specific service technician, which means that in normal circumstances he or she is the only person doing repair and maintenance activities on that specific machine. This is considered as facilitating the creation of strong customer relations, making it easier for the customer to get in contact with the right person when necessary. It also facilitates for the service technician to plan and organize his work according to his own schedule.

Apart from the field service technicians, five people are employed at the workshop in Munich where repair of defective parts is carried out. When repaired, these parts return to the regular spare parts flow. Two individuals are employed in the spare parts warehouse doing all the necessary picking and packing of incoming and outgoing goods. There is also one back office person responsible for all the order handling activities as well as providing customer support. This person takes care of all spare part orders both from customers and service technicians. He is also placing orders to DC Lund and DC Mirandola, as well as to the local suppliers. One of the individuals working in the warehouse can act as a backup for the back office person in case of sickness or vacation.

5.2.2 FRANCE

The French Sales organization is located, together with technical service, in Lyon. Important to note is that there are actually two sales companies representing Gambro in France. One is called Gambro S.A. and the other one is known as Hospal S.A., a division of the sales organization related to the different product lines offered by the company. In general terms, Hospal can be seen as the brand of the machines and spare parts produced in Dasco whilst the Gambro brand constitutes those machines and spare parts that are produced in Lund. Despite this, the technical service organization in France is the same for both sales companies. There are currently 52 field technicians employed by the technical service organization. They are, just as in Germany, geographically spread out across the country with a higher concentration around some of the bigger cities such as Paris and Bordeaux, where the service contract customers are mainly located. The total machine fleet in France constitutes approximately 9 600 machines as of 2010. About 35 %, 3 360, of these fall under a service contract agreement between the customer and the French technical service organization, which yields an average of approximately 65 machines per service technician. This percentage value varies across the country. In the big city areas, it is very typical that there is a service contract for 50 % of all the machines in that region, whereas this value can be as low as 20 % in the more rural districts of the country. The majority of the service contracts that have been negotiated with the customers are full service contracts. In these service contracts, however, different service times are agreed upon. The shorter the time guaranteed by technical service for the machine to be up and running, the more expensive is the contract. When no special service contract has been arranged with a customer, the technical service organization in France is usually committed to repair a machine within 48 h. For service contracts, on the other hand, different steps have been defined, such as a time guarantee of 24 h, 12 h or even 6 h between the call from the customer and the service intervention. Most contracts are based on the 24 h service guarantee, 12 h is usually the standard for renal intensive care machines and the 6 h guarantee is most common for water treatment installations.

One special characteristic of the French technical service organization is the concept of service teams. All the 52 service technicians have been divided into groups, so called service teams. Service technicians that operate in approximately the same geographical region of France normally constitute one service team, and for the moment there are 11 service teams. Because of the varied machine distribution throughout the country, the number of service technicians in one service team thus varies accordingly. At the moment, two service “teams” consist for example of only one service technician each, while the biggest service team is the one in the Paris area with a total of 15 service technicians. The stock that is located in the cars of technicians that are members of the same service team can therefore be seen as a shared stock. It has been decided in France that this is the most rational way of managing spare parts when there is a wide range of products that are being served and when a large portfolio of spare parts is used. This structural setup has thus been considered as providing for the most optimal balance between the customer service level offered and the inventory level needed. The total aggregated stock of a service team is mainly spread among the different cars. There are however a number of depots available for some of the service teams where they can keep some of the shared stock. These depots have proven to be effective for storage of such spare parts that are important but expensive to be kept by each service technician in his or her car. Instead, the part can be located at this kind of depot, and be available for any service technician in the service team when it is in fact needed. These depots are located in Lyon, Merignac (close to Bordeaux) and in Paris.

At the office in Lyon, one individual is employed at the workshop in Lyon, doing repair of PD monitors only. The reparation activities in France are thus not of the same importance as they are in Germany. Two individuals are employed in the spare parts warehouse dealing with picking and packing. The back office consists of three people in total, responsible for all order handling activities concerning spare parts and equipment. Two of these are exclusively dealing with the spare parts order receiving processes from customers and service technicians as well as the ordering of spare parts from the two DC's and the local suppliers.

5.3 INFORMATION SYSTEMS AT GAMBRO

The use of information technology is of very high importance and a necessity in the logistics network at Gambro. Some of the main systems that are being used will be touched upon in this section.

5.3.1 ERP SYSTEMS

SAP is currently the leading ERP (Enterprise Resource Planning) system in the organization. It is the system that is implemented at the production facility in Lund and the one that is used by the DC in Lund as well. All the spare part and machine production planning activities carried out by the SCM equipment group for spare parts produced or sourced in Lund are done with the aid of SAP. The same goes for all the order handling, warehousing and shipping activities of spare parts at the DC in Lund and at the spare parts warehouse in Malmö. SAP has also been implemented at several satellites around the world. This is however not the case for the sales subsidiaries that are of interest to this thesis. Germany, France and also Italy use their own local ERP systems. In Germany this system is called Scout, the French equivalent is called Minos and the name of the Italian system is SIA. They all work in different ways, thus making it complicated or sometimes impossible to apply the same working routines when working with Gambro counterparts in these countries. The production planning of machines and spare parts produced in Italy is therefore carried out by the SCM equipment group in SIA. At the moment of this writing, Gambro in the US is implementing SAP in their organization and they will be fully up and running with this system at the start of year 2010. There have been many discussions regarding a possible implementation of SAP in the three big European countries, but no concrete decision has been taken. There seems to be a standstill at the moment concerning this question and no implementation of SAP in any of these countries can therefore be expected in the next coming years.

5.3.2 SYSTEM SETUP IN GERMANY AND FRANCE

The German system setup is very straightforward from a spare part point of view. In Scout the local warehouse in Munich is represented as one stock location and the same goes with the German service technicians. Each one of the 38 technicians has a stock location number in Scout, keeping all the stock quantities stored by them in their cars separated system-wise. Each member of the workshop has also been assigned an exclusive stock location in Scout. For France the system setup is somewhat different, which is partially related to the sales subsidiary division mentioned earlier. The spare part stock of the two companies is separated in Minos, meaning in principle that for each defined physical stock location in the system there is one stock location for the spare parts owned by Gambro S.A. and one stock location for parts owned by Hospal S.A., even though both companies' spare parts are physically kept in the same place, such as the French local warehouse or a service technicians' car. In Minos, a total of 24 stock locations related to spare parts have been defined. However, 22 of these are representing those 11 stock locations that are common to both the Gambro and Hospal sales subsidiaries, whereas the remaining two stock locations only exist in one of the two sales companies. If one would ignore the fact that the Gambro and Hospal owned stocks are separate organizational and system-wise, the result would be 13 unique stock locations in total. Another thing that is special with the French system setup is the fact that each service technician is not represented in Minos with a unique stock location. This is related to the service team structure mentioned earlier, with the result of an aggregated stock of the members of one service team constituting one stock location in Minos. Of the 13 unique stock locations in Minos, if we treat the Hospal and Gambro subsidiaries as one entity, one stock location represents the French local warehouse located in Lyon, one is the PD workshop and the remaining 11 stock locations represent the different service teams. In practice this means that what is visible in Minos is the aggregated stock of all the service technicians included in a specific service team. It is thus not possible to identify the stock quantity of one of many service technicians in a team, nor is it possible to determine which of the service technicians in a team is in possession of a spare part that the team has in stock.

5.3.3 APS SYSTEMS

The APS (Advanced Planning System) that has been used at Gambro for quite some time is called i2. The two main components of this planning system that are being used are the Demand Manager (DM) and the Supply Chain Planner (SCP) tools. The SCP tool offers a consolidated view of the inventory available as well as providing for different advanced planning options, both for the replenishment and production planning of those products that are managed through the system. The DM tool is used as a forecast tool with inputs being made by the sales representatives around the world with monthly updates. Historical shipments of a specific product to the different markets are also visible in this system. The combination of these two systems provide for a full visibility of the global inventory as well as a good predictability of future sales, making it relatively easy to manage and handle the production and replenishment planning of the included products. As has already been mentioned, i2 is only used for the planning of disposables and machines. Spare parts have not and will not be included in this same process. For spare parts there is, at the moment, no system in place providing a full visibility of the global spare part stock. Because of the typical irregular demand of spare parts and the vast amount of SKU's available, no forecasts from the sales subsidiaries are neither available.

The data input to the i2 systems is done automatically. First of all, the relevant data must be extracted from the different ERP-systems that are in use, such as SAP, Minos, Scout, SIA and so on. This is being carried out a number of times per week so that the data used for planning through the i2 tools is as updated as possible. The data that is extracted from the local ERP systems is then being transferred to i2 through special interface files of the local systems, so called INS-files. Each ERP system sends a number of different INS-files containing different kind of information. Not all data that is available in the local ERP systems is transmitted however. What data is included in the files is based on the decision that has been made in the SCM group on what products and stock locations should be included in the i2 planning process. The INS-files send for example information about:

- On hand stock (INS001)
- Open customer orders (INS002)
- Open purchase orders (INS006)

In these files, the actual quantity at the moment of extraction of the stock on hand and the open customer and purchase orders can be viewed on a stock location and per product level.

Apart from these INS-files, information is also sent from the master data management tool, MDM. This is a database that contains information about all products that are in some way included in the Gambro supply chain. This can be information about product code and description, actual product status, manufacturing plant, product category, product owner etc. This database is maintained and updated frequently.

5.3.4 QLIKVIEW

One relatively new member to the information systems group at Gambro is an application known as QlikView. It's a tool used for reporting, data analysis and presentation. It is also good at combining data from various sources, such as different ERP systems, Excel files etc. So far, QlikView has only been used in a limited manner at Gambro. Important to note is that QlikView is not an advanced planning system such as i2. It does not feature any demand forecasting tool such as the i2 Demand Manager and it does not contain the logic that the i2 tools are using to create the production and replenishment plans mentioned earlier. It is however a good tool for performing user defined calculations and analyses of large amounts of data. The same INS-files that are transmitted to i2 are today also being used in QlikView. With this data, QlikView produces special reports for actual inventory situations, safety stock calculations, outbound shipment details and so on. It is easy to use and it presents data in an effective way, making it a good complement to the i2 tools.

An important aspect with QlikView is that spare parts have now been included in the INS-files that are transmitted to the application, making it possible to some extent to get a global visibility of the spare part stock. This is however a work in progress, since all relevant spare part stock locations have not yet been defined in the files used by QlikView. Up to recently, QlikView has been used by the SCM equipment only for making safety stock calculations for the DC warehouses stock in Malmö and Mirandola. For some months now, however, QlikView has also served as the main production planning tool for spare parts produced in Dasco. For this purpose QlikView is provided with data extracted from SIA, the Italian ERP system, as well as information regarding minimum and maximum order quantity, production time, capacity and target safety stock for all the relevant products, defined in an Excel file. Based on this information and the necessary calculation steps, also defined in an Excel file by the SCM equipment group, QlikView produces a production planning report with production suggestions for each product. This report is updated automatically every time new INS-files have been read, which is done a number of times per week, and can thereafter be extracted to Excel for further usage.

5.3.5 GFS

Gambro employed service technicians do not use SAP or any of the local ERP systems. Instead they use a special platform that has been developed exclusively for them called GFS, as in Gambro Field Service. The technicians use this system both for the purpose of ordering spare parts as well as creating service reports after a maintenance or repair action, and the platform gives the technicians instant access to vital records including warranty or contract status, preventive maintenance schedules and modification levels when they visit a customer's site. The system is continuously being improved and adjusted in order to better suit local market conditions and the way of working of the technicians in the specific market.

GFS is not fully synchronized with any of the local ERP systems, such as Minos or Scout, meaning that no automatic transfer of data is taking place between the systems. Since it is an offline system, you cannot be sure that the figures you see in Scout and Minos are the same ones that you have in GFS at a given time. There are however stock checks being made every year and only then can the mismatches be discovered and corrected.

The local ERP systems are sending master data through a special interface to the GFS system, which means that information regarding machines, customers, contracts and allowed spare parts is transferred to GFS. The main data that is being transferred is the data that comes from MDM. In GFS, this master data is then filtered so that for example only spare parts that are allowed for the country in question are visible to the service technician. The technical service organizations in France or Germany can therefore define what substance of information from MDM they want their service technicians to be able to see and have access to. This is mainly a safety precaution so that a service technician does not order a spare part by mistake that should not be available in that specific country.

Another interface between the local ERP systems and GFS is the one used for service reports. For Scout for example, the service technicians use a special application in the German version of GFS with which they can export service reports. There is also a special application within Scout to import these. As was mentioned, this is not an automatic process. Instead everything needs to be done manually by the back office personnel. They decide when they want to export service reports from GFS and when they do, a file is created on the Scout server and then they can decide to import the files into Scout. When the files are imported the back office personnel go through the service reports and check if it is correct. The normal process in Germany is that the back office personnel also have, in addition to the electronic version of the service report, a printed copy sent to them by e-mail from the service technician or the customer. If the paper version matches the electronic version in Scout, everything is OK, and they can then process the service report in Scout. When they do, the inventory quantities in Scout are automatically updated, reducing the inventory of the spare parts that were used according to the service report on the stock location of the specific service technician. In France this procedure works a little bit differently. The service reports are created and then put on an ftp-server. In addition to this, the whole information is also sent as an attachment by e-mail to the back office personnel in France. Apart from this the process works in practically the same way.

5.3.6 INVENTORY UPDATES

The inventory status of a product at a stock location in the local ERP systems is updated at basically three different occasions. First, when shipments arrive from the DCs and the local suppliers, the received quantities are generating a stock increase accordingly. Second, when products are shipped to customers or service technicians from the local warehouse, the local warehouse stock decreases and, in the case of a shipment to a service technician, the stock location of the technician increases with the same quantity. Third, when a service technician consumes a spare part when maintaining or repairing a machine, he creates a service report in GFS defining all the spare parts that have been used. This service report is then registered by the back office personnel according to the procedure described above and the stock quantity at the stock location of the technician in the local ERP system decreases when this service report has been processed. A fourth alternative is outside the normal spare part flow and concerns movements of stock between service technicians. In Germany, if a service technician wants to provide his colleague with a spare part from his own stock, this kind of movement has to be communicated to the back office in Munich so that the same movement can be registered in Scout. In France, this works a little bit different because of the service team structure mentioned earlier. If two technicians in the same service team want to move spare parts between their cars, they can do this without any further notice. This is the whole idea behind the service team concept, making the aggregated stock of all technicians in a service team a common, shared stock. Since they are all sharing the same stock location in Minos, no movement of stock has to be made by the back office in Lyon. This would only be necessary if two service technicians from different service teams would like to do the same thing. This however happens very infrequently.

The inventory setup in GFS is similar to the setup of the local ERP-systems. In Germany, every service technician can see the spare part stock of his car directly in GFS. Although not synched with Scout, the numbers in GFS for a certain stock location should match the numbers in Scout for the same stock location if everything has been carried out according to the defined process. Simply put, if the service technician manages and registers all his usage and movement of spare parts in GFS correctly, then GFS and Scout should basically show the same numbers. This is checked once a year, when the inventory in the service cars is compared to the inventory that is visualized in Scout. If there are any mismatches in this comparison, it means that some transaction during the year was not registered properly. In France, just as there is a separation of brands in Minos, this is also the case for GFS. This means that every service technician has two stock locations defined in GFS, one for Hospal and one for Gambro. The consequence of this split is that when a service technician places an order, he has to place one separate order for the Gambro stock and one separate order for the Hospal stock, depending on what products need to be ordered. Because of the service team structure, however, the stock quantity numbers that the service technicians see in GFS are not the stock quantities of their car; instead it is the stock of the whole team. Hence, GFS does not provide for a more detailed view of where the products are located. The same comparison carried out in Germany is also done in France, once a year. In this latter case, it is naturally harder to investigate the mismatches that occur since only the total stock of the whole service team is compared to what is seen in Minos.

5.4 SPARE PARTS DISTRIBUTION STRUCTURE

The general physical flow was presented and discussed in the beginning of this chapter. Now we will look in detail at the information and physical flow of spare parts in both Germany and France. Since the information flows and the physical flows of these two markets are very similar and follow very much the same structure, the same figures will be used for the overall illustration. Then, the details of the respective market will be presented and discussed.

Figure 5.2 illustrates the general information flow, starting with an order placed either by a service technician or a customer.

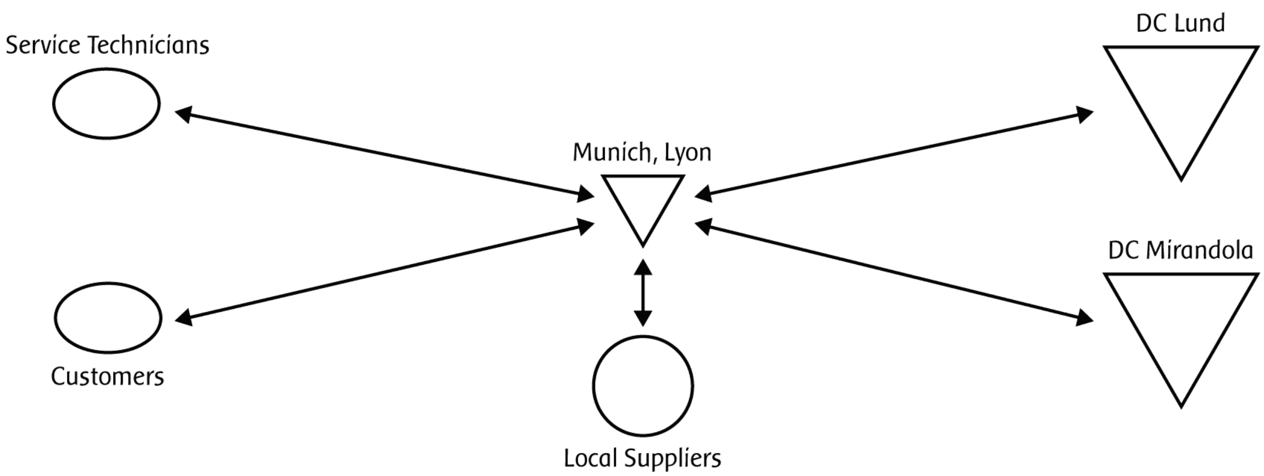

Figure 5.2 The general spare part information flow in Germany and France

Figure 5.3 illustrates the general physical flow of goods, starting with the shipment of spare parts from one of the DCs or a local supplier.

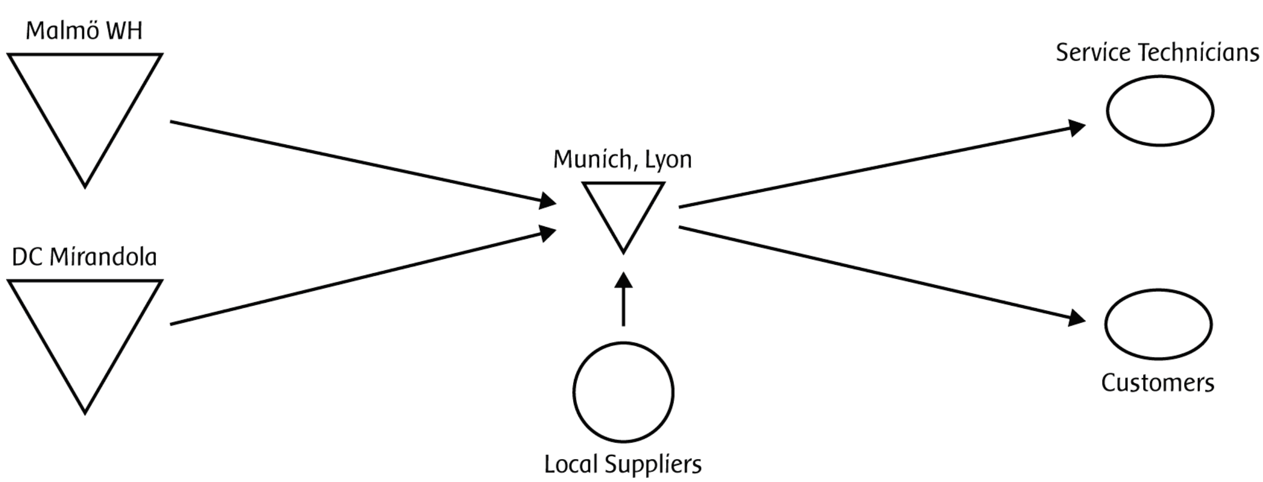

Figure 5.3 The general physical spare part flow in Germany and France

5.4.1 GERMANY

As has already been mentioned the spare parts in Germany can be found either at the local warehouse in Munich or in the service technicians' cars. The back office personnel in Munich receive orders from customers and service technicians and place orders to the two DCs and to the local suppliers.

Information Flow, Customers/Service technicians – Sales subsidiary

Customers place orders mostly through phone, but they can also order through e-mail and fax. The back office personnel in Munich enter this order manually into Scout as a sales order and notify the customer whether the spare part is available in stock or if it has to be ordered from the supplier. In most cases, however, the part is ready available at the Munich warehouse and can be shipped immediately.

