Logistics and Transport Management
Master Thesis No 2003:9

COORDINATION OF INBOUND LOGISTICS FLOWS

A CASE STUDY OF TERMS OF DELIVERY FOR THE SUPPLY OF COMPONENTS FROM EXTERNAL SUPPLIERS TO SKF FACTORIES

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ISSN 1403-851X
Printed by Elanders Novum

Abstract

Changes as the increasing globalization, changes in customer expectations and preferences, consistent technology advances in manufacturing and communications areas, as well as the increasing demand for social and especially environmental responsibility, forces the companies to revise their processes in order to stay competitive in the marketplace. Revising the inbound logistics flows is not an exception.

The purpose of this study is to determine the most advantageous Term Of Delivery for SKF factories by mapping and evaluating the current inbound flows of components from suppliers to SKF factories in Europe. Furthermore, the purpose is to evaluate the improvement potential of using the most favorable Terms Of Delivery by identifying flows that have such possibilities of improvement. In addition, other possible improvements related to the inbound logistics will also be analyzed and presented.

The result of this research is that SKF should revise the use of certain delivery terms that are applied today and choose the delivery term that provides the company with the most responsibility and cost undertaking when it comes to inbound transportation. Thereby, SKF obtains the greatest possible control of the goods flows into and from the company. By having control of the goods flow, a company can make warehousing, production and transports more efficient, create routines and thereby cut costs. Three different suggestion alternatives are presented as possible improvements related to a coordination of mapped inbound flows.

Acknowledgments

Co-writer of this master thesis is Kristian Klasson, who is not part of the Masters Programme in Logistics and Transportation at Graduate Business School. Kristian Klasson has written this thesis in order to obtain his Degree of Master of Science in Business Administration, at the Department of Business Administration, School of Economics and Commercial Law, Gothenburg University.

It has been an exciting and instructive semester and we feel privileged to have had the opportunity to carry out this thesis at SKF, a company with long tradition within the manufacturing industry. This thesis has given us a great insight in SKF's activities and understanding for the company's logistics processes.

With these acknowledgments, we would like to thank all people who helped us throughout this thesis.

First, we would like to thank our supervisors at SKF Logistics Services, Jonas Dahlqvist and Jims Chu, for their helpful advices, coaching and encouragement. Next, we would like to thank Yngve Ohlsson and Mats Kjellberg as well as all other personnel at SKF Logistics Services who have contributed with valuable inputs and guidance. Special thanks to Björn Zeidler at SKF Group Purchasing for his support and valuable inputs.

Furthemore, we would like to thank all the people that were involved in our empirical research. Special thanks to all the purchasing managers and their staffs within SKF Group Purchasing that have participated in this study. Without their contribution, this thesis would not have been possible. We would also like to thank Stig Arvidsson and other personnel at Goods Reception, Niklas Wallenlind and Carl Johan Gentzel at Supply Chain Medium Bearings in Gothenburg.

Moreover, we would like to express our gratitude to Leif Enarsson, our supervisor at the School of Business and Commercial Law, Gothenburg University, for his inspiration and endless support along the way.

Furthermore, we express thanks to our opponents Viktoria, Marcus and Per for their helpful critique and valuable inputs. Finally, yet importantly, we would like to thank our families for always being there for us.

Göteborg, December 2003

Kristian Klasson Alina Tunovic

Table of Contents

List of Figures

List of Tables

List of Abbreviations

This list covers all the abbreviations used in this thesis, except the abbreviations for the Terms Of Delivery, which are described in Section *3.4 Terms Of Delivery*.

DTS	Daily Transport Service (Offered by SKF LS)
EU	The European Union
EUR	The official abbreviation for Euro.
FPM	Factory Purchasing Manager
FTL	Full Truck Load
GPM	Global Purchasing Material (within SKF)
GTS	Global Tracking Service (offered by SKF LS)
LTL	Less Than a Truck Load
SKF	Svenska Kullagerfabriken
SKF GPO	SKF Group Purchasing Office
SKF LS	SKF Logistics Services
SKF LSU	SKF Logistics Services Unit
TOD	Terms Of Delivery
VAT	Value Added Tax

1 Introduction

This chapter introduces to the reader the background of this report. It also describes the problem definition, the purpose of the study, and in conclusion, delimitations and layout of the thesis.

1.1 Background

In recent decades, manufacturing and distribution companies have experienced considerable changes in their business environments. One of the key drivers behind the changes in the business environment is the increasing globalization with a more accessible international market and a harder competition situation for the companies as a consequence.[1]

Also, the changes in customer expectations and preferences, consistent technology advances in manufacturing and communications areas, and the increasing demand for social and especially environmental responsibility can be seen as important key drivers in the business environment.