As has already been mentioned, service technicians mainly use GFS when they want to order new spare parts from the local warehouse. Of course they can also use phone or e-mail, but these are only used in exceptional cases. The order creation process in GFS is based on a consumption-based replenishment model. This means that when a service technician enters the order mode in GFS, the system generates an order proposal. This proposal consists of those spare parts that have been consumed since the last time the technician placed an order. The information about consumed parts has been collected from all those service reports that were registered by the technician in GFS. This proposal is not something that is set in stone. The technician can at this moment adjust the order according to his needs by deleting and adding products and quantities in the list, and even place a comment on each order line if necessary. When pressing the order button, the order is generated and stored in the local GFS database. If a product in the order has been assigned the status of withdrawn in MDM, an alert window will appear in GFS telling the technician that the parts have been withdrawn and that they cannot be ordered. The technician then needs to check for the code of the updated part in GFS and order this part instead. After the order has been generated, the service technician needs to connect to the Gambro network so that all changes in their local database will be updated in the central GFS database. This central database is executing some procedures every two hours that checks on new orders. When new orders have been found, these are then sent as an e-mail attachment to the back office in Munich. The orders then need to be entered manually into Scout. Since the spare parts are not sold to the technician, in Scout this kind of order is only represented by a regular stock movement transaction. Service technicians usually place one order per week. Of course there can be exceptions to this rule. If the technician needs a spare part very urgently, he or she will usually place an order in addition to the regular weekly order. The rule of one weekly order has mostly practical reasons. It would not be effective for the technician to stay at home waiting for packages on every day of the week. With weekly orders, the technician can receive all the ordered parts at one single time. The service technicians have also been assigned individual ordering days, so that the workload at the warehouse can be held at a constant level throughout the whole week.

Information Flow, Sales subsidiary – DCs

The back office personnel in Munich, responsible for receiving orders from customers and service technicians, are also responsible for placing spare part orders to the DCs in Lund and Mirandola. These orders are normally placed once a week. In most cases the ordering of spare parts from the DCs is not directly related to the customer and technician orders that have been received, these are two separate processes. The back office personnel instead use the planning tool available in Scout, which is basically based on a reorder-point system, to determine what spare parts to order and when to order. When the Munich local warehouse stock of a spare part reaches a certain minimum stock target level, the system will give an order suggestion. The back office personnel go through the whole list of suggestions, adjust when they feel there is a need, and then they create the purchase order in Scout. Two orders need to be created, one for spare parts from Lund and one for spare parts from Italy. These orders are then exported to Excel and sent by e-mail to the responsible shipper at the DCs.

At the DCs, the orders received from Munich are entered manually into the relevant ERP system as sales orders by the responsible shipper. At DC Lund this is done in SAP and at DC Mirandola the same thing is done in SIA. If we take DC Lund as an example, the sales order is created and an order number is created. After this, an order confirmation is sent to the back office personnel in Munich through a mail function in SAP. This order confirmation contains the confirmed shipment date for all those spare parts that are available as well as an availability date for the spare parts put on back order. The availability date represents the day when the parts should be in stock at the warehouse in Malmö according to the information available in SAP.

Physical Flow, DCs – Sales subsidiary

Spare parts are shipped from the DC spare part warehouses directly to the local warehouse in Munich. In Sweden the spare parts warehouse is located in Malmö and in Italy it's located in Mirandola. The normal way of transport is by truck, through the use of a local forwarder. Shipments from Malmö for example are carried out by a company called Transfargo and they take place on Tuesdays or Fridays according to the figure below.

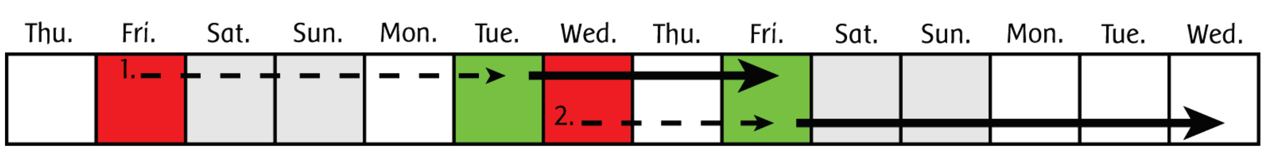

Figure 5.4 Shipment schedule from Malmö to Munich

The light gray squares indicate the shipment date from the warehouse in Malmö. The dark grey squares show when the order from Munich has to be entered into SAP for the shipment to take place on Tuesday (case 1) or on Friday (case 2). If we look at case 1, the sales order is entered into SAP by the responsible person at DC Lund on Friday. The same person then performs a delivery action of the order in SAP, which activates the order as ready to be picked at the warehouse in Malmö on the same day. The warehouse personnel then have one day for picking and packing. On Monday the goods are packed and the responsible shipper at DC Lund is notified about the volume and weight of the goods. A delivery note is also created in SAP. This information is then passed on to the forwarder. The day after that, on Tuesday, the goods are picked up by the forwarder and shipped to Germany. The transportation lead time can vary between two and three days. At latest, the goods arrive in Munich on Friday. As soon as the delivery note has been created in SAP, an invoice can be generated and sent to the back office in Munich. Transportation costs from the DCs to the sales subsidiaries are put on the DC accounts.

If an urgent order has been placed, courier transportation with UPS is usually used and with this alternative the spare parts can be shipped on the same day if the order was received before noon and they are usually delivered to Munich within 24 hours.

Physical Flow, Sales subsidiary – Customers/Service technicians

Customer orders that are received before 13:00 are shipped to the customer the same day and the standard delivery time for these kinds of orders is 48 h, shipped with UPS. The transportation cost is not debited the customer. If the customer, however, wants to use an express shipment alternative he will pay for the extra cost. For customers, a minimum order value of 50 Euro has also been set, in order to encourage them to consolidate their orders.

The standard delivery time of 48 h applies for shipments to service technicians as well, also shipped by UPS. Spare parts to service technicians are usually shipped to their homes. In some cases, however, it is more practical to ship the parts directly to the clinic or hospital where the technician is doing some maintenance or repair action. This can cut lead times and provide for a fast action from the technician. However, this option is only used under special circumstances.

5.4.2 FRANCE

The French spare part stock is located either in the local warehouse in Lyon, in the service technicians' cars or in one of the few depots that are available for storage of shared spare parts for some of the service teams. The back office personnel in Lyon receive orders from customers and service technicians and place orders to the two DCs and to the local suppliers.

The information and physical flow in France follow very much the same structure as in Germany. Much of what has already been said therefore applies for France as well. Some differences may however be worthwhile mentioning.

Information Flow, Customers/Service technicians – Sales subsidiary

Customer places orders mostly through phone, just as in Germany, by contacting the back office personnel in Lyon, who then create a sales order manually in Minos and notify the customer about delivery time.

Service technicians place orders mainly through GFS and the same procedure as in Germany takes place here. However, the central GFS database in France updates only once every night, instead of every two hour as is the case in Germany, when it sends the order as an e-mail attachment to the back office in Lyon, who create a stock movement in Minos. As has already been pointed out, the divided sales organization structure in France force the service technicians to create two separate orders for the Hospal and the Gambro organization. When the technician has been working on a Gambro machine, GFS will suggest placing a spare part order from the Gambro channel and vice versa. Sometimes this can lead to mistakes, especially when the same spare part is used in both sales organizations. Some service teams have also, as mentioned, physical depots where they can keep spare parts that are shared among the team members. It is up to the team members to decide together on how this stock should be treated, how those spare parts should be ordered and so on.

Information Flow, Sales subsidiary – DCs

The back office personnel in Lyon are producing orders to DC Lund and DC Mirandola usually once a week, sometimes even more frequently. The order quantities are mainly based on the proposals that are generated in Minos, a procedure similar to the one used in Scout, with adjustments made where deemed appropriate.

The processes of entering these orders into SAP and SIA at the DCs are identical to the ones described above for Germany.

Physical Flow, DCs – Sales subsidiary

The physical flow between the DCs and the French sales subsidiary is very similar to the German flow as it was described above. Another forwarder is however used for standard deliveries and shipments are carried out at different week days.

Physical Flow, Sales subsidiary – Customers/Service technicians

In France, most of the shipments are carried out with Chronopost, a courier company comparable to UPS. The transportation time is usually 24 h, but can sometimes be 48 h for more distant customers. It also depends on when the order has been entered into Minos. Really urgent orders can be picked up by Chronopost at 5 p.m. and delivered at the customer at 9 a.m. in the morning the day after. This is of course more expensive. The customer is not charged with this extra cost if it is only used in extreme cases. Another thing with Chronopost that is pointed out as an advantage is the full traceability of all shipments which they offer through their website. The French technical service organization tries to encourage the customers to consolidate their orders since the transportation cost is not debited the customer, just as in Germany. There is also a minimum order value of 100 Euro set for customers. If this value is not respected, 30 Euros can be charged as an order administration cost.

Spare part shipments to service technicians are also carried out by Chronopost in most cases. The spare parts are shipped either to the shared stock depots or the home of the technicians. In some cases the parts can be shipped directly to the customer site if it is urgent and time needs to be saved, just as in Germany.

5.5 Issues With Spare Parts

There are several reasons as to why Gambro has issues with the supply of spare parts and they are related to multiple areas. Apart the ones already discussed, some of the main issues that have been identified at Gambro relate to the following areas:

- Raw material
- Quality
- Planning
- Change Orders
- Customer Orders
- Stock Location
- Capacity
- Visibility

The suppliers of raw material are not always able to deliver the required quantities on due date to manufacturing. This of course has implications further down the supply chain. Quality issues are frequently experienced with components or finished products being put on hold at the DC warehouses, sometimes for very long periods of time. The planning accuracy by the SCM team is not always proving to be effective, thus resulting in shortages down the line. There is a lot of phasing-in and phasing-out of spare parts and numerous rebuilding orders are being carried out, making it harder to plan for and maintain a rational stock. Sudden peaks in demand are also experienced in the orders from the local sales subsidiaries which sometimes completely deplete the stock at the DCs, with the result of several backorders for that specific spare part. Availability issues arise frequently at the DCs although the spare parts are available globally in the different local warehouses. For many parts, there is a capacity limit at the production facilities which also cause problems, especially when the demand is high. As has already been mentioned, there is no consolidated view of the global spare part inventories, thus making it hard to manage allocations when shortages at the DC level arise.

All of these issues have an impact on the service level perceived by the end customer. Although it is difficult to measure what financial impact an unsatisfactory customer service level has, the present situation in any organization is rarely optimal and actions should always be taken in order to improve those areas that are evidently causing problems. Not all issues can however be solved with one single solution. As has been pointed out in chapter 1, the focus of this thesis is to evaluate the possibilities of solving the problem with fluctuating demands from the local sales subsidiaries as well as examining the possibilities of a direct distribution implementation in the three big European countries.

5.6 DIRECT DISTRIBUTION

The above described distribution structure has been the standard setup for most countries at Gambro. However, during the last years, decisions have been made and action has been taken to solve some of the main issues that the supply of spare parts is experiencing. One of the solutions has been the implementation of direct distribution of spare parts to the local markets. The concept of direct distribution of spare parts is not very new to Gambro. What it implies is that spare parts are shipped directly from the DC to the customer clinic or hospital and directly to the service technician that ordered the parts. The main benefits this kind of distribution structure would result in are:

- Reduced inventory
- Increased availability of parts
- Reduced administrative work

Reduced inventory is naturally the obvious effect since the local warehouses are not keeping any spare parts in stock any more. The increased availability would come as a result of a single central spare part warehouse. With direct distribution, all inventory is accessible for everyone in one location. Lower demand fluctuations will also be experienced since no order consolidation is done at the sales companies. Shipments are only made directly to customers and service technicians, whose orders are more based on real demand. The risk of going out of stock at the DC level because of big orders is therefore diminished and higher service levels can be achieved. Since the orders from customers and service technicians are only processed once and the fact that local stock replenishment is no longer needed, the administrative work load is also reduced.

This kind of distribution structure has been in place for all the Nordic countries for quite some time, which has mainly been possible due to the smallness of these markets, the use of SAP as the only ERP system as well as the proximity to the spare parts warehouse in Malmö. It was decided that this should be implemented in all European countries where SAP is in place and as a pilot project the UK market was chosen.

The physical flow of spare parts in the UK prior to the direct distribution implementation was structured in the same way as figure 5.3 shows for France and Germany, with the local warehouse being located in Huntingdon. The information flow also followed the outlined flow in figure 5.2, however with some exceptions. The service technicians were not using GFS to order spare parts. Instead they e-mailed and phoned the UK customer service when they needed to place an order. The UK customer service personnel was, and still is, located in Zaventem in Belgium. They would receive the order, enter it into SAP as a stock movement for service technicians and as a sales order for customers, both as outgoing from the local warehouse in Huntingdon. The sales organization in Huntingdon would place consolidated spare part orders both to DC Lund, DC Mirandola and to local suppliers in order to replenish their local warehouse. With the direct distribution implementation, both these flows changed.

The physical flow has changed in a way depicted in figure 5.5 below. Spare parts are now only shipped from the warehouse in Malmö, rerouting the parts that are produced in Italy through Malmö. Since the demand for Italian spare parts in the UK is very low, this has not been a problem. Only small safety stocks of relevant Italian parts are being stored at the warehouse in Malmö. Shipments are carried out directly to customers and to service technicians. For the latter, a depot system is used so that the service technicians can pick up their ordered parts when they have the time. The dotted lines in the figure indicate the physical flow of some 15-20 critical spare parts that the UK sales organization have decided that they still want to have in stock at their local warehouse. The flow of these products as well as the flow of spare parts ordered from local suppliers has thus not changed.

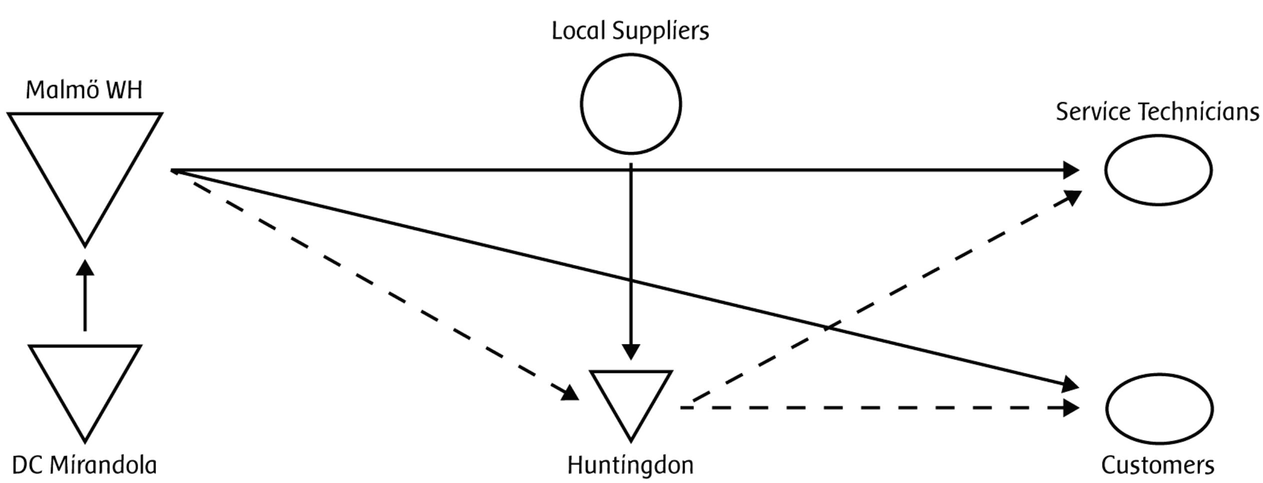

Figure 5.5 Physical flow of spare parts in the UK after the direct distribution implementation

When it comes to the information flow, it is now much more automated. The service technicians use GFS when they want to order spare parts and they do this mainly once a week. Because of a special interface between GFS and SAP, the orders that are created in GFS are automatically generating a purchase requisition in SAP. This order is then checked upon by a customer service representative in Zaventem and is then pushed through as a stock movement from the Malmö warehouse to the stock location of the service technician. Every service technician has its own stock location defined in SAP. A special system batch-job that is carried out a number of times per day performs the delivery action in SAP, indicating to the warehouse personnel in Malmö that the order is ready to be picked and packed. Customers place orders by contacting customer service, who then create a sales order in SAP. This sales order is then also caught up by the system batch-job and passed on to the warehouse personnel. When packed, the goods are shipped with UPS and with the standard transportation alternative it arrives within 72 hours. There are of course express alternatives available that have the goods available at the customer site or the depot on the next day. The transportation cost is debited the customer so the customer can choose if he wants to pay for an extra cost for the express shipment or not.

At the time of this writing, the direct distribution structure has now also been setup for the Benelux countries and the first weeks of direct shipments have already been performed. Next countries in line are the remaining SAP countries in Europe, mainly Spain and Portugal.

It is important to note that the UK direct distribution solution cannot be applied directly on to the German, French or Italian market because of several reasons. First of all, the German, French and the Italian sales subsidiaries are legal entities separated from the Gambro Lundia AB entity. The UK subsidiary, on the other hand, is a part of the latter. This makes it possible for DC Lund to invoice the customer in the UK directly when spare parts are being shipped from Malmö. This is not possible for the three big countries. DC Lund as well as DC Mirandola can only invoice the sales subsidiaries, who then are the only ones with the legal rights to invoice the end customer. For service technicians the procedure is somewhat simpler and more straightforward. The sales organization does not invoice the service technician when a spare part shipment has been carried out, since it is only treated as a stock movement. Another main reason why the UK solution is not suitable for Germany and France is because of the different ERP systems that are in place. In UK, SAP is used and everything can be organized, visualized and handled in one system only. There is also the already mentioned interface between GFS and SAP, which is facilitating the information flow from the service technicians. As we have already seen, none of this is in place in Germany and France, neither is it in Italy. They have their own local ERP systems which are not integrated with SAP in any way and there is also no interface between GFS and the local ERP systems. This makes an implementation in these countries much more complicated and more aspects have to be taken into consideration. This brings us back to the main purpose of this thesis and these questions will therefore be discussed in more detail in the next chapter.

6. ANALYSIS

The purpose of this chapter is to present the analyses that have been carried out based on the information obtained through the empirical findings. The chapter has been divided into several distinct sections, each dealing with aspects that have been seen as most relevant to the purpose of this thesis. These comprise analyses of the actual inventory situation at the local subsidiaries, the inbound deliveries and outbound shipments of the local warehouses and a detailed comparative analysis of the relationship between inventory and outbound shipments at the local sales warehouse and in the service vans. This chapter also presents the distribution structure alternatives that have been identified as most suitable, followed by a discussion on the expected outcome of these alternatives as well as some of the consequences that an implementation of these alternatives will bring.

6.1 INTRODUCTION

In order for the reader to fully understand the purpose of the analyses conducted and described in this chapter, it could be useful to recap the initial purpose of this thesis. As stated in chapter 1 a general purpose of the thesis can be defined as to examine and evaluate the possibilities to solve the problem with fluctuating demands on spare parts from the local sales offices in the three big markets in Europe. A more detailed purpose can be defined as to investigate what the possibilities are to implement direct distribution of spare parts to these countries and what the implications of such an action would be.

Important to note is that this analysis part of the thesis has been a continuously progressive process from the beginning to the end. The work that has been carried out and the results that have appeared have constituted the starting point for recurring discussions with relevant people, mainly in the SCM and DC groups in Lund but also with responsible people at the local sales subsidiaries. These discussions and meetings have proven to be of great importance as consensus has been gained on both sides on the results of the analyses so far as well as on the understanding of the various complexities related to the subject. They have also proven to be good occasions for discussing and making decisions on what next steps should be carried out in the analysis and, when necessary, redefining the purpose of this specific thesis to better match the revealed situation and special circumstances as well as the expected future outcome.

The analysis chapter of this thesis could basically be divided into two distinctive parts. The first part consists of **quantitative analyses** based on all the numerical data that has been gathered. The second part of the analysis has been of a more **qualitative nature**, namely defining, constructing and discussing those possible and suitable future distribution structures that could be implemented and solve some of the issues at hand. Both parts of the analysis are important. The numerical analyses provide for a deeper understanding of the present spare part situation in Germany and France, as well as highlighting those aspects that are of high importance and directly related to the spare parts issues that this thesis deals with. This part of the analysis also influences the upcoming qualitative analysis, where a discussion regarding the future possible distribution structures are presented. Drawn conclusions are very much based on both the empirical findings presented in the preceding chapter as well as the numerical analyses presented in this chapter. Related very much to the true purpose of this thesis, this qualitative part also describes the organizational and monetary implications of an implementation of the analyzed distribution setups.

6.2 INVENTORY

The first numerical analysis that was conducted was an in-depth examination of the actual spare part inventory situation at the sales organizations in both Germany and France. Although the main focus of this thesis has not been to question or investigate the reasons behind the actual inventory levels being held at the sales organizations, this analysis does provide some insight and understanding of the actual situation in these countries. Some harmless reflections can of course also be made in connection to this. Important to note is that the charts presented in this section of the analysis only picture a snapshot image of the inventory from July, 1st 2009. A more representative image of the inventory would have appeared if the yearly average of the inventory could have been used instead. This has however not been possible. This specific date was chosen due to the fact that the shipment data that was used in later analyses refer to the period of 2008-07-01 to 2009-06-30.

Due to the large amount of different spare parts that exists within the Gambro organization, each with different characteristics and different consumption patterns, it does not make any sense to illustrate the following tables with quantities as the basis of measurement. Just as there is no use in comparing apples with pears, it is rather pointless to include the quantity of cheap O-rings and the quantity of expensive CPU-boards in the same illustration and in the later comparisons. Therefore the subsequent diagrams will be compared based on inventory value, stated in Euros, instead.

The same kind of diagrams will be showed for both Germany and France so that a direct comparison can be made and so that later conclusions and remarks can be drawn based on the same kind of data.

6.2.1 GERMANY

As has already been mentioned in the preceding chapter, the Germany Sales organization keeps spare parts in basically two different kinds of physical locations. One is the inventory stored at the Sales Warehouse in Munich and the other one comprises all the inventory that is being kept in the cars of the service technicians, named the Service Van stock from now on.

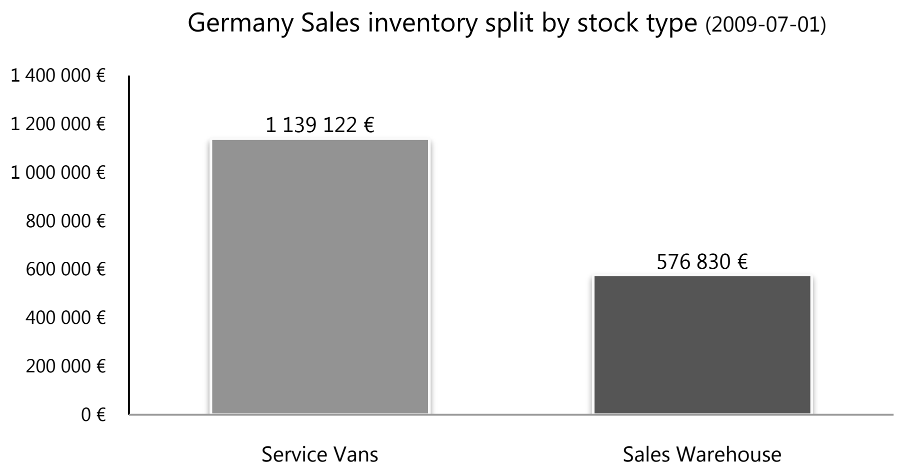

Figure 6.1 Germany Sales inventory split by stock type

Figure 6.1 shows the distribution of the total inventory value for these two categories. Approximately one third of the total inventory value is located at the Sales Warehouse and two thirds are found in the Service Vans, with a total inventory value of roughly 1.7 M €. The inventory split, as it is illustrated in the table above, can naturally have several reasons. It seems however as if the German service technicians prefer to have most of the spare parts readily available in their cars. For some spare parts this can also be the result of a recommendation from a higher level on what the technicians should absolutely keep in the car.

It is interesting to reflect on the fact that this inventory split relationship has not always been showing the same ratio for the total German Sales inventory. Five to ten years ago the distribution between the total inventory in Service Vans and the Sales Warehouse was approximately 50/50. The tendency has thus been a movement of inventory from the central stock at the Sales Warehouse to the different service cars. Another interesting thing is to compare this present inventory situation at the German Sales organization with the inventory distribution in the UK sales organization prior to the direct delivery implementation. The distribution of the total spare part inventory in the UK was actually the opposite of the one that Germany is currently showing. Roughly two thirds of the inventory was kept at the local Sales Warehouse in Huntingdon and the rest in the service cars. It is of course difficult to draw any objective conclusions based only on this information. Nevertheless, the present inventory distribution in Germany can raise questions and discussions as to whether the inventory is managed in an optimal way.

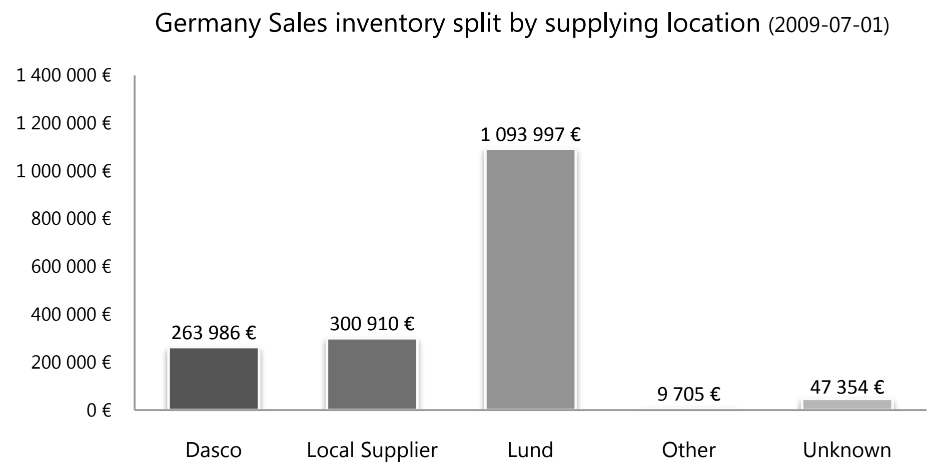

Figure 6.2 Germany Sales inventory split by supplying location

In figure 6.2, the total Germany Sales inventory has been split up by the supplying location of the spare parts. The major supplying locations are naturally Lund, Dasco and local suppliers. The distribution between Lund and Dasco is mainly influenced by the installed machine fleet in the studied country. In Germany the majority of the installed machines are produced in Lund and therefore most spare parts have their origin in Lund. What is interesting to see is the rather big share of spare parts that is being sourced locally. The reasons behind this are often very market specific. In the case of Germany, a large part of the local supplied parts are related to water treatment installations. The supplying location of some of the products have not been identified and these products have been gathered in the "Unknown" - column. The reason for this has in most cases been due to the fact that the spare parts were not at all found in MDM.

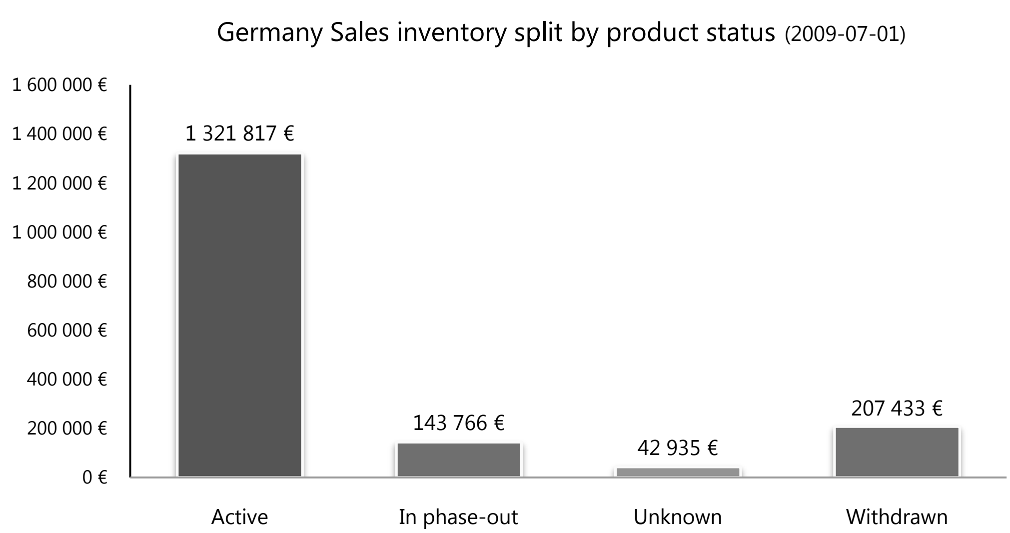

Figure 6.3 Germany Sales inventory split by product status

Figure 6.3 once again illustrates an inventory split of the Germany Sales inventory, this time by actual product status. At Gambro, there are four status definitions that a spare part can have. If the spare part is *active*, it is part of the weekly production planning in either Lund or in Dasco or it is available to purchase from a local supplier. When a spare part is to be replaced by another part or if it is not supposed to be supported any longer, the status of the part changes from active to *in phase-out*. The part is usually from this moment on no longer included in the production planning process. When the global stock, either in Lund DC or Mirandola DC, of the in phase-out product has been completely depleted, the status of the product changes once again to *withdrawn*. The fourth status that a spare part can have is *in phase-in*. A spare part is normally in phase-in only for a short period of time and becomes active as soon as everything has been setup for the spare part. Figure 6.3 illustrates one of the problems that the concept of direct delivery aims at solving or at least reducing the negative effects of. The risk of spare parts becoming obsolete becomes evident when looking at the amount of spare parts that have the status of in phase-out and withdrawn. Together these two status categories constitute approximately 20 % of the total inventory or, put in monetary terms, roughly 350 000 €. Of course the fact that a spare part has the status in phase-out or withdrawn does not immediately mean that the product is useless and that obsolescence is a fact. It can still be shipped and consumed at a local market level. The risk of obsolescence is however definitely in some way related to the amount of inventory that has one of these statuses.

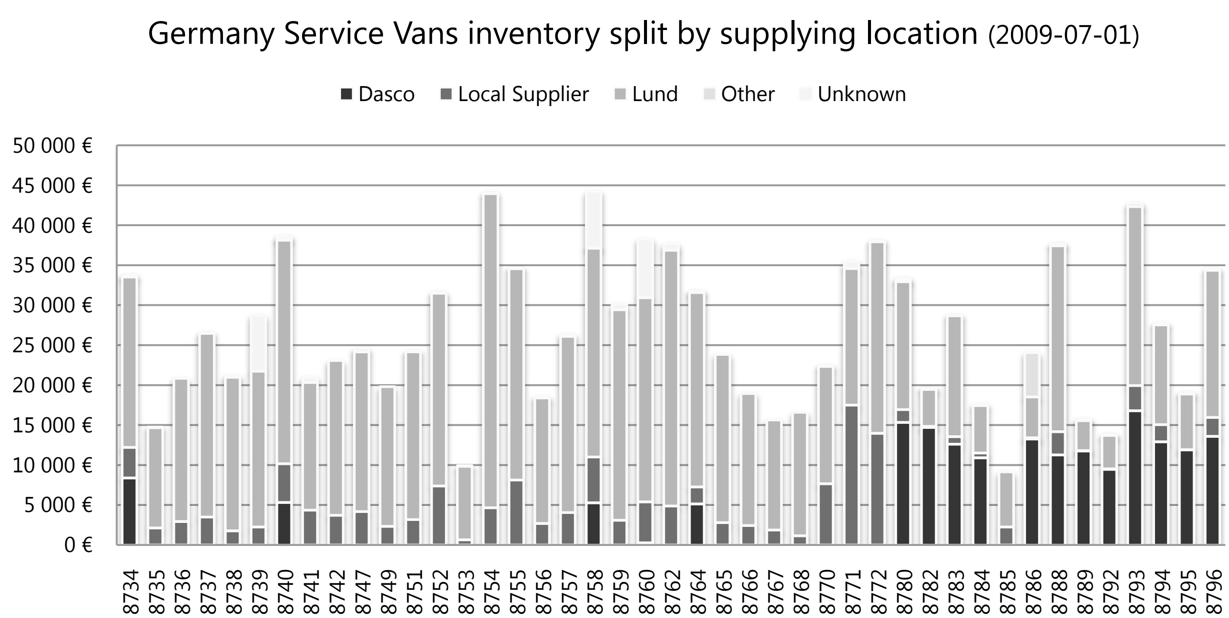

Figure 6.4 Germany Service Vans inventory split by supplying location

A detailed view over the inventory distribution among the different service vans in Germany is found in figure 6.4. This figure also shows what kind of products the inventory consists of by splitting it by supplying location. With this split, one can clearly see the type of machine that a specific service technician specializes in. A total of 16 service technicians deal with Italian produced machines as can be seen by the yellow columns, which represent Dasco spares. Service technicians 8770, 8771 and 8772 are dealing exclusively with water treatment installations, which is the reason behind the relatively high red columns, representing spares sourced from local suppliers. One service technician, 8786, is the only one with a light green colored column. This part of the stock refers to spare parts for the C3 machine, which is no longer produced and spare parts are no longer supplied, although some repair activity is however being carried out on old machines that are still being used in some places. Service technicians 8753, 8766, 8767 and 8785 represent external service technicians that are only being used occasionally when the service pressure is high, thus explaining to some extent why these columns are lower than most other columns.

What is interesting to see is that there seem to be quite some big differences in inventory value among the different service vans, even among those that are dealing with the same kind of machines. The inventory of service technicians 8754 and 8758 for example, are almost reaching 45 000 € each, while service technicians 8741 to 8751 all have an inventory value of 20 – 25 000 €, half the value of the first mentioned technicians. The same thing can be observed for the service technicians dealing with Italian machines. This can of course have different reasons. One reason could be that some technicians are dealing with more machine variants than others do and that they therefore need to keep more spare parts in their stock. Another reason could be that the technicians with the exceptionally high columns, at this specific day that the figure is depicting, were performing some mandatory maintenance on a large fleet of machines. What happens then in reality is that the spare parts that are needed for the maintenance are transferred to the stock location of the service technician before the maintenance has been carried out, even though the parts are physically shipped directly to the customer. This can increase the Scout stock of a service technician quite dramatically and thus show big differences when compared to other technicians. If this is the case with the high columns in this figure is unknown. The average inventory value per German service technician is 26 500 €.

6.2.2 FRANCE

The spare part inventory of the French Sales organizations is distributed among the local warehouse in Lyon, the service technicians' cars and the few depots that are available for some of the service teams. The latter will, in the figures presented in this section, be included in the Service Van stock since, as has already been explained, it is not possible to distinguish the parts that are in the cars from those parts that are located at the depots.

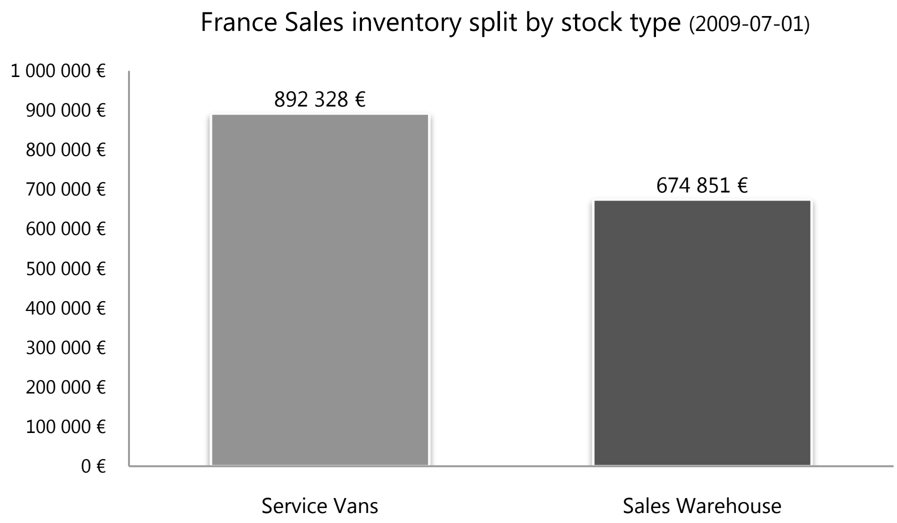

Figure 6.5 France Sales inventory split by stock type

In figure 6.5 we see how the French total spare part inventory is distributed, with a total inventory value of approximately 1.56 M €. As was the case with the German inventory distribution in figure 6.1, a larger part of the total inventory is being kept in the service vans. The ratio however is not as big as it is in Germany. Roughly 43 % of the total stock is kept in the Sales Warehouse, compared to the 33 % in Germany. One interesting thing that can be identified when comparing these two figures is the fact that although the total inventory value in Germany is bigger than in France (1.7 M € vs. 1.56 M €), the French Sales Warehouse inventory value is about 100 000 € larger than the German Sales Warehouse.

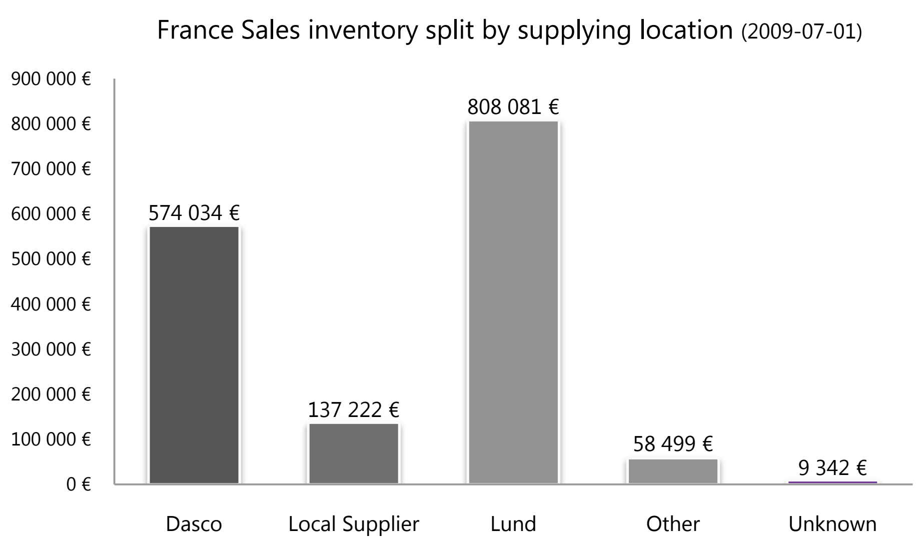

Figure 6.6 France Sales inventory split by supplying location

The inventory split by supplying location that is depicted in figure 6.6 shows that a more significant amount of Dasco spares than was the case with Germany is being kept in stock. This is due to the fact that the machine base in France differs from the one in Germany, with a relatively high percentage of Italian machines installed in France. Although not as much as in Germany, spare parts are to some extent supplied from different local suppliers and these parts are also mainly related to water treatment installations. The “Other”-column refers for the most part to C3 spares and the “Unknown”-column comprises spare parts that could not be found in MDM.

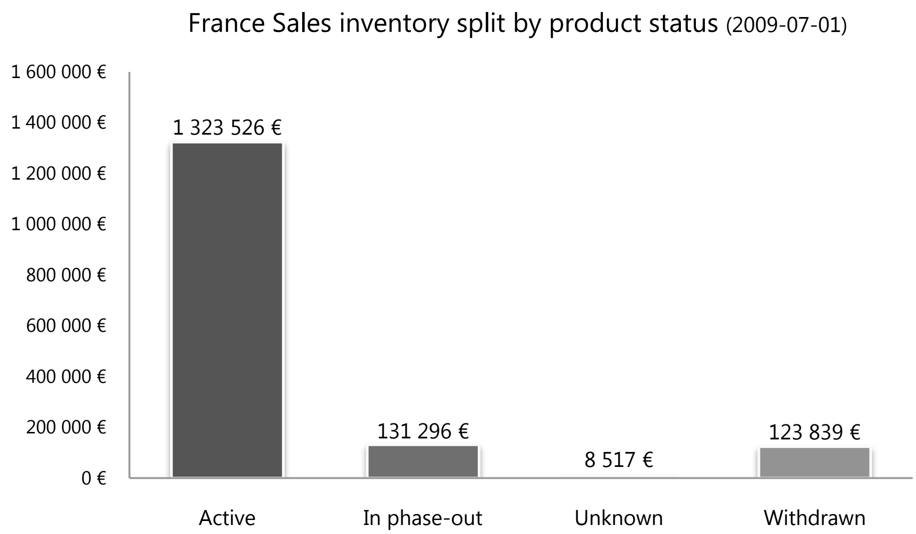

Figure 6.7 France Sales inventory split by product status

Figure 6.7 once again illustrates the obsolescence risk that is present when a large amount of slow moving spare parts are being kept in stock. Spare parts with the status of in phase-out and withdrawn constitute roughly 16 % of the total inventory value in France. Later in this chapter we will see how these parts have been moving during the last year.

In figure 6.8 the inventory value of the ten different service teams in France, split by the supplying location, is shown. It is difficult to draw any conclusions as to how the inventory is distributed among the different service technicians since no such information is available. It is only possible to see what each service team has in total. Since every service team consists of a different number of technicians, one cannot compare the columns straight off. It is possible to note however that there are available technicians dealing with Italian and Swedish produced machines almost in every team. Service team 311 is the one located in Paris, constituting of 15 service technicians, which is the reason behind its height. Team 310 and 317, on the other hand, consist of only one technician each. Team number 309 is solely dedicated to the repair of water treatment installations, which is the reason why a big amount of the parts supplied by local suppliers can be found at this stock location. The average inventory value per French service technician is 17 200 €, 64 % of the average inventory value of a German technician.

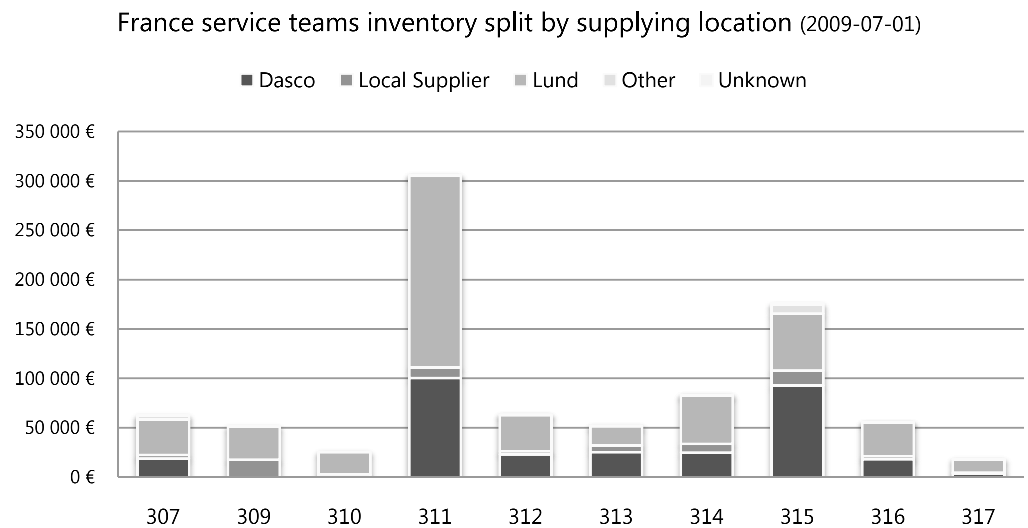

Figure 6.8 France service vans inventory split by supplying location

6.3 SALES WAREHOUSE INBOUND VS. OUTBOUND

In order to visualize the problems that have been experienced at the DC level with several demand peaks from the sales subsidiaries, an analysis of the order pattern from the sales subsidiaries was carried out. Two sources of data were used for this purpose. On the one hand there was the shipment data extracted from SAP with information about all shipments of spare parts during a period of one year from the warehouse in Malmö to the local sales warehouses in Germany and France. On the other hand there was the shipment data received from both sales organizations with shipment information of all shipped spare parts from the local sales warehouses to customers and service technicians during this same period. These both sources of data were then combined so that it would be possible to make an inbound vs. outbound analysis of the sales warehouses in both countries. Only spare parts shipped from Malmö to the sales warehouses were taken into consideration for this illustrative purpose, although the same conclusions apply for shipments of spare parts from Italy to the respective markets.

The data that has been used relates to the period 2008-07-01 to 2009-06-30. This time quantity instead of value has been used as the basis of measurement, since we will only look at one spare part at a time.

6.3.1 GERMANY

A perfect example of how a common order and shipment pattern from the sales subsidiaries can look like is shown below in figure 6.9.

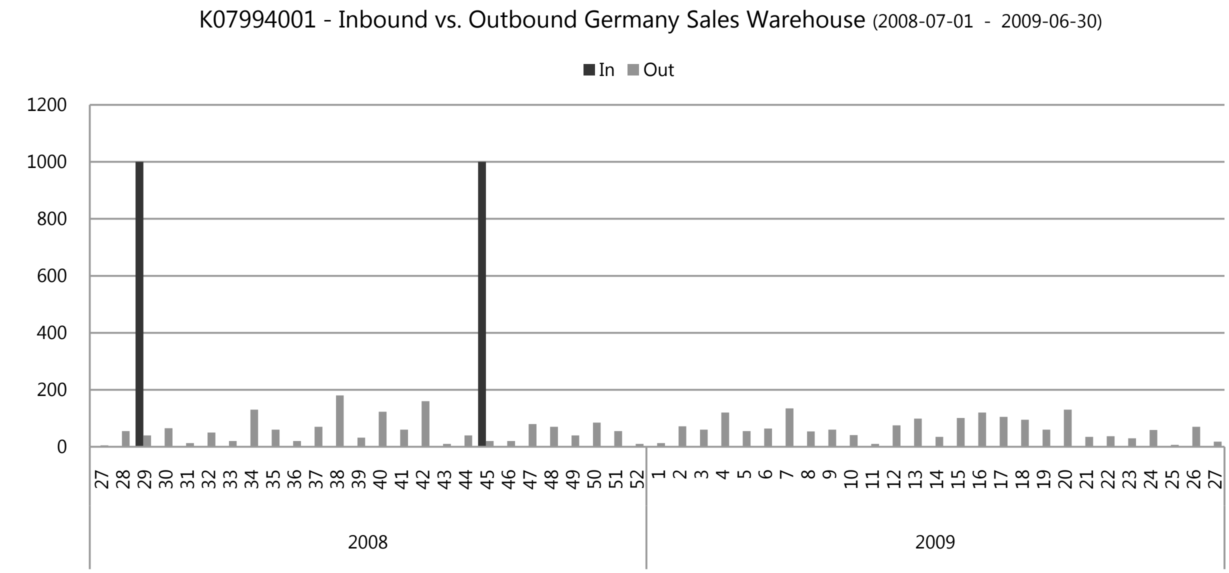

Figure 6.9 Inbound vs. Outbound pattern at the Germany Sales Warehouse (K07994001)

The two dark gray columns represent those quantities that have been shipped from the central warehouse in Malmö to the German local warehouse in Munich, whereas the light gray columns represent those quantities that have been shipped out from the local warehouse. The light gray columns comprise both shipments of sales to customers as well as internal movements to the service technicians' stock. As the figure clearly shows, this specific spare part is ordered from DC Lund very seldom but at high quantities, namely 1 000 pcs per order. In contrast, the outbound shipments from the local warehouse are occurring basically every week with a total weekly quantity ranging from 5 pcs to a maximum of 180 pcs. For the period of one year which is illustrated in this figure the total inbound quantity from the warehouse in Malmö was 2 000 pcs and the total outbound quantity was 3 273 pcs. Of course the figure does not tell us how much was in stock at the local warehouse at the beginning of this period or at the end. The purpose of this visualization is not however to examine how the stock level at the local warehouse has been evolving during this period of time. Instead, the important thing to understand is that these kind of high columns cause unnecessary problems at the DC level, in this case at the warehouse in Malmö. Although the German demand of this spare part has been pretty stable with a weekly demand of 60 pcs on average, the ordered quantities from DC Lund are 1 000 pcs each, a quantity corresponding to roughly 17 weeks of demand in Germany. This means that the warehouse in Malmö would need to keep in stock at least 1 000 pcs of this spare part all year round in order to be prepared for the order of 1 000 pcs that will come eventually, although no one knows for sure when. Furthermore, this figure is only illustrating the German orders. If one takes into consideration the fact that other countries, such as France and Italy are ordering in the same way, it is easy to see that 1 000 pcs would probably not be a sufficient amount. Although the DCs could maybe in many cases handle the demand peaks of one market once in a while, the situation would probably be very difficult or impossible to handle if several markets' demand peaks would occur at the same time or in close proximity to each other. What happens then is a fast depletion of the DC stock by one of the peaks and all other orders that have not been fulfilled are put on backorder. The time that these backorders will have to wait in order to be fulfilled can then be as high as several weeks or a couple of months, depending on the lead time in manufacturing. This of course results in poor customer service levels and in the worst case, an inability to fulfill agreed service contracts and in the long run non-returning customers.

One could argue that this specific spare part is a very cheap spare part and therefore it makes no sense to order quantities smaller than 1 000 pcs, and that the DC should be able to keep a high safety stock of this item in order to be able to supply all markets even if they order big quantities at the same time. This may of course be true for some spare parts. However, if one should apply this rule to all "cheap" spare parts, the aggregated inventory value of all these parts at the DC level that this would result in would be tremendous. The safety stocks set at the DCs of course need to be economical and reasonable. The question whether this is the case today will remain unanswered, since it is not in the focus of this thesis. Even if this would not be the case however, improvements in the area of ordering from the sales subsidiaries can be achieved, thus improving the inventory situation at the DC level. Let us look at another example.

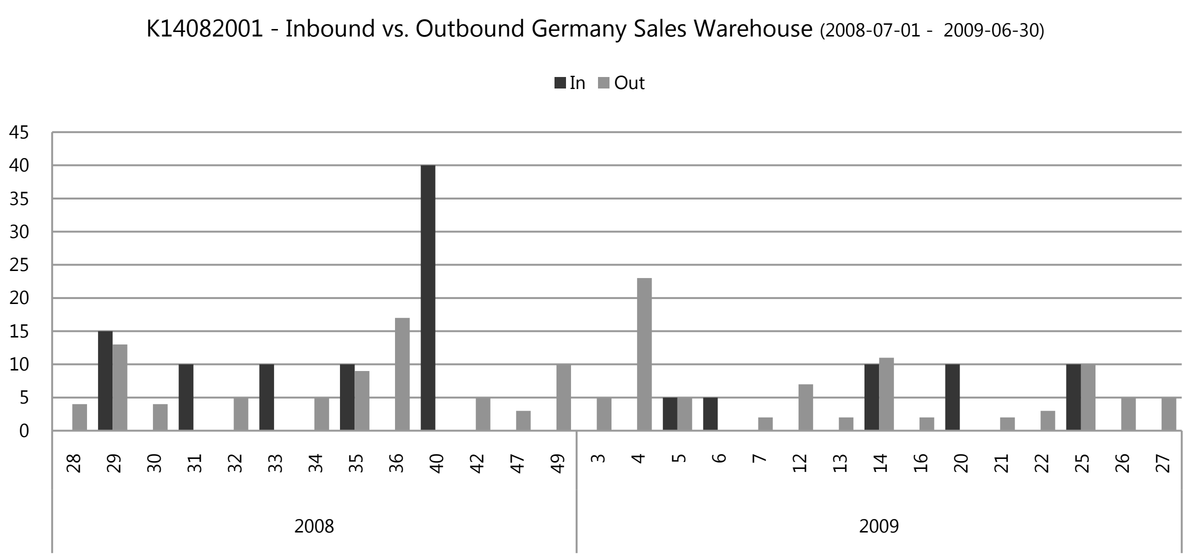

Figure 6.10 Inbound vs. Outbound pattern at the Germany Sales Warehouse (K14082001)

Figure 6.10 shows the inbound vs. outbound pattern of another spare part, this time a more expensive one compared to the first one. Once again, the average weekly demand of those weeks where an outbound shipment actually takes place is roughly 7 pcs. The total inbound quantity for the whole period is 125 pcs and the total outbound quantity is 157 pcs. The outbound shipments range from 2 pcs to a maximum of 23 pcs in week 4 and the ordered quantities, the blue columns, are quite evenly spread out through the whole year with quantities ranging from 5 pcs to 15 pcs, with one exception, namely the blue column in week 40 of 40 pcs. The order pattern during weeks 28 – 36 in year 2008 is pretty stable with one order of about 10 pcs to DC Lund approximately every second week. The same pattern can be seen during the late weeks in 2009. In week 40 in 2008 something strange happens. Suddenly an order of 40 pcs is placed to DC Lund. This quantity is relatively high and probably not something that the planners at SCM in Lund predicted. This order of 40 pcs occurred even though the demand in Germany during the weeks before and after was not increased to any significant extent. What is even more interesting, that this figure also shows, is the fact that the next order to DC Lund is not placed until week 5 in 2009, 17 weeks later, whereas the typical order pattern for a large part of the year consisted of placing one order every second week. One probably does not have to emphasize what problems these kinds of demand peaks are causing both the SCM planners in Lund as well as the inventory status at the warehouse in Malmö. If we add to this the orders from the other sales subsidiaries who are ordering in the same unpredictable way, the problems will of course be much greater.

There are numerous examples of spare parts showing this exact same pattern, so these two products are by no means exceptions.

6.3.2 FRANCE

Similar examples as the ones shown for Germany can be found for France as well.

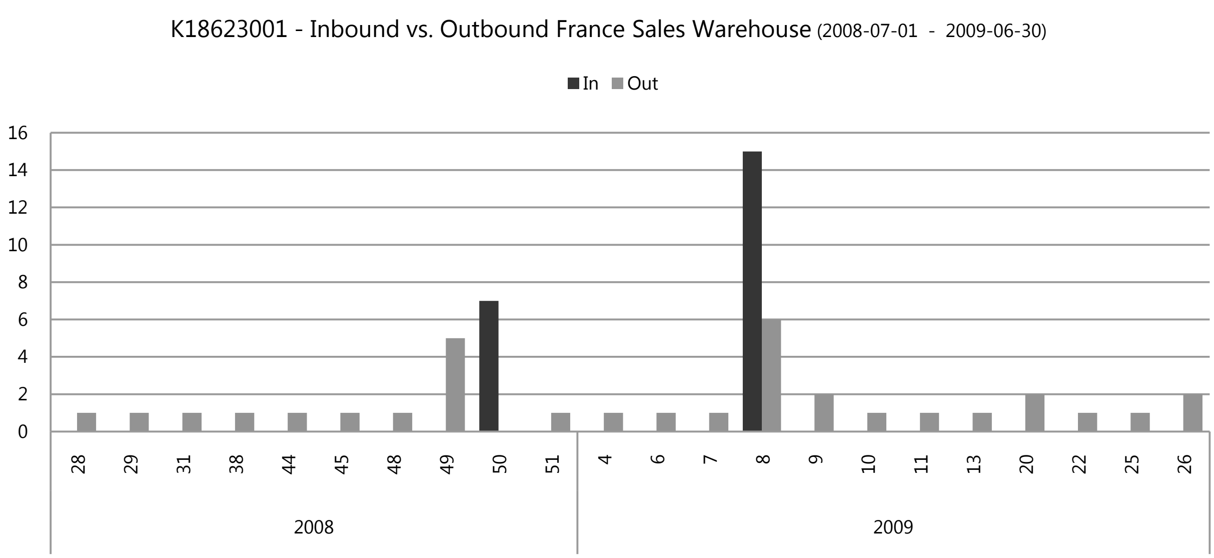

Figure 6.11 Inbound vs. Outbound pattern at the France Sales Warehouse (K18623001)

Figure 6.11 for example shows the order pattern for one of the many spare parts that is used in France and sourced from DC Lund. The total inbound quantity for the whole period is 22 pcs and the total outbound quantity out from the local warehouse to either customers or to service technicians is 33 pcs. The outbound quantity is however spread among 22 weeks, whilst the inbound quantity is divided only by two occasions. On the weeks where there has been a local demand, the average demand quantity has been 1.6 pcs, ranging from 1 to a maximum of 6 pcs. The two orders to DC Lund, on the other hand, have been for 7 and 15 pcs respectively. Naturally this affects the planning in Lund and the inventory level at the warehouse in Malmö. As a curiosity it can be interesting to note that the total inventory of this product that was available in France on the 1/7-2007, week 27 in 2009, was 20 pcs. 4 pcs were located at the sales warehouse in Lyon, while the remaining 16 pcs were located in the service technicians' vans or their shared depots. Although 17 pcs had been consumed during the 19 weeks since the last order to DC Lund in week 8 in 2009, the French sales organization still had 20 pcs in stock. This corresponds to roughly 13 weeks, or 3 months, of demand. This means that in week 8 in 2009 when the last inbound quantity was received, the total stock of this spare part equaled 35 pcs or, in other words, 22 weeks of demand which is more than 5 months of demand.

Another French example is shown in figure 6.12.

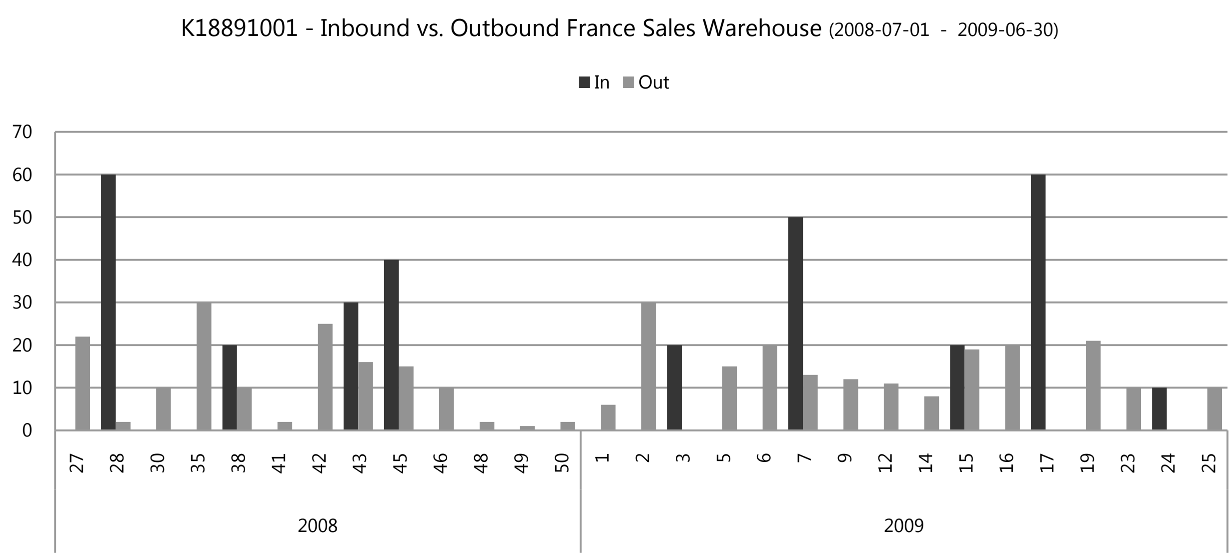

Figure 6.12 Inbound vs. Outbound pattern at the France Sales Warehouse (K18891001)

All the things that have already been said for the previous spare parts apply for this product as well. The total outbound quantity for the period was 342 pcs and the total inbound quantity was 310 pcs. The average outbound shipped quantity was approximately 13 pcs, ranging from 1 to a maximum of 30 pcs per week. The big orders in week 28 (2008) and in week 7 and 17 (2009) of 60, 50 and 60 pcs respectively are clearly not the effect of high demand prior to or after the order to DC Lund. Instead these products are put on the shelves in the local warehouse for a number of weeks until they are finally shipped out from the warehouse. It is also certain however that these peeks, when combined with the orders of other sales subsidiaries, cause stock-outs at the warehouse in Malmö, thus forcing customers in other markets to wait several weeks for their demand, even though the parts are available globally.

6.3.3 GERMANY AND FRANCE COMBINED

Although the previous two sections probably already have made clear to the reader how the high demand peeks affect the DC inventory, it can be good to show a combined example of this phenomena.

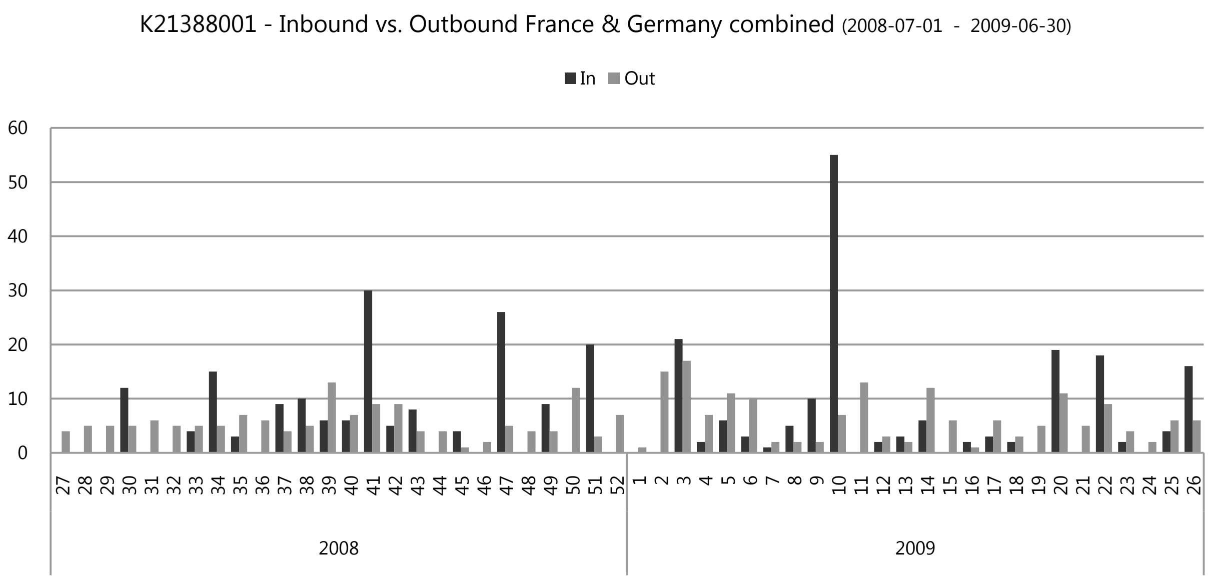

Figure 6.13 Inbound vs. Outbound France & Germany combined (K21388001)

In figure 6.13 the inbound and outbound shipments of the French and German local warehouses have been combined for a certain spare part. The aggregated average outbound quantity for these two markets is about 6 pcs per week, with quantities ranging from 1 to a maximum of 17 pcs per week. As it is pictured clearly in the figure, although the inbound flow is pretty even during some parts of the year, there are evident peaks occurring several times during the period. Most notable are the ones in week 41, 47 (2008) and in week 10 (2009), with outbound quantities of 30, 26 and 55 pcs respectively. Not one of these three peaks has been solely caused by only one of the two illustrated countries. Instead it is the combination of orders from both countries that result in these high columns. For the inbound quantity in week 41 in 2008, 20 pcs have been shipped to France and 10 pcs to Germany. In week 10 in 2009, 40 pcs have been shipped to France and 15 pcs to Germany. These aggregated peaks are causing major issues at the DC level since they are often depleting the total inventory at the DC, thus causing stock-outs and backorders for other markets, where perhaps there is an immediate need for the spare part in a given week. One can easily imagine how these columns would only grow larger and larger if one would include other big countries such as Italy and the US in the analysis. A more frequent order pattern from the sales subsidiaries with smaller quantities per order would most certainly improve the situation.

6.4 INVENTORY VS. SHIPMENT

Another part of the numerical analyses conducted concerned the comparison of the actual spare part inventory level in the sales organizations on a certain date with the shipments of these specific spare parts during the preceding one-year period. The starting-point for this analysis is the inventory data from 2009-07-01 that has been used in the preceding sections, which shows exactly how much inventory of every product that was stored at the different stock locations on that specific date. This information has then been combined with the shipment and consumption data for the period 2008-07-01 to 2009-06-30 that have been received from the technical service organizations in both Germany and France. This shipment and consumption data comprises shipments from the local sales warehouse to customers (sales) and to service technicians (internal movements) as well as the service technicians' consumption of spare parts when maintaining or repairing a machine.

With this information, it was possible to make some calculations that, when presented on an overview level, give some indications as to how much movement had been occurring for these spare parts during the last year compared with the inventory that was in stock at the end of the period. The turnover for each spare part was calculated and this was then translated into how many weeks of inventory of every spare part that was kept in stock on 2009-07-01. A table was constructed and all the spare parts were sorted into one of the defined ranges of weeks of inventory. The inventory and shipped value of these spare parts was also added to the table. These tables will be presented and discussed in this section. The analysis has been carried out for both Germany and France and for both countries the analysis has been conducted on the local sales warehouse inventory only, the service vans inventory only as well as on the total sales inventory. The first two of these will be presented in this section, whereas the tables of the total analysis can be found in Appendix B and C.

As has been highlighted before, it is important to note that the inventory data from 2009-07-01 is only a snapshot of what the inventory consisted of on that specific date. An average inventory quantity of each spare part for the whole analyzed shipment and consumption period would perhaps have been more justifying. It has however not been possible to retrieve this kind of data, therefore we will have to make the best out of the information that is available. On the other hand, on an overview level, the presented results in this section should to a large extent give a fairly true picture of what the actual situation looks like.

6.4.1 GERMANY SALES WAREHOUSE

Table 6.1 Germany Sales Warehouse Inventory vs. Shipments

Weeks of inventory		SKU's	% of SKU's	Inv. Value €	% of Value	Shipped Value €	% of Sh. Value
0	6	119	6 %	72 153	13 %	1 330 006	60 %
6	12	151	8 %	69 543	12 %	411 162	19 %
12	26	281	15 %	106 336	18 %	315 429	14 %
26	52	228	12 %	72 462	13 %	98 434	4 %
52	∞	1 054	58 %	256 335	44 %	48 539	2 %
		1 833		**576 830**		**2 203 569**	

Table 6.1 shows the result of the analysis on the local Sales Warehouse in Munich. All spare parts that were in stock at the local warehouse on 2009-07-01 are included. The shipments that have been taken into consideration for this specific analysis are the shipments from the local warehouse directly to customers and the internal movement of stock to service technicians, i.e. all the outbound shipments from the local warehouse, no matter the destination. As we can see there was a total of 1 833 different SKU's in stock, with a total inventory value of 576 830 €, which is the same value that was illustrated in figure 6.1 for the German local warehouse. Many interesting conclusions can be drawn from the information that has been gathered in this table. First of all, it is striking to see that 1 054 SKU's, 58 %, have been grouped in the "more than 52 weeks of inventory" – range. What does this mean? Let's take it step by step. If the inventory on the date of 2009-07-01 equals the shipped quantity during the analyzed period of 2008-07-01 to 2009-06-30, the inventory of this spare part will equal 52 weeks of inventory (WOI). If the quantity that has been shipped during the whole year is less than the inventory on hand at the end of this period, the stock will correspond to a WOI value greater than 52. If, on the other hand, more has been shipped than what was in stock at the end of the period, naturally the stock will equal less than 52 WOI. What this implies in this case is that for 58 % of all products in stock, there was more in stock on the day of 2009-07-01 than what had been shipped out from the local warehouse during the whole preceding year. What is even more interesting to see is that these 58 % of the SKU's equal 44 % of the total inventory value and only 2 % of the total shipped value. Furthermore, a total of 85 % of all SKU's in stock had a WOI value of more than 12, meaning that the inventory of 85 % of all spare parts in stock could cover more than 3 months of demand. These 85 % equal as much as 75 % of the inventory value but only as little as 20 % of the shipped value. Looking at the top rows of the table we see the opposite. 119 SKU's, 6 %, represent 13 % of the inventory value but 60 % of the total shipped value. Together with the second row, 14 % of these SKU's stand for 25 % of the total inventory value and 79 % of the shipped value. From an inventory planning perspective, these 270 SKU's seem to be managed very good. A low inventory is being kept, ranging from 0 to 3 months of demand, and the spare parts are being used frequently, probably with a fairly stable demand for the whole year. The two

bottom rows can however raise questions as to whether it makes sense to keep so much inventory of the spare parts in these ranges when the shipped value of these SKU's only represent 6 % of the total shipped value.

Important to note is that the shipped values only reflect the shipments that have occurred for the spare parts that were kept in inventory on the date of 2009-07-01. There have of course been other shipments. Those shipments have however been for parts that were not in stock at the above mentioned date, and thus not included in the analysis.

Table 6.2 Germany Sales Warehouse Inventory vs. Shipments (product status)

		Active			Withdrawn			In Phase-out			Unknown		
WOI		Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €
0	6	104	62 421	1 077 117	9	2 335	146 357	6	7 397	106 157	0	0	375
6	12	137	61 589	367 638	8	6 817	36 997	6	1 137	6 527	0	0	0
12	26	255	102 054	303 817	11	2 490	6 829	15	1 792	4 783	0	0	0
26	52	180	44 761	62 373	19	6 152	6 845	28	21 216	28 715	1	333	500
52	∞	770	195 122	43 068	145	31 803	2 187	114	24 582	3 266	25	4 829	18
		1 446	**465 945**	**1 854 014**	**192**	**49 597**	**199 214**	**169**	**56 125**	**149 448**	**26**	**5 162**	**893**

Table 6.2 is a continuation of table 6.1 with the same WOI ranges but now split by product status. Looking at table 6.2, it becomes obvious that a majority of the parts that are withdrawn or in phase-out are located in the bottom WOI range. Although the table shows that withdrawn and in phase-out spare parts are still being used and can be sold or consumed, the risk of high obsolescence becomes evident since a big portion of the withdrawn and in phase-out parts are very slow-moving but represent a large part of the total inventory value of the respective status group.

Table 6.3 Germany Sales Warehouse Inventory vs. Shipments (supplying location)

		Lund			Dasco			Local			Other			Unknown		
WOI		Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €
0	6	87	54 472	1 000 431	24	4 446	65 067	8	13 234	259 458	0	0	4 674	0	0	375
6	12	88	47 826	296 982	54	12 894	66 588	8	7 911	41 208	1	912	6 383	0	0	0
12	26	168	58 158	182 064	83	24 861	73 752	27	15 603	41 930	3	7 714	17 684	0	0	0
26	52	148	50 929	68 570	54	7 395	10 745	23	13 789	18 603	2	16	16	1	333	500
52	∞	539	110 259	18 524	249	35 341	3 848	194	99 004	25 769	47	6 902	380	25	4 829	18
		1 030	**321 645**	**1 566 570**	**464**	**84 938**	**220 000**	**260**	**149 541**	**386 969**	**53**	**15 544**	**29 138**	**26**	**5 162**	**893**

Table 6.3 has only been included to show that the described situation is not correlated to the supplying location of the spare parts. Spare parts sourced from Lund, Dasco and from local suppliers all show the same pattern, with the majority of the inventory value only representing a minor share of the total shipped value.

6.4.2 GERMANY SALES SERVICE VANS

Table 6.4 Germany Sales Service Vans Inventory vs. Consumption

Weeks of inventory		SKU's	% of SKU's	Inv. Value €	% of Value	Consumed Value €	% of Cons. Value
0	6	12	1 %	3 049	0 %	55 163	7 %
6	12	9	0 %	4 858	0 %	24 999	3 %
12	26	68	3 %	58 657	5 %	160 493	20 %
26	52	177	8 %	242 991	21 %	339 003	42 %
52	∞	1 849	87 %	829 567	73 %	222 978	28 %
		2 115		**1 139 122**		**802 637**	

In table 6.4 the same analysis that was presented and described in the preceding section has been applied on the inventory of the German Service Vans. This time, however, the inventory is compared to the consumed quantity, i.e. the quantity used by the technicians during maintenance or repair. The results from this analysis are somewhat different from the ones in table 6.1, mainly if one looks at the consumed value column. The percentage of SKU's and inventory value gathered in the 52 and above WOI range is still worryingly high, but the consumption value percentage of these SKU's is not as low as they were at the local warehouse. It seems as if the service technicians consume many of the SKU's that they carry in stock. The question however remains whether they need to carry this much inventory in their vans as the table shows. It would probably be possible to centralize a large portion of the SKU's that are in the 52 - ∞ WOI range at the local warehouse in Munich instead, thus reducing the total German Sales inventory. Inventory that today is, to a large extent, locked away in the vans of the service technicians.

Table 6.5 Germany Sales Service Vans Inventory vs. Consumption (product status)

WOI		Active			Withdrawn			In Phase-out			Unknown		
		Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €
0	6	8	2 481	47 081	4	569	8 016	0	0	66	0	0	0
6	12	7	3 052	13 981	2	1 805	11 018	0	0	0	0	0	0
12	26	58	53 960	146 945	8	4 331	12 522	2	367	1 027	0	0	0
26	52	132	196 988	281 251	32	24 216	27 317	13	21 787	30 435	0	0	0
52	∞	1 243	630 684	185 674	360	129 999	22 753	207	66 387	14 060	39	2 498	491
		1 448	**887 164**	**674 931**	**406**	**160 920**	**81 626**	**222**	**88 541**	**45 589**	**39**	**2 498**	**491**

Table 6.5 once again shows the obsolescence risk that is present on the spare parts stored in the service vans as well. The withdrawn and in phase out spare parts found in the 52 - ∞ WOI range constitute roughly 200 000 € of inventory value but the consumed value of these parts during the analyzed period has only reached an amount of approximately 37 000 €. There is a high risk that

the consumption of these spare parts will only decrease and that the Sales organization will end up with obsolete spare parts that have to be scrapped.

Table 6.6 Germany Sales Service Vans Inventory vs. Consumption (supplying location)

		Lund			Dasco			Local			Other			Unknown		
WOI		Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €
0	6	7	1 614	21 726	1	22	715	4	1 413	32 723	0	0	0	0	0	0
6	12	5	4 017	20 705	2	840	4 292	2	0	2	0	0	0	0	0	0
12	26	32	35 608	105 008	25	13 190	33 150	10	9 241	20 011	1	619	2 324	0	0	0
26	52	95	178 974	237 304	52	20 962	30 639	29	42 794	70 626	1	261	435	0	0	0
52	∞	946	576 843	163 311	513	144 098	39 599	261	98 363	19 425	90	7 766	151	39	2 498	491
		1 085	**797 055**	**548 054**	**593**	**179 112**	**108 395**	**306**	**151 812**	**142 787**	**92**	**8 646**	**2 909**	**39**	**2 498**	**491**

6.4.3 FRANCE SALES WAREHOUSE

Table 6.7 France Sales Warehouse Inventory vs. Shipments

Weeks of inventory		SKU's	% of SKU's	Inv. Value €	% of Value	Shipped Value €	% of Sh. Value
0	6	327	14%	182 922	27%	3 649 685	77%
6	12	316	14%	105 898	16%	696 599	15%
12	26	388	17%	88 479	13%	267 917	6%
26	52	222	10%	48 080	7%	61 882	1%
52	∞	1 035	45%	249 472	37%	57 374	1%
		2 288		**674 851**		**4 733 457**	

The same type of analysis has been made for the French inventory. In table 6.7 we see the how the inventory of the local warehouse in Lyon is distributed when it comes to WOI, inventory value and shipped value. Overall, the same phenomena that we saw for Germany can be observed here. A substantial amount of the SKU's in stock, 72 %, represent 57 % of the inventory value but only 7 % of the shipped value during the studied period. What's interesting to see is that a larger percentage of the SKU's, 14 %, fall under the first WOI range of 0 to 6 WOI compared to the German case, where the corresponding percentage value was only 6 %. These SKU's have a high turnover, with approximately 183 000 € of inventory value but at the same time a shipped value of 3.7 M €, which is very good. Just as with the German case, it can however be questioned whether it is necessary to keep such a high inventory of the 1 035 SKU's that fall under the 52 - ∞ WOI range. They stand for roughly 250 000 € of inventory value but only 57 000 € of shipped value.

In table 6.8 below, we see how the different SKU's in the different WOI ranges are distributed when it comes to product status. Once again, we see that a large amount of spares that are either withdrawn or in phase-out fall under the 52 - ∞ WOI range, thus increasing the risk of obsolescence. Approximately 60 000 € of inventory corresponds to only 5 600 € of shipments. If these SKU's would have been stored centrally at the DC level instead, the scrapping costs that eventually will occur would probably have been much less than what will be the case with the present setup. It should however also be noted that some withdrawn and in phase-out SKU's have been shipped quite a lot. The spare parts in the first row, a total of 20 SKU's constitute about 14 500 € of inventory value but have been shipped for a value of roughly 700 000 €. This shows that although the products are withdrawn or in phase-out they can still be sold, used and generate income. It is important to note however that these SKU's had the status of withdrawn or in phase-out on the day of 2009-07-01. They could have been active for most part of the preceding year, which could be the reason behind the large shipped value observed in this table.

Table 6.8 France Sales Warehouse Inventory vs. Shipments (product status)

		Active			Withdrawn			In Phase-out			Unknown		
WOI		Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €
0	6	305	166 558	2 905 417	8	983	324 135	12	13 753	378 919	2	1 628	41 214
6	12	282	82 999	521 373	10	11 444	88 226	22	11 414	86 797	2	40	203
12	26	344	82 138	250 026	11	1 723	5 428	29	4 190	11 044	4	427	1 418
26	52	190	42 966	55 846	11	3 211	3 755	18	1 888	2 263	3	15	18
52	∞	684	186 177	51 548	126	19 810	3 297	202	40 019	2 413	23	3 466	116
		1 805	**560 838**	**3 784 210**	**166**	**37 172**	**424 841**	**283**	**71 264**	**481 436**	**34**	**5 577**	**42 969**

Table 6.9 below only illustrates that no matter the supplying location of the spare part, the majority or large part of the inventory value corresponds to a small share of the total shipped value.

Table 6.9 France Sales Warehouse Inventory vs. Shipments (supplying location)

		Lund			Dasco			Local			Other			Unknown		
WOI		Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €
0	6	154	86 084	1 887 668	106	62 873	1 095 657	58	26 067	545 952	3	6 032	63 187	6	1 865	57 221
6	12	158	44 810	287 385	105	52 771	364 701	38	6 873	36 891	13	1 405	7 418	2	40	203
12	26	209	36 614	105 227	108	37 695	123 952	49	10 111	27 222	18	3 631	10 098	4	427	1 418
26	52	114	18 310	22 083	69	25 840	35 240	26	3 054	3 593	10	861	947	3	15	18
52	∞	503	115 920	30 972	263	88 116	23 525	105	17 627	1 301	130	24 001	1 460	34	3 807	116
		1 138	**301 739**	**2 333 336**	**651**	**267 295**	**1 643 076**	**276**	**63 731**	**614 958**	**174**	**35 930**	**83 111**	**49**	**6 155**	**58 977**

6.4.3 FRANCE SALES SERVICE VANS

When taking a look at this kind of analysis on the French service vans inventory, we again see similarities to what was observed in the German case. Although a large part of the SKU's, 76 %, and the inventory value, 49 %, fall under the 52 - ∞ WOI range, table 6.10 shows that the consumption value is spread out across the five WOI ranges in a fairly homogenous manner, with percentage value ranging from 10 % to a maximum of 32 %. Apparently there is some high usage even of those parts where the WOI is high. Still, the big inventory value that the bottom WOI range constitutes, namely 49 %, can be questioned when we see that the shipped value of these parts only represent 10 % of the total consumed value.

Table 6.10 France Sales Service Vans Inventory vs. Consumption

Weeks of inventory		SKU's	% of SKU's	Inv. Value €	% of Value	Consumed Value €	% of Cons. Value
0	6	21	1%	15 649	2%	347 928	24%
6	12	34	2%	27 247	3%	146 104	10%
12	26	156	8%	175 097	20%	467 987	32%
26	52	257	13%	236 543	27%	338 277	23%
52	∞	1 491	76%	437 792	49%	145 294	10%
		1 959		**892 328**		**1 445 589**	

Table 6.11 shows that a large part of the French service technicians stock that is withdrawn or in phase-out consists of slow-moving articles. Once again, this raises questions as to whether these SKU's would not be better off if they would be kept more centrally at the local warehouse or even back at the DC, from an obsolescence risk point of view.

Table 6.11 France Sales Service Vans Inventory vs. Consumption (product status)

		Active			Withdrawn			In Phase-out			Unknown		
WOI		Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €
0	6	11	5 805	135 349	5	5 795	99 835	5	4 050	112 700	0	0	44
6	12	28	26 043	139 121	2	963	5 775	3	241	1 207	1	0	0
12	26	130	143 943	372 985	14	13 410	42 969	12	17 745	52 033	0	0	0
26	52	215	213 366	305 431	15	14 092	20 984	21	7 772	10 549	6	1 313	1 313
52	∞	1 031	356 181	130 127	195	50 344	7 827	205	30 098	7 315	60	1 169	24
		1 415	**745 338**	**1 083 014**	**231**	**84 603**	**177 390**	**246**	**59 906**	**183 804**	**67**	**2 482**	**1 381**

For the sake of providing a complete picture table 6.12 is presented, although nothing new which has not already been discussed can be observed.

Table 6.12 France Sales Service Vans Inventory vs. Consumption (supplying location)

		Lund			Dasco			Local			Other			Unknown		
WOI		Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €	Q	Inv. V. €	Con. V. €
0	6	8	10 273	183 963	9	3 415	109 120	3	1 952	53 568	0	0	1 008	1	9	269
6	12	13	23 088	120 097	14	2 241	16 078	6	1 918	9 929	0	0	0	1	0	0
12	26	66	71 494	182 729	65	97 345	268 590	19	5 711	15 141	4	396	1 171	2	150	355
26	52	125	104 735	150 880	85	104 706	151 862	32	24 609	33 001	9	1 180	1 222	6	1 313	1 313
52	∞	746	287 450	102 567	379	99 032	36 252	162	38 136	5 419	142	11 918	1 031	62	1 257	24
		958	**497 040**	**740 236**	**552**	**306 739**	**581 902**	**222**	**72 327**	**117 059**	**155**	**13 495**	**4 431**	**72**	**2 728**	**1 961**

6.5 SHIPMENT STATISTICS

Before we move on to the qualitative part of this analysis chapter let us have a quick look at some shipment statistics for the two markets of interest.

Table 6.13 Shipment and consumption data Germany

Germany (2008-07-01 - 2009-06-30)	**Sales** (Sales Warehouse to customers)	**Internal movements** (Sales Warehouse to service technicians)	**Consumption** (Service technicians at customer sites)
Quantity	63 284	138 066	56 878
SKU's	1 098	1 410	1 606
Customers or Service technicians	351	45	475
Orders	3 309	2 232	6 638
Average orders/day	13	9	26
Orderrows	7 865	16 009	34 647
Average orderrows/day	30	62	133

In table 6.13 we see the shipment and consumption statistics for the German market during the period 2008-07-01 to 2009-06-30. Important figures from this table are the ones showing the number of orders that are processed during one year by the back office personnel in Munich. A total of 5 541 orders (3 309 + 2 232) are received from customers and service technicians during one year and these orders need to be manually entered into Scout. What is also interesting to see is that the quantity that has been shipped from the sales warehouse to the service technicians, 138 066 pcs, widely exceeds the quantity that has been consumed by the service technicians, 56 878 pcs. This result implies to some extent that a quite significant part of the total sales inventory has been moved to the stock of the service technicians during this period, a tendency that we also highlighted in section 6.2.1.

Table 6.14 Shipment and consumption data France

France (2008-07-01 - 2009-06-30)	**Sales** (Sales Warehouse to customers)	**Internal movements** (Sales Warehouse to service technicians)	**Consumption** (Service technicians at customer sites)
Quantity	104 164	47 889	35 476
SKU's	2 024	1 492	1 613
Customers or Service technicians	943	96	641
Orders	8 897	2 838	10 035
Average orders/day	34	11	39
Orderrows	22 100	11 686	22 638
Average orderrows/day	85	45	87

In France a total of 11 735 orders have to be entered manually into Minos during one year of time, according to table 6.13. During a 260 working days year this results in 45 orders per day that the back office personnel in Lyon have to take care of.

6.6 DISTRIBUTION STRUCTURE ALTERNATIVES

We have now reached the more qualitative part of the analysis. The purpose of this section is to present and discuss the different distribution structure alternatives that have evolved as possible future alternatives during discussions with relevant people in the SCM organization and with responsible people from the technical service organization.

As with any investigation and research, this one also started with some thoughts and assumptions concerning a possible final solution that would solve some of the issues experienced at Gambro with spare parts, such as fluctuating demand and high inventory in the wrong places. Since a direct distribution structure such as the one implemented in the UK or the other SAP countries cannot be applied to the German, French or Italian market because of the reasons mentioned in section 5.6, a different distribution structure would have to be thought of.

The first proposed solution that was discussed, even before the work with this thesis had started, involved the usage of QlikView as a leading tool in the future spare part distribution structure. What was suggested was that using QlikView, a consumption-based replenishment process would be established for all service cars in those markets where SAP had not been implemented and direct shipments of spare parts would then be carried out to these technicians from the DCs. By making the replenishment of the service cars consumption-based, one would be sure that no unnecessarily large quantities would be shipped to the service technicians from the DCs. Only those quantities that had been consumed by the technician and those quantities that there was a real demand for would be shipped. At the same time the inventory at the local warehouse could be reduced. This was originally also one of the main purposes with this thesis, namely to investigate in what way QlikView could be used to manage this kind of process and how it would need to be setup to reach this purpose. However, as the empirical results of this thesis started to reveal themselves this initial hypothesis was challenged and eventually ruled out as a feasible option. First of all, the QlikView solution would only be able to manage shipments of spare parts to service technicians. Customers do not use QlikView and the inventory level of customers is not monitored by Gambro in any way. As we have seen in the preceding sections of this chapter, a large amount of the spare parts in Germany and France are shipped to customers, thus implying that the consolidated orders from the sales subsidiaries that are causing demand peeks at the DC level are related to both customer and service technicians order. Therefore, going for a solution that would only solve the part of the demand peeks that is due to the service technicians orders does not seem wise. Inventory would still need to be kept at the local warehouse in order for the sales organization to be able to supply customers with products, and demand peaks would therefore probably still occur. Alternatively a separate process would need to be thought of that would manage customer orders separately from service technician orders. Another aspect that ruled out the QlikView solution as a feasible one is the fact that service technicians in both Germany and France as well as in most other countries in Europe are using GFS as an ordering instrument. As was discussed in the preceding chapter, the ordering function in GFS is actually also consumption-based at the initial stage of the order process. When the technician wants to order, GFS presents a proposal with all consumed spare parts since the last order was placed. The technician can then adjust this order to better meet his need for the upcoming weeks. If one would implement the QlikView solution, not only would this replace a system with the same consumption-based function, but it would also eliminate the possibility for the service technician to adjust the consumption-based replenishment proposal. A separate order flow for all the parts that the service technician would like to order apart from the ones consumed would therefore be needed. It seems as if GFS is a system that the service technicians are feeling comfortable with and that it is here to stay. Technical service in both Germany and France have made clear that the possibility of making adjustments before sending the real order, even though it is initially consumption-based, is a necessity from a service technician's point of view. Therefore, it does not seem wise to construct future possible scenarios where GFS is no longer used by the technicians. All in all these aspects made the QlikView solution impractical and new distribution alternatives had to be suggested.

Further discussions with all the involved people on this matter resulted in basically two spare part distribution structure alternatives that from at least a theoretical point of view would be feasible. These have been defined as:

- Consumption-based replenishment of the local sales warehouses using QlikView
- Direct Delivery to customers and service technicians from Malmö warehouse

The first alternative is basically a modified version of the initial QlikView solution discussed above. Instead of implementing a consumption-based replenishment process for the service technicians' stocks, this alternative goes back one step in the supply chain and look at a consumption-based replenishment of the local warehouses only.

The second alternative is a straightforward direct distribution solution where all spare parts would be directly shipped from the warehouse in Malmö to service technicians and customers in Germany and France. The observant reader will probably wonder how it is possible that this second alternative is seen as a feasible solution since it was clearly stated in the beginning of this section that direct distribution as it was setup in the UK could not be implemented in the non-SAP countries. This is a fair question and it will be answered in the following sections.

The two distribution alternatives outlined above will now be described and discussed in a detailed manner.

6.7 LOCAL SALES WAREHOUSE REPLENISHMENT

The distribution alternative concerning a consumption-based replenishment of spare parts to the local sales warehouses has one main purpose, namely to eliminate or at least reduce the demand peeks that appear at the DC level because of the high quantity orders from the back office personnel in Germany and France. Demand peeks occur at basically two sections of the spare part supply chain as it was depicted in the beginning of the preceding chapter in figure 5.1. First of all, we have the orders placed by the back office personnel at the sales subsidiaries to the DCs in Lund and Mirandola. These orders are consolidated and as we have seen in section 6.3 the ordered quantities are much bigger than the actual need in the specific market. Second, we have customers and technicians who place orders to the local warehouse. The quantities in these orders may also be larger than the actual end demand, thus causing an unnecessarily high demand at the local warehouses. However, service technicians and customers are probably more reluctant, than are the local warehouses, to order bigger quantities than they need since they usually do not have the storage capacity to keep big amounts of spare parts in their vans or in the clinics and hospitals. The demand peeks that may occasionally occur in this part of the supply chain are thus of minor importance to the overall picture and can therefore be neglected. The proposed solution of a consumption-based replenishment of the local warehouse would consequently only solve the demand peeks caused by the local warehouse, as they were depicted in section 6.3, since the ordering pattern of the service technicians and customer would not be interfered with or changed.

As the name of this solution suggests, the local warehouse stock would in this scenario be replenished with the quantities that had been consumed during a certain period of time and the quantities in the orders to the DCs would be closer to the real demand. The basic idea behind this solution is to assign a target level quantity at the local warehouse on every spare part that is sourced from one of the two DCs. This target would be based on a certain safety stock level together with a quantity corresponding to the estimated demand during the chosen replenishment period. By comparing this target quantity with the actual inventory of a given spare part at a given day, a replenishment proposal could then be generated. When the actual inventory of a certain spare part would be less than the target quantity, a replenishment quantity that would make the actual inventory reach the target level would be proposed and eventually shipped from the DCs to the local warehouses.

The main advantage with this solution when implemented is of course that the demand peaks at the DC level will be reduced or even eliminated. This will in turn improve the availability of spare parts at the warehouses in Malmö and in Mirandola. There are however other advantages as well. One is the fact that everything will be continued as normal from an end customer and service technician point of view. They will not be aware of this change since their order processes and their information flow will function in the exact same way as they are today. Only the back office personnel at the local warehouses will be affected and their work will actually be reduced since they will no longer have to place any orders to the DCs. This will instead be done centrally. Another advantage with this method is that it is quite straightforward and easy to understand and communicate throughout the organization. The setup and implementation of this solution will also not require any major monetary investments or working hours, thus making it both fast and simple. There will however be some increased workload at the DCs and at the local warehouses related to the picking and packing/unpacking of products. This is due to the fact that every weekly order will naturally contain more orderrows than today. A preliminary estimation, based on a calculation on German market figures, shows that the number of orderrows would in fact double. In order to get a better feeling of how this consumption-based replenishment of the local sales warehouses would work in practice, let us take a closer look at the proposed structure.

6.7.1 REPLENISHMENT SETUP

Flow of information

Figure 6.14 shows how the flow of information would be arranged in the discussed scenario. In this figure the green ovals represent information systems, the blue objects symbolize different administrative functions and the grey triangles represent the concerned warehouses.

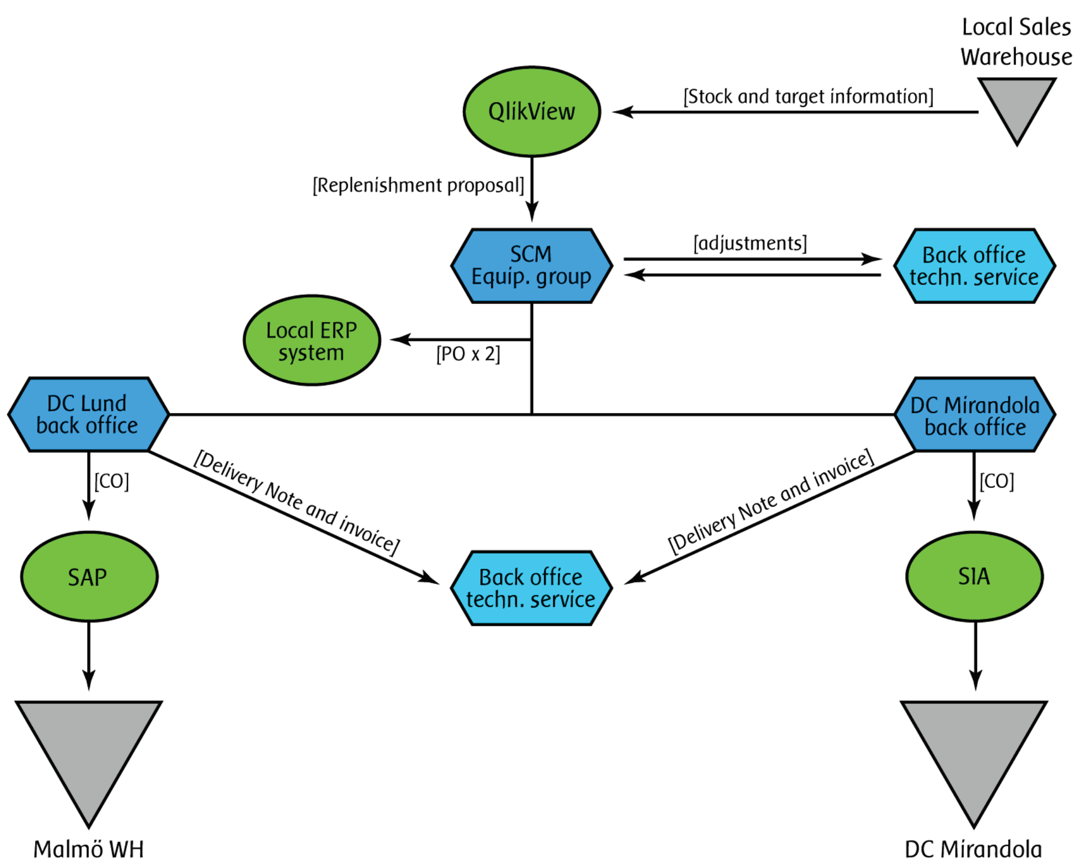

Figure 6.14 Consumption-based replenishment of the local warehouses information flow

As has already been mentioned, in this situation customers and service technicians will order spare parts in the exact same way as they are today and they are therefore not included in this figure. Starting from the top of figure 6.14 we see that QlikView receives stock and target information from the local warehouses. This is in fact an automatic process and no manual intervention has to be carried out for this information to be transmitted. Actual stock information will be included in the INS-files that are frequently read into QlikView, whereas the target information for all relevant spare parts will be kept and maintained in an Excel-file, which will also automatically be read into QlikView when necessary. Based on a predefined algorithm, QlikView will then do the necessary calculations with the numbers from these both files and come up with a replenishment proposal for a chosen local warehouse, such as the one in Munich or Lyon. Since there are two sourcing location, DC Lund and DC Mirandola, two proposals will be generated for each local sales warehouse. These proposals will be extracted from the SCM Equipment group on a regular basis as agreed with the technical service organization in the respective market, for example weekly. The replenishment proposals will then be sent by e-mail to the back office personnel in the respective market, who will be given the possibility to adjust the proposed quantities as well as add products to the proposals before sending them back to SCM. It is important to note that only adjustments concerning extraordinary demand and special circumstances should be allowed. Otherwise there is a high risk that the back office personnel will simply adjust the proposed quantities so that they match those high order quantities that are being ordered today and the desired effect will not be obtained. When the replenishment proposals return to SCM, they have to be transformed into firm orders and entered into the relevant systems. Two purchase orders have to be created in the local ERP systems of the respective markets, one for each sourcing location. This will be done by the SCM Equipment group in Lund. At the same time two customer orders have to be created at the DCs. The back office personnel of DC Lund and DC Mirandola will receive the adjusted proposal with the relevant PO-number and they will then manually create the customer orders in SAP and SIA respectively. From this moment on, everything will continue as normal. When the spare parts are ready to be shipped from the central warehouses, a delivery note and invoice will be sent to the back office personnel in the local markets.

Flow of goods

The physical flow of spare parts will not be changed. Spare parts will still be shipped from the DCs in Lund and Mirandola to the local sales warehouses, who will then ship to customers and service technicians, as it was depicted in figure 5.3.

Prerequisites

As was mentioned, no big investments need to be done in order to have this solution fully implemented. First of all, the new way of ordering has to be communicated to and agreed on with the technical service organizations in the relevant countries. Also, together with the technical service representatives, it has to be decided which products would be suitable for this kind of solution. Should all spare parts sourced from DC Lund and DC Mirandola be included or not? Secondly, QlikView has to be setup in order to work as intended which will require some consultancy hours. The necessary adjustments are very basic however and 4-5 consultancy hours will be fully sufficient for these operations. Also, the necessary information from the local ERP systems has to be transmitted through the relevant INS-files. This may require some work carried out by the local IT-departments in the concerned countries. Something of importance that has not been mentioned earlier concern those replenishment quantities that QlikView would propose as a result of the calculation algorithm. This calculation needs to take into consideration such aspects as minimum order quantities. A part of the preparation work of this solution therefore comprises the need to establish and define these quantities for all the involved spare parts. The implications of the increased workload at the warehouses will also have to be considered.

6.8 DIRECT DELIVERY

The second suggested distribution alternative, the direct delivery distribution, is a solution that, if implemented, will solve many of the issues that are at hand for spare parts. Just as with the consumption-based replenishment solution discussed before, direct delivery of spare parts to customers and service technicians from the DC will result in reduced or eliminated demand peaks. This is simply because of the fact that only real orders, i.e. orders with quantities that are equal to or very close to the real need, will be dealt with at the DC. When direct delivery is implemented, the spare parts that today are kept in the local warehouses can be sent back to the DC and therefore reduce the total inventory levels. Another consequence of these both aspects is a higher availability at the DC level, since the local warehouses will not place consolidated orders to the DCs anymore. Due to the same reason, the administrative work carried out by the back office personnel in the relevant markets will be somewhat reduced as well. Customers and service technicians will also not be affected by this change of distribution. They will still order spare parts in the exact same way as they are doing today.

As has already been discussed, the direct delivery alternative as it was implemented in the UK cannot be directly implemented in any of the non-SAP countries. A new kind of setup therefore has to be constructed. In the simplest form, one way of organizing direct delivery to service technicians and customers would be by only making some slight changes to the existing way of working. Customers and service technicians would continue to order spare parts in the exact same manner as they are today. The back office personnel would however no longer place consolidated orders back to the DCs. Instead, in the case of a service technician order, the back office personnel would create a purchase order to the DC for each and every received order, setting the stock location of the concerned service technician as the receiving location. In the case of a customer order, the back office personnel would first have to create a sales order in the local ERP system just as they do today, due to the fact that the sales subsidiaries are the only legal entities allowed to sell spare parts to customers. In addition to this sales order however, a purchase order for each and every customer order would have to be created to the DC, setting the customer as the receiving address. All these purchase and sales orders would have to be manually created in the relevant local ERP system. For each and every purchase order from a customer or service technician, the back office personnel at the DC would then have to manually enter each order into the relevant system as a separate sales order. Each order would then be packed and shipped separately to the specified address. A delivery note and an invoice would have to be sent by the DC back office personnel to the back office personnel in the local market for every single order with information regarding products that have been delayed or put on backorder and so on. The local back office personnel would then need to keep track of all shipped orders and update the purchase and sales orders in the local ERP system accordingly. They would also have to invoice the customers on those spare parts that had in fact been shipped from the DC. This setup is simple since it requires no special investment or big change of any sort. However, if we look back at the shipment statistics tables presented in section 6.5, it becomes obvious that this setup would be administratively unsustainable in the long run. A total of 5 541 orders and 11 735 order per year for Germany and France respectively would have to be entered into two ERP systems manually by the back office personnel at the local warehouses and the DCs. The same people would also need to keep track of every single one of these orders and update them when necessary. Because of the administrative complexity of this kind of setup, it was decided that this would not be a feasible solution. Instead something had to be thought of that would automatize large portions of this process in order to reduce the administrative burden. The UK setup served as a good example of how this solution should be constructed, although adjustments would have to be made in order to overcome the discussed obstacles when it comes to implementing this kind of solution in the non-SAP countries. It was clear though that the future solution would need to include an IT integration of some sort. How could this then be achieved?

First of all, it would have been good if an integration as the existing one between GFS and SAP could be arranged between GFS and the local ERP systems. This way, the local back office personnel would not have to enter each service technician order manually into their local system. When this matter was discussed with the experts on GFS however, it was concluded that this would not be possible in the near future for any of the local ERP systems. This implied that whatever direct delivery solution would be constructed, the back office personnel in the local markets would still need to receive orders from customers and service technicians in the way it is managed today and then enter these orders manually into the local ERP systems. The automation would therefore need to start right after this step, so that no double work would have to be carried out by the DC back office personnel. After discussion with IT representatives, one possible solution was constructed and seen as a feasible solution. Let us have a look on how this solution would be constructed, both when it comes to the flow of information and the physical flow of goods. Important to note is that if a direct delivery setup would be implemented for such big countries like France and Germany, all Gambro sourced spare parts would need to be shipped from one DC only. Keeping spare parts both at the warehouse in Malmö and in DC Mirandola would not be a feasible solution. Since it seems as if the general opinion at Gambro is that this could only be managed at the warehouse in Malmö, the setup described here will make the assumption that all spare parts are to be shipped from Malmö.

6.8.1 DIRECT DELIVERY SETUP

Flow of information – service technicians

Figure 6.15 shows how the flow of information would be handled in a direct delivery setup when a service technician would place a spare part order.

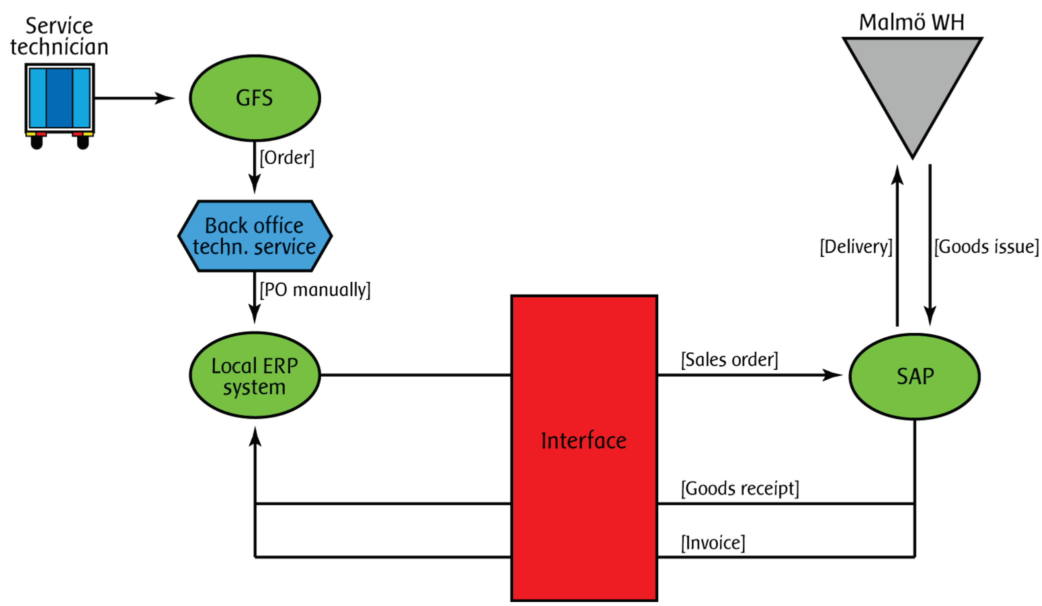

Figure 6.15 Direct delivery flow of information – service technician order

Just as today, the technician would use GFS when placing a spare part order. This order would then be received by the technical service back office personnel who would enter the order manually into the local ERP system as a purchase order to DC Lund with the stock location of the technician as the receiving location. At this point the automated part of the process will commence. This is essentially carried out by a special interface or, in reality, a number of interfaces that need to be developed which are interacting both with the local ERP system on the one side and with SAP on the other side. These interfaces will then manage all the necessary information transactions that need to be transmitted from one system to the other. For example, the purchase order created in the local ERP system will automatically generate a sales order in SAP with the aid of one of the interfaces. Although not specifically included in this figure, it is possible that a special interface would need to be constructed in order to handle order confirmations generated in SAP that would then be transmitted through the interface back to the local ERP systems. It is however uncertain at this stage of the process if such an action is necessary. With an automatic batch-job carried out as was the case in the UK setup, a delivery action will be performed on the sales order in SAP making it visible for the Malmö warehouse personnel as ready for picking and packing. When the goods have been packed at the warehouse a goods issue action will be performed on the order by the warehouse personnel. This will in turn trigger a goods receipt through another interface back to the local ERP system. The relevant purchase order in that system will then be updated with those quantities that have been shipped. With the goods receipt, information regarding backorder quantities and preliminary shipment dates of these quantities will also be transmitted, thus acting as an order confirmation to some extent. Parallel to this an invoice will also be sent, either through an interface as the figure suggests to the local ERP system or through e-mail directly to the back office personnel.

This automated part of the whole process eliminates the need of having back office personnel at the DC entering the order manually into SAP and monitoring the order until completion. They will instead only need to arrange for transportation of the orders. The administrative work of the back office personnel at the local warehouses will also be drastically reduced. They will not need to update anything in the local ERP systems since this is carried out automatically.

Flow of information – customers

Figure 6.16 shows how the flow of information would be handled when a customer would place a spare part order instead.

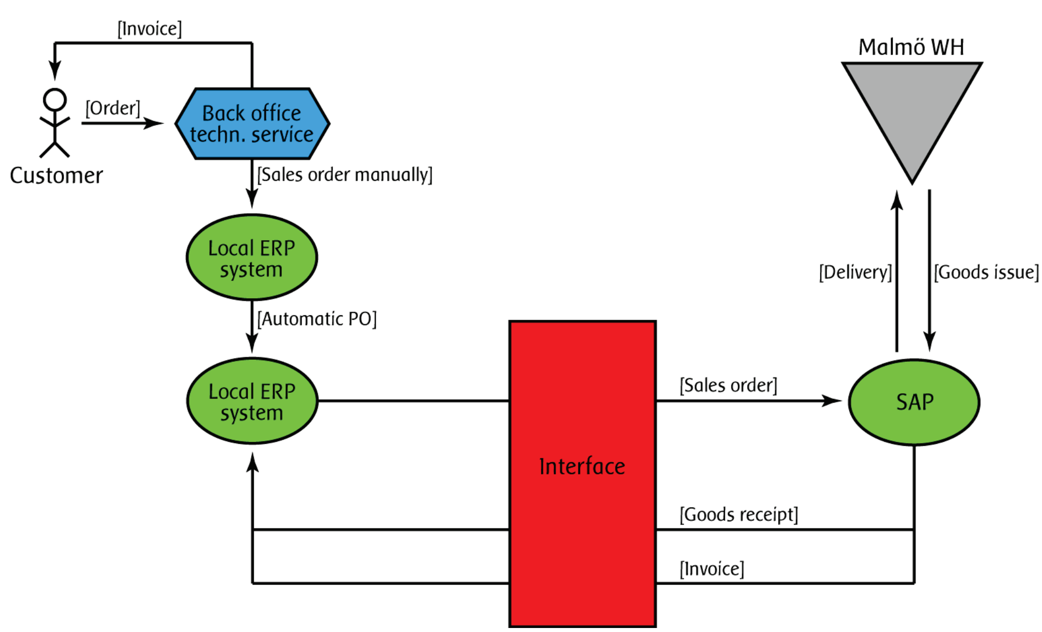

Figure 6.16 Direct delivery flow of information – customer order

The only difference from the above discussed information flow concerning a service technician occurs in the initial stage of the order process. When a customer places an order to the technical service back office personnel, the first thing that is entered into the local ERP system is a sales order to the customer from the sales organization. Of course, in a direct delivery setup, a purchase order to DC Lund has to be created in the local ERP system as well so that the order/shipment process can proceed in the same way as it did for the service technician order. It would not be effective to have the technical service back office personnel first enter the sales order manually into the local ERP system and then do the same thing in order to create a purchase order. Instead, this step would also have to be automatized and thus having the local ERP system create the purchase order as an automatic consequence of creating the customer sales order. When the goods have been shipped from the warehouse in Malmö directly to the customer, the back office personnel need to invoice the customer just as they do today when they ship spare parts from their own local warehouse.

Flow of goods – service technicians and customers

The physical flow of goods in a direct delivery setup would follow the one that is in place for SAP-countries such as the UK as depicted in figure 6.17 below.

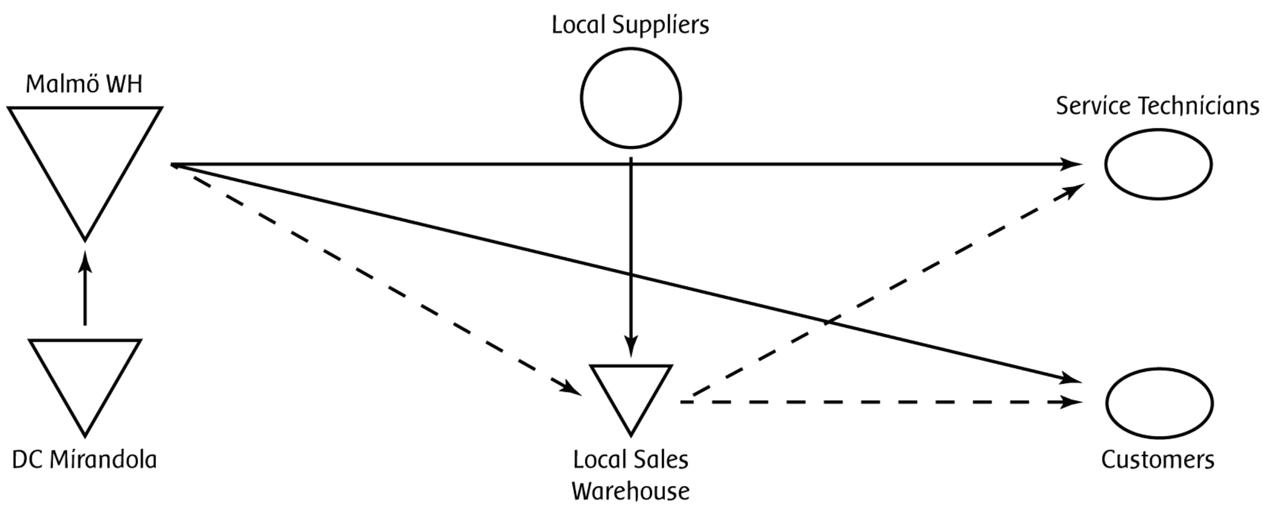

Figure 6.17 Physical flow of goods in a direct delivery setup

All Gambro sourced spare parts would be shipped out from the warehouse in Malmö by a courier, such as UPS. The consequence of this would naturally be that all the inventory of spare parts produced and sourced in Dasco would need to be kept in the warehouse in Malmö together with spare parts produced and sourced in Lund. Just as in the UK case, the physical flow of the local spare parts and some critical spare parts that would still be kept at the local warehouses would remain unmodified. These products would also be handled separately from the order flow described above, leaving everything in the same way as it is managed today.

Prerequisites

As this presentation has probably made clear, the direct delivery solution will result in bigger investments, both in time and money, than what was necessary with the first discussed solution. First of all, all the IT related aspects of this solution would have to be defined in a detailed manner and developed accordingly. The IT departments for the local ERP systems and for SAP would therefore need to be involved from the beginning of the discussions and eventually make the necessary development efforts in order for this solution to be implemented. From an order process handling perspective, it is not as complicated as one might perceive. It is however important that consensus and agreement can be reached among all the involved people, namely Technical Service in the relevant countries, DC Lund, SCM and the IT departments of all the systems of relevance, as to how this setup should be constructed and implemented in the best possible way. This will probably take some time. Apart from time, monetary investments will also need to be made when it comes to the development of the necessary interfaces, which at least on the SAP side would have to be carried out by external consultants. Another important cost related aspect is the one of transportation. It is at this stage of the process unknown what the exact total transportation cost implications would be since a cost analysis has not been carried out on all the relevant countries. This will therefore have to be further verified by estimations and calculations. The estimations and calculations of all the expected up-coming costs would need to be put on the table early on in the process so that everyone is aware of what the consequences of an implementation would be. A cost vs. benefit analysis would then have to be carried out taking into consideration all relevant aspects and consequences of an implementation. The result of this kind of analysis will then provide the basis for a decision on how and if to proceed with the implementation of the suggested solution. To give the reader some kind of indication on the possible cost implications of an implementation of this kind, a general cost analysis has been carried out on the local market of Germany and it will be presented next.

6.8.2 COST ANALYSIS – GERMAN MARKET

Before we look at the figures and the results of the cost analysis on the German market, let us just revise what relevant cost items we are dealing with today in the present distribution setup that will be affected and what new cost items an implementation of a direct delivery distribution structure would result in.

The relevant cost items concerning the distribution of spare parts as it is setup in Germany today mainly comprises:

- Transportation costs for shipments from Malmö warehouse to the local warehouse in Munich
- Transportation costs for shipments from DC Mirandola to the local warehouse in Munich
- Transportation costs for shipments from the local warehouse in Munich to customers and service technicians

- Local warehouse personnel costs
- Inventory scrapping costs because of obsolete spare parts at the local warehouse

After an implementation of the direct delivery situation, the relevant cost items to be taken into consideration would be:

- Transportation costs for shipments from Malmö warehouse to customers and service technicians in Germany
- Transportation costs for shipments from DC Mirandola to Malmö warehouse
- Transportation costs for shipments of local spare parts from the local warehouse in Munich to customers and service technicians
- Additional Malmö warehouse personnel costs

In a direct delivery setup there will most certainly not be a need for 2 warehouse individuals handling the picking and packing of the local spare parts in the local warehouse in Munich. However, the working load will most certainly increase at the warehouse in Malmö. Assuming that the salaries for warehouse personnel are roughly similar in Germany and Sweden, these two cost items could be seen as equal and ignored in the analysis. Another thing to take into consideration is that fact that some cost items are onetime investments or onetime savings, i.e. they should only be included in the cost analysis once, whereas the other cost items are recurring annual costs or savings and should be included in the long term cost analysis. The different relevant cost items have been estimated and calculated according to the following table and are discussed below:

Table 6.15 General cost analysis - Germany

Annually recurring costs	Costs today (€)	Future costs (€)
1. Malmö WH - Munich warehouse	40 000	-
2. DC Mirandola - Munich warehouse	5 000	-
3. Munich warehouse - customers and service technicians	65 000	8 000
4. Obsolescence costs	30 000	-
5. Malmö WH - customers and service technicians	-	210 000
6. DC Mirandola - Malmö WH	-	5 000
	140 000 €	**223 000 €**

Onetime investments & savings	Investments (€)	Savings (€)
7. IT integration (Scout – SAP)	13 500	-
8. Reduced inventory	-	400 000
	13 500 €	**400 000 €**

Cost item comments

1. The transportation cost for shipments from the warehouse in Malmö to the local warehouse in Munich was estimated with the use of a series of invoices which were then multiplied so that an annual value could be retrieved. The value of 40 000 € comprises both standard shipments with Transfargo and courier express shipments by UPS, each representing 20 000 € of the total cost. In the new setup this cost would not be present. Only some very critical items would be shipped to the local warehouse, but due to the assumed low cost of these shipments it is neglected here.

2. The transportation cost estimate for shipments from DC Mirandola to the local warehouse in Munich has been based on a previous analysis carried out at Gambro as well as on a comparison with cost item 1 and the percentage share of value of Dasco spare parts compared to Lund spare parts. This cost would naturally not be present in the new setup.

3. The transportation cost for shipments from the local warehouse in Munich to customers and service technicians has been based on an exact annual cost record provided by technical service in Germany. This cost has also been verified at a later stage when true cost records for these shipments were provided by UPS. In a direct delivery setup, the local warehouse would still ship local spare parts to customer and service technicians. The cost of 8 000 € has been estimated based on the percentage share of all the shipped spare parts during one year that are locally supplied.

4. The obsolescence cost item has been based on the analysis made earlier in this chapter and it must be pointed out that this value is most uncertain and can therefore be both higher and lower in value. The reasoning behind a value of 30 000 € is that the risk of obsolescence is particularly high for those spare parts that have a status of withdrawn or in phase-out. In table 6.2 the local sales warehouse inventory value of these spare parts were presented. A total inventory value of roughly 50 000 € were withdrawn and 56 000 € were in phase-out, a total of 106 000 €. It could be assumed that a substantial amount of these spare parts will not be used and they will as a consequence become obsolete. For example, if one looks at the 52 - ∞ WOI range in table 6.2, the total inventory value of the withdrawn and in phase-out spare parts is approximately 55 000 €, whereas the shipped value during one whole year for these spare parts has been 5 400 €. It could therefore perhaps be fair to say that a value of 30 000 € as an annual cost of obsolescence is justified. In the future scenario these obsolescence costs would not be present as there would be no inventory at the local warehouse and there would be no increase of inventory at the warehouse in Malmö.

5. The transportation cost for shipments from the warehouse in Malmö to customer and service technicians in Germany was completely estimated and based on a file provided by UPS containing a 3 month shipment weight and cost record on a per shipment level of spare parts

shipped by UPS from the local warehouse in Munich to customers and service technicians. Together with actual tariffs and rates for shipments from Sweden to Germany, a total cost was retrieved for these 3 months of shipments as if the shipments had been carried out from Sweden instead of Germany. This total cost was then multiplied in order to get an annual cost. Also, this annual total cost was then reduced so that the shipment of local spares would not be taken into consideration. A percentage value as the one used for cost item 3 was used here as well. The result after these calculations was an annual total cost of approximately 210 000 €.

6. The same cost of transportation that was estimated for cost item 2 was assumed here as well. It is hard to come up with an estimation of what the real costs would be for transportation of spare parts from DC Mirandola to the warehouse in Malmö in the future scenario. One need to bear in mind that in a direct delivery setup all spare parts produced and sourced in Dasco would be transported to the warehouse in Malmö and this would be shipped by truck. Assigning a transportation cost for only one market in such a situation is difficult or even impossible. Therefore, the same cost as it is today has been used for the future scenario. It will however probably be smaller.

7. The one time investment of 13 500 € is based on an estimation made by the Swedish IT-department concerning the necessary IT integration between Scout, the local ERP system in Germany, and SAP. Since external consultants would probably need to be involved in this, an hourly rate of 100 € for these has been used, as suggested by the IT representatives. The time estimation given by them of 120-150 hours has resulted in a average total cost of 13 500 €. Important to note is that this only concerns the SAP side of the integration. Work would have to be done on the German side as well. This would however be done by their IT-department and it would most likely be carried out by internal staff. No costs have therefore been assigned to their part of the development of the interfaces.

8. The one time saving of 400 000 € is related to the reduced inventory at the local warehouse which is a direct consequence of implementing a direct delivery solution. All Gambro produced or sourced spare parts would be removed from the local warehouse in Munich and sent back to the warehouse in Malmö, where they would enter the normal flow. No safety stock increases would probably be needed at the warehouse in Malmö as a direct effect of this change and the total inventory value would therefore be reduced eventually. The 400 000 € are the sum of the Munich local sales warehouse inventory value of spare parts sourced from Lund and Dasco, according to table 6.3.

Cost analysis conclusion

What these figures imply is that the onetime investments and savings would result in a positive result of 386 500 €, whereas the annual cost analysis results in a negative number of 83 000 €. This means that according to these presented estimates and calculations, there would be an increase in annual costs of 83 000 €, with a onetime saving of 386 500 € if this solution would be implemented. This is not a good result from a business case point of view. Using an estimated cost of capital of 16 %, the onetime saving of 386 500 € would generate earnings of 61 840 € during the first year, which would not cover up the increase in annual costs of 83 000 €. In the long-term, if these values would prove to be true, the direct delivery solution would therefore result in a loss. Before a decision is made however, there are some additional things to keep in mind.

First of all, we have now only been looking at the German market and what the cost implications would be if an implementation would be carried out only for this single country. If a direct delivery setup as the one discussed in this chapter would be implemented, France and Italy would be included in this process as well. In order to get a complete view of the future cost implications, a complete cost analysis would therefore have to be made including all these three countries. It is very possible that the final result of such an analysis would prove to be positive. The reduced inventory in France only for example, would result in a onetime saving of roughly 570 000 € according to table 6.9, whereas the IT integration cost would be about the same as for the Germany case, namely 13 500 €.

In connection to this, it is also important to bear in mind that there are big differences today when it comes to the transportation expenses that the different technical service organizations are experiencing. We saw in the analysis that this cost item equals roughly 65 000 € in the case of Germany. When compared with other countries, this number is very low. In France for example, the yearly transportation costs for shipments from the local warehouse to customers and service technicians is approximately 300 000 €, almost five times the number in Germany. This number increases the suspicion that a positive result could possibly be achieved in a total cost analysis taking into consideration all three countries. The French technical service organization is not using UPS for its shipments. In a direct delivery setup, all shipments from the warehouse in Malmö would be carried out by one single package delivery company to Germany, to France and to Italy. In the cost analysis above, the rates and tariffs that have been used are not necessarily the ones that would be used in this possible future scenario. It is most likely that better terms and discounts could be arranged, thus further reducing the total transportation costs for shipments out from the warehouse in Malmö to the local markets.

In the cost analysis above, only the inventory of the local sales warehouse in Munich has been taken into consideration. The spare parts in the service technicians' vans have thus been left out. As section 6.4 showed, a large part of the inventory that is located in the service vans today would most definitely do more good if it would be kept centrally. If such an action would be carried out, moving some percentage amount of the service vans inventory back in the chain, this would further increase the onetime savings of 400 000 € as this part of the inventory would also be reducing the total inventory value. The same reasoning goes for the obsolescence cost estimation given above. The big amount of inventory that is kept in the service vans increases the risk of obsolescence and this could probably also be further reduced if some of the inventory in the vans would be moved back in the supply chain.

Other aspects that have not been taken into account in the cost analysis are those effects or advantages that an implementation of a direct delivery distribution structure brings along, but which have not been possible to quantify in monetary terms. As has already been pointed out there would be increased availability at the DC since only "real" orders would be handled and shipped. As a consequence there would no longer be any consolidated orders from the concerned countries with demand peaks depleting the whole DC safety stock. This would in turn improve customer service levels in the whole Gambro organization which would most certainly have an effect on the end customers. The future income that these satisfied customers will generate is hard to estimate, but good service levels will surely contribute to the success of these future sales.

6.9 DISTRIBUTION ALTERNATIVES SUMMARY

Let us round this chapter up by putting together a general overview of the two distribution alternatives that have been considered in this chapter in table 6.16.

Table 6.16 Distribution Alternatives Summary

Distribution Alternative	Consequences	
	Positive	Negative
Local Sales Warehouse Replenishment	▪ Reduced or eliminated demand peaks ▪ Increased availability ▪ Less administrative work ▪ Easy to implement	▪ Increased warehouse workload
Direct Delivery	▪ Increased availability ▪ Reduced total inventory ▪ Less administrative work ▪ Obsolescence risk reduced ▪ One central spare part inventory	▪ IT integration necessary ▪ Possibly higher transportation costs

7. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this chapter is to present some general conclusions regarding the empirical findings and the analysis from the preceding chapters as well as the recommendations of the author on how to proceed with the two alternatives discussed earlier. Future action steps in order to reach the desired goals are also presented. Finally, some discussions concerning other aspects of relevance to the subject of this these will be given.

7.1 CONCLUSIONS

The purpose of this thesis was to examine and evaluate the possibilities to solve the problem with fluctuating spare part demands from the Gambro local sales offices in the three big markets in Europe, with a special focus on Germany and France. In connection to this, an investigation of the possibilities to implement direct distribution of spare parts in these countries and the different implications such an action would imply was also mentioned as a desired outcome from this thesis.

The different problems related to the issues mentioned above as well as in chapter 1 were made clear in chapter 5 when an in-depth description of the relevant organizational, technical and administrative aspects of the distribution structure as it is structured today was presented and discussed. Many things of importance were mentioned in this chapter and these provided for an understanding of the current situation and set the base for the upcoming discussions. It became clear that technical service as a function constitutes an important part of Gambro's overall business in both Germany and France. Although the organizational structures in both these countries differ from each other, many similarities could be found such as service contracts for the different machines as well as the roles of the service technicians and the back office personnel in each country. Different information technology aspects were considered and the importance of the several information systems involved in the supply of spare parts were highlighted. This chapter also revealed the fact that the problem with fluctuating demands at the DC level is only one of many identified issues which are present in the Gambro supply chain of spare parts.

In chapter 6 the results from a series of numerical analyses were presented. From these results, conclusions could be drawn concerning the inventory situation in Germany and France as well as the movement of spare parts both from the DCs to the local sales warehouses and from the local sales warehouses to customers and service technicians. It became evident that the total spare part inventory value in both these countries is remarkably high, especially when compared to the shipped value of these spare parts during a period of one year. The problem with fluctuating demand was also illustrated in a detailed way, making the issue obvious to the reader. These analyses were followed by a more qualitative discussion regarding possible future solutions. Two different solutions were suggested and discussed in detail: a consumption-based replenishment of the local warehouses and a direct delivery distribution structure.

I think that the facts and figures that have been presented and discussed throughout this thesis to some extent speak for themselves. There is no doubt that high fluctuating demand from the sales subsidiaries cause availability issues at the DC level and as a consequence orders are put on backorder resulting in longer lead times for many customers in other countries. The goodwill damages and upset customers that these availability issues are causing are hard to quantify, but they are most certainly present. As the preceding chapter has shown, these frequent high demand peaks are in most cases a result of certain ordering routines that have been adopted at the sales subsidiaries, which are not reflecting the true demand that is experienced in the local market at the time of ordering. What has also been shown is that the solutions suggested in chapter 6 would eliminate these high demand peaks and thus increase the availability at the DC level which in turn would improve customer service levels. From a logistical point of view the results and discussions presented imply that something should definitely be done.

However, since other organizational entities are involved, it is always important to look at things from their point of view as well. Technical service and in particular the Gambro employed service technicians are the only ones in the entire Gambro organization that are in contact with end customers on a daily basis. This makes them and the work that they carry out extremely important. Just like the case with any person doing some work for somebody, service technicians have a desire to perform their best and make the customer fully satisfied with his or her services when performing a repair or maintenance action on a Gambro machine. The technician wants to be able to help the customer as fast as possible and in the best way possible. In order for service technicians to be able to fully meet the demands of the customer, they need to have access to spare parts, preferably directly available in their car. From a service technician point of view, it is therefore no surprise that much inventory is being kept locally, even though a large part of it has not been moving for quite some time. Service technicians rarely have to think about the costs of high inventory and other problems that are a consequence of high inventory in the wrong places. The same reasoning can be applied for the sales subsidiaries in the concerned countries. They prefer to have big inventories close to their end customers so that they will be able to rapidly supply these with spare parts when needed. Although these facts justify to some extent why high inventory is being kept in the local warehouses and in the service technicians' cars, they do not give good reasons for the ordering of big quantities, which cover several weeks or months of demand, from the DCs in Lund and Mirandola.

As we have seen, these demand peaks can be eliminated or at least dramatically reduced by adopting one of the suggested solutions, without interfering with the availability of spare parts in the local markets in any negative way. Instead, both solutions seem to improve the availability of spare parts at the DCs substantially and as a consequence improve the availability of spare parts in all local markets. This is a direct effect of the fact that in these scenarios only real demand is supplied from the DCs to the local markets. Even though the focus of this thesis has not been to question the high local inventories, the results presented in this thesis do show that there are probably many possible improvements than can be accomplished on this end as well, for example by moving slow moving spare parts back in the supply chain. The most notable consequence of high inventory that was highlighted in the preceding chapter was the high risk of obsolescence that was evidently present in the studied markets.

I believe that by adopting one or both of the suggested solutions in this thesis, improvements would be noticed both on inventory levels and costs as well as on customer service levels. Usually these two features do not go hand in hand. The conclusion that a simultaneous improvement of these aspects is possible, again stresses the reason why something should be done. As with any organizational changes, it is hard at an initial stage of the process to predict all the possible hurdles that may appear on the way towards the final goal. The important thing, however, is not that everything is clear from the beginning or that every single thing works out as planned. The important thing is instead that every change made is a step in the right direction. I believe that the two solutions that have been presented and discussed in this thesis both constitute actions which are pointing the steps in this direction.

7.2 RECOMMENDATIONS

Given that the main purpose of this thesis was to find a solution to the fluctuating demand problem and the secondary purpose was to look into the direct delivery possibilities of spare parts to the non-SAP countries, my recommendation is that Gambro adopts a two-step implementation plan. The two suggested solutions in chapter 6 are not necessarily mutually exclusive. Since all cost implications of a direct delivery distribution structure has not yet been fully identified and verified and since that specific solution requires substantial amounts of both time and money it could be a good idea to combine the two suggested solutions:

Phase 1: Local Sales Warehouse Replenishment

Phase 2: Direct Delivery

In the first phase, the consumption-based replenishment of the local sales warehouse would thus be implemented. As we saw in the preceding chapter this solution will most probably solve the issues with high fluctuating demands and in the same run increase availability at the DC. It is also a very straightforward solution which does not require much investment in time or in money. Parallel to this, the work with planning and organizing the work related to a direct delivery implementation could be initiated. Although a decision concerning a future distribution structure with only one DC and direct delivery to all markets has to some extent already been made at Gambro, it could be good to make a cost analysis similar to the one made for Germany for all the concerned markets in order to get a sense of what the cost implications could possibly be and then decide on how to proceed.

Important to bear in mind is that it is possible that sometime in the future, SAP will be implemented in the non-SAP countries such as Germany, France and Italy. However, as we saw in the cost analysis section in chapter 6, the IT integration cost is not the major or decisive one. First of all it is a onetime investment and as we saw the onetime savings are of a much greater value. Instead it is the long-term costs that are of most relevance and especially the transportation costs. Even if SAP would be implemented in these countries the way of transportation would still be the same. It would only affect the process administratively and system-wise.

This thesis has focused on the two markets of Germany and France. The same conclusions and results could however be applied on the Italy market as well. If a direct delivery distribution structure will be acknowledged as a suitable solution, I suggest the following long-term implementation plan for all these three countries:

Table 7.1 Long-term implementation plan

Period		Germany	France	Italy
2010	Q1	Phase 1		
	Q2			
	Q3	Phase 2	Phase 1	
	Q4	Phase 2		Phase 1
2011	Q1		Phase 2	
	Q2		Phase 2	Phase 2
	Q3			Phase 2
	Q4			

Germany has been chosen as the first country to adopt the Phase 1 mostly because of the proximity to Lund and that they have the least complicated information system structure in place. Initial discussions regarding Phase 1 and Phase 2 have also already been carried out with the technical service representatives in Munich and consensus has been gained on all relevant points. It therefore seems as the most natural way to start with Phase 1 in Germany. The outcome of this implementation could thereafter be used as a, hopefully, good example when the solutions are to be presented to and discussed with the French and the Italian technical service organizations. After consensus has been gained with representatives from these organizations it should not be difficult to apply the same Phase 1 implementation in both these countries simultaneously. The direct delivery distribution structure, Phase 2, is more complicated and more time should be devoted in order to fully prepare all involved parties for the implementation of this solution. Once again, it seems as if Germany at the moment is best suited to have this kind of solution implemented. More complications can arise when integrations between SAP and Minos and SIA are to be constructed, and these should therefore be initiated after a working solution in Germany has been fully implemented.

The full effect of reduced demand peaks and higher availability at the DC level will be possible only when a consumption-based replenishment of the local warehouses in all markets have been successfully implemented. Of course Germany, France and Italy are top priority in this sense since they are ordering high quantities compared to other smaller markets. It's important however that other big countries such as the US and Canada are taken into consideration as well. Otherwise, the countries that are replenished in a consumption-based manner will suffer the most if there will still be countries that continue to place big orders which in turn deplete the DC stock. Efforts should therefore be made in order to have all markets supplied with spare parts only when there is a true local demand. When Phase 1 has been implemented in the European countries, actions should be taken to implement a similar solution in both the US and in Canada. Canada has SAP implemented and the US will have SAP up and running in the beginning of 2010. Therefore no special procedure, as the one with QlikView, has to be arranged for these both markets. Instead, a simple weekly MRP procedure could most certainly be setup and constructed in SAP in order to make the supply of spare parts to both these countries consumption-based. This would further reduce the demand peaks at the DCs and thus increase availability. With Canada, however, the fact that their spare part inventory is maintained and controlled by a third party may increase the complexity and cause practical problems in this aspect.

7.2.1 IMPLEMENTATION ACTION STEPS – PHASE 1

The necessary actions that need to be executed for each country prior to a full implementation of Phase 1 in Germany, France and Italy have been summed up in the table below. In the case of Germany, some of these action steps have already been initiated by the responsible individuals.

Table 7.2 Implementation action steps – Phase 1

Action	Responsibility
1. Identification of target products	SCM/TS
2. Defining units of measurement and minimum order quantities	DC
3. Target quantity setting	TS
4. QlikView validation	SCM
5. Establishing the QlikView calculation process	SCM
6. Replenishment procedure outline	SCM/TS
7. Purchase order creation process definition	SCM/TS/IT
8. Sales order creation process definition	SCM/DC

1. First of all, it has to be decided what spare parts should be included in the replenishment process. As has already been discussed, in order to gain full effect of the implementation all spare parts sourced and produced in Dasco and Lund should be included. Locally sourced spare parts as well as repairable spare parts should however not be a part of this process. This is how it has been decided for Germany but it is something that has to be discussed and agreed on with the technical service organization in each country.

2. For all the spare parts that are to be included in the replenishment process, units of measurements and minimum order quantities from the DCs has to be defined. This is important since it will affect the replenishment proposal calculations carried out in QlikView. The main responsibility regarding this matter lies on both DCs in Sweden and Italy for their respective products. This should however be synchronized with technical service and the local systems in the concerned countries.

3. When the two preceding action steps have been taken care of, the target quantities of all spare parts to be included in the process must be set. The final decision on what these quantities should be is the responsibility of the concerned technical service organization, although the SCM group could probably make a proposal for these as well if necessary, for example using "Slim Supply". In theory, these quantities would comprise a safety stock quantity and an estimated average demand during the period between two replenishments. All these quantities will be kept and maintained in an Excel-file.

4. In order for the consumption-based replenishment process to function properly, all necessary information from the local ERP systems need to be transmitted to QlikView and then validated. What this means in practice is that the relevant INS-files, more specifically INS001 (actual inventory), INS002 (open customer orders) and INS006 (open purchase orders) that are being read into QlikView from Scout, Minos and SIA need to include the relevant stock locations for the local warehouses in each country. When this information has been included in the files, some minor QlikView changes need to be carried out in order for the information to show up properly and as desired. The information that becomes visible in QlikView should also be validated with the true stock and order information that can be extracted from the raw INS-files. This action step may require some QlikView consultancy hours. It is important however that everything in QlikView is setup correctly before proceeding to action 5. The main responsibility of this and the next action step lies with the SCM group.

5. When everything that should be visible in QlikView is in place, the replenishment proposal calculation algorithm has to be defined and implemented into QlikView. A separate application in QlikView will be used for this. The calculation algorithm to be used can be of varied complexity. It should however be sufficient to compare actual inventory levels with the set target quantities and have the algorithm take into consideration open purchase orders and

minimum order quantities. It is also possible to include open customer orders into the equation. There is one situation when this would be necessary to include. If technical service in for example Germany would receive an order from a customer for a quantity higher than the actual local inventory and the set target in the local warehouse and no part shipment would be made, QlikView would not make a replenishment proposal since the actual inventory would not be reduced with any quantity. If open customer orders are not included in the algorithm, this customer order will never be fulfilled. The question is whether this is a possible scenario and whether this would not be detected in any other way by the technical service back office personnel. Including open customer orders in the algorithm would solve this issue.

6. An agreement has to be gained between the SCM group and the technical service representatives in each concerned country as to when and how often this kind of replenishment should be carried out. The most natural solution would be to have weekly replenishments since this is the most common order frequency today. When all three countries will have Phase 1 fully implemented, there will be 6 replenishment proposals generated every week, three per each DC. It also has to be decided on how updates and exceptions should be taken care of. The most feasible solution would be to let the technical service be in charge of all relevant updates. They should therefore be responsible for managing the Excel-file with target products and target quantities and synchronizing all updates with the SCM equipment group so that everyone involved knows what is in use and what is not. The calculation of new target quantities could also be done by the SCM equipment group on a regular basis and then proposed to the technical service organization.

7. As was stated in the preceding chapter and depicted in figure 6.14, the SCM equipment group will first send the replenishment proposal generated by QlikView to the technical service back office personnel who will check it and make adjustments only when something extraordinary calls for it. SCM will then create the necessary purchase orders automatically in the local ERP system. This automatic purchase order creation has yet to be setup for each concerned country. Although this is most probably not a complicated thing to implement, it is best if the SCM equipment group first get authority and learn how to create these kind of purchase orders manually in Scout, Minos and SIA. The SCM replenishment group is today already creating PO's in all these systems, with the exception that the receiving destination for all these purchase orders are the DCs for finished products and not the local spare part warehouses. The SCM equipment group should therefore get in contact with the back office personnel in Germany, France and Italy and get detailed instructions as to how they usually place purchase orders to DC Lund and DC Mirandola, what parameters they need to enter and so on.

8. The last part of the Phase 1 implementation plan is to define the sales order creation process. This is not a complicated action. The back office personnel at the DC in Lund and in Mirandola only have to be informed about the new ways of ordering from the local sales

warehouses. Instead of receiving weekly or biweekly orders from the technical service back office personnel the DC back office personnel will receive weekly orders from the SCM equipment group. Otherwise everything works as normal.

7.2.2 DIRECT DELIVERY

As has already been stated, the direct delivery solution, Phase 2, requires more preparatory work before it can be implemented. Although, according to the IT department in Lund, the technical aspects of the integration are not as complex as one might think, it is time-consuming to have all required steps in the final process completely defined and agreed on with all involved parties. It is therefore important to initiate these discussions as soon as possible. A final decision regarding the "one spare part DC" - location should be made by top managers, since having only one spare part DC is a prerequisite for this solution to be feasible. Transportation alternatives should be decided on and tariffs and discounts should be negotiated with the most suitable package delivery company as was discussed earlier in the preceding chapter. A deeper cost analysis than the one carried out for Germany comprising all relevant markets should also be conducted if deemed necessary.

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Gambro Intranet

UPS shipment rates and tariffs

APPENDIX A

PATIENTS - REGIONAL DEVELOPMENT (2008)

North America	445,500	4 - 5 %
(U.S.)	(370,000)	(3 - 4 %)
Europe/Africa/Middle East	520,000	5 - 6 %
(EU)	(300,000)	(3 - 4 %)
Asia-Pacific	620,000	10 - 11 %
(Japan)	(290,000)	(3 - 4 %)
Latin America	185,000	7 - 8 %
WORLDWIDE	1,770,000	7 %

Figure A1 Regional development of dialysis patients with annual growth rates[113]

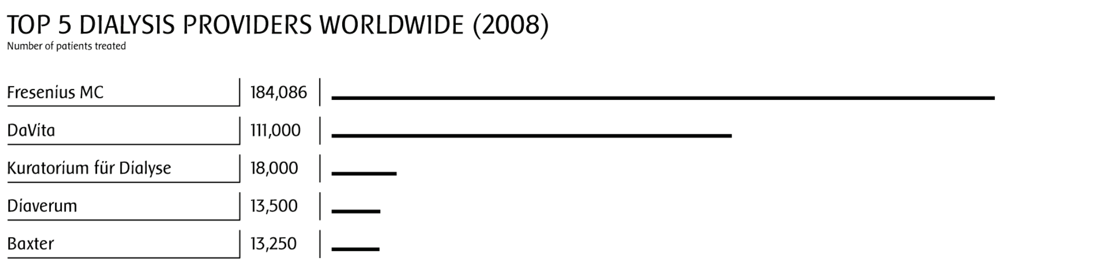

Figure A2 Top 5 dialysis treatment providers worldwide according to number of patients[114]

MARKET POSITION IN MAJOR PRODUCT GROUPS (2008)

	Rank 1	Rank 2	Rank 3
Dialyzers	Fresenius MC	Gambro	Asahi
Dialysis machines	Fresenius MC	Gambro	Nikkiso
Hemodialysis concentrates	Fresenius MC	Fuso	Gambro
Bloodlines	Fresenius MC	Gambro	Kawasumi
Peritoneal dialysis products	Baxter	Fresenius MC	Pisa

Figure A3 Market position in major dialysis product groups[115]

113 http://reports.fmc-ag.com/reports/fmc/annual/2008/gb/English/401040/dialysis-market.html (2009-11-02)
114 ibid.
115 ibid.

APPENDIX B

Table B1 Germany Sales Total Inventory vs. Shipments

Weeks of inventory		SKU's	% of SKU's	Inv. Value €	% of Value	Shipped Value €	% of Sh. Value
0	6	16	1%	7 441	0%	117 291	7%
6	12	27	1%	11 960	1%	68 796	4%
12	26	124	5%	201 907	12%	566 533	36%
26	52	223	9%	378 271	22%	562 704	36%
52	∞	2 215	85%	1 116 372	65%	266 752	17%
		2 605		**1 715 952**		**1 582 077**	

Table B2 Germany Sales Total Inventory vs. Shipments (product status)

WOI		Active			Withdrawn			In Phase-out			Unknown		
		Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €
0	6	11	5 391	95 422	4	1 789	17 493	1	261	4 376	0	0	0
6	12	17	3 865	23 059	8	8 074	45 611	2	21	126	0	0	0
12	26	99	166 366	484 440	13	11 311	23 992	12	24 231	58 101	0	0	0
26	52	176	332 231	500 080	36	39 081	53 055	11	6 959	9 570	0	0	0
52	∞	1 504	845 256	226 988	413	150 262	15 231	242	113 195	23 748	56	7 660	785
		1 807	**1 353 110**	**1 329 990**	**474**	**210 516**	**155 381**	**268**	**144 666**	**95 922**	**56**	**7 660**	**785**

Table B3 Germany Sales Total Inventory vs. Shipments (supplying location)

WOI		Lund			Dasco			Local			Other			Unknown		
		Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €
0	6	9	2 490	24 082	2	26	232	4	4 664	88 601	1	261	4 376	0	0	0
6	12	15	9 534	54 350	8	980	5 265	3	534	2 798	1	912	6 383	0	0	0
12	26	83	150 749	429 771	20	7 493	19 027	17	35 293	98 653	4	8 372	19 081	0	0	0
26	52	140	276 279	418 724	60	60 885	83 031	19	41 025	60 868	4	82	82	0	0	0
52	∞	1 108	679 647	173 665	599	194 665	44 229	343	219 837	47 615	109	14 563	457	56	7 660	785
		1 355	**1 118 699**	**1 100 594**	**689**	**264 050**	**151 784**	**386**	**301 353**	**298 535**	**119**	**24 190**	**30 379**	**56**	**7 660**	**785**

APPENDIX C

Table C1 France Sales Total Inventory vs. Shipments

Weeks of inventory		SKU's	% of SKU's	Inv. Value €	% of Value	Shipped Value €	% of Sh. Value
0	6	95	3%	72 354	5%	1 337 389	29%
6	12	158	5%	252 062	16%	1 434 501	31%
12	26	408	14%	436 864	28%	1 323 051	29%
26	52	437	15%	263 024	17%	370 169	8%
52	∞	1 839	63%	542 876	35%	158 551	3%
		2 937		**1 567 179**		**4 623 660**	

Table C2 France Sales Total Inventory vs. Shipments (product status)

		Active			Withdrawn			In Phase-out			Unknown		
WOI		Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €
0	6	64	44 968	727 112	13	7 326	215 060	15	18 381	357 439	3	1 679	37 778
6	12	142	236 638	1 316 846	5	11 348	92 631	8	4 033	24 821	3	42	202
12	26	346	370 129	1 101 840	24	27 704	104 770	33	37 777	113 604	5	1 254	2 838
26	52	384	248 321	351 610	24	7 828	9 668	23	6 456	8 471	6	420	420
52	∞	1 186	406 120	132 759	282	67 569	14 471	296	64 523	11 186	75	4 664	135
		2 122	**1 306 176**	**3 630 168**	**348**	**121 774**	**436 600**	**375**	**131 170**	**515 521**	**92**	**8 059**	**41 371**

Table C3 France Sales Total Inventory vs. Shipments (supplying location)

		Lund			Dasco			Local			Other			Unknown		
WOI		Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €	Q	Inv. V. €	Sh. V. €
0	6	36	28 338	524 597	26	20 106	364 479	21	15 642	336 246	5	6 203	58 996	7	2 065	53 071
6	12	72	133 169	802 158	43	104 238	553 395	33	13 733	73 882	6	782	4 080	4	140	985
12	26	214	223 349	667 652	110	172 779	533 687	64	34 336	105 289	15	5 147	13 586	5	1 254	2 838
26	52	224	127 820	171 620	139	101 746	152 069	56	30 811	43 537	12	2 228	2 523	6	420	420
52	∞	908	286 104	79 732	462	175 165	65 694	188	41 537	8 974	194	35 065	4 016	87	5 005	135
		1 454	**798 779**	**2 245 759**	**780**	**574 034**	**1 669 324**	**362**	**136 058**	**567 928**	**232**	**49 425**	**83 202**	**109**	**8 883**	**57 448**