According to Mattsson, the continual and more and more increasing rate of change has become one of the most demanding challenges of our time. Many of these changes have dramatic implication and influence on individuals, society and the world as a whole. However, the existence of changes also represents the opening of new opportunities.[2]

As the world is becoming more global, the business context of many companies is changing radically. Most changes are not mere trends but the result of large, unruly forces, which have a lasting effect on the world economy.[3]

Globalization is perhaps the clearest example of such changes. It has been intensifying the competition amongst companies in recent decades.[4] The rise in transport, as well as the communication technology, began in the 1970's and accelerated in the 1990's, when it reached a breakthrough in the middle to later part of the decade. Global sourcing of raw materials, components and labor is a

[1] Mattsson, 2000, p 13
[2] Mattsson, 2000, p 14
[3] van Weele, 2002, p 5.
[4] Lambert & Stock, 2002, p 13.

direct consequence of globalization; companies have simply expanded their horizons. The formation of European Union, deregulations in China and its WTO (World Trade Organization) accession, as well as the opening of former Soviet Union and Eastern Europe, have all contributed to expansion of the global market.

Global sourcing has been a widely used concept amongst companies in recent years, as a full liberalization of the world economy caused the break down of financial and trade barriers. These economic changes led to comparative advantages for some markets, where for example, cheapest input factors, best access to and the most efficient use of production resources.[5]

Other widely used concepts in recent years concern customer focus, such as customer satisfaction, customer success and customer loyalty. Satisfying customer demand has always been an important part of company operations. The way of looking at customer satisfaction and its importance has, according to Mattsson, changed during the recent years and is expected to change even more in the years to come.[6]

Perfect order performance, which requires zero defects in logistics operations, is nowadays a matter of course for the customer. The higher demands from the customer have been put on the company to also extend beyond the typical logistical operational considerations to also include factors related to communication, credibility access, responsiveness and customer-specific knowledge as well as the reliability and responsiveness of operations.[7]

Greater focus has been put on the companies and their need to have intimate knowledge about the customer's needs and their operational requirements and thereby obtain customer success and customer loyalty.[8] It is a question of not only creating satisfied customers but also customers that are "delighted" over the performance and the service that has been provided to them and that experience that they have received more than expected.[9]

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[5] Transport & Mobility, Leuven, Learning Logistics, http://www.tmleuven.be/Home/home_en.htm
[6] Mattsson, 2000, p 33.
[7] Bowersox et al., 2002, p 91.
[8] Bowersox et al., 2002, p 91.
[9] Mattsson, 2002, p 126.

Today's companies have to adapt to the new world order and the new economy, by always looking for new ways for improvements and to establish competitive advantages.[10] By dividing the firm into its strategically relevant activities in order to understand the behavior of costs and the existing and potential sources of differentiation, a firm gains competitive advantage by performing strategically important activities more cheaply or better than its competitors.[11]

Because of the fierce international competition, European manufacturing companies need to investigate and pursue all the possibilities for cost reduction, quality improvement and efficiency improvement. Managers are becoming increasingly aware that the largest part of their end products' costs are related to the materials and services purchased from suppliers.[12]

In recent years, effective logistics management has been recognized as a key element in improving both profitability and the competitive performance of firms.[13] For international companies, globalization implies longer distances and more complex logistics operations, which results in increased cost of logistics as a percentage of total cost. Therefore, according to Coyle, Bardi & Novack, the single most important factor for successful international companies is logistics, when procurement is included. Transportation, in particular, has been affected because of the distances involved both inbound to manufacturing from foreign sourcing, and outbound for additional manufacturing or delivery to customers. Transportation may account for as much as 50 percent of the total logistics cost.[14]

Surprisingly few companies take control of their own inbound transportation, and in general, companies exercise less control over their inbound transportation than the outbound transportation. Stock & Lambert mean that purchasing procedures tend to look at total delivered cost and separate analysis of inbound cost is not performed as often or in as much depth. Therefore, significant cost savings are possible.[15]

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[10] Tapscott, 1996, p 4.
[11] Christopher, 1992, p 8.
[12] van Weele, 2002, p 4.
[13] Lambert & Stock, 2002, p 6
[14] Coyle, Bardi & Novack, 2000, p 4..
[15] Stock & Lambert, 2002, p 279.

However, some industries have come further than others when it comes to controlling their inbound logistics movement. Automotive and retail industries are traditional examples where the more strict control of inbound movement has implied great savings and quality of the process. These industries are characterized by having numerous suppliers and complex logistics operations; an automaker may have as many as 10 000 suppliers and thereby very complex supplier network. Logistics operations in the automotive supply chain represent a mayor expense and therefore need for improvements.[16]

1.2 Problem Definition

One way of analyzing the inbound logistics is to see how to apply the current trade standards, Terms Of Delivery, the Incoterms. Since the global sourcing environment is a fact, it is becoming more and more important to understand what effect the Incoterms have on the total cost of the product.[17]

By exercising greater control of the inbound logistics, a firm can leverage its buying power when purchasing its own transportation. It can also consolidate shipments from multiple shippers that previously would have arranged their freight individually.[18]

In addition, a company works directly with the hauler, instead of making a booking with the supplier and waiting for them to come. The supplier costs are reduced since the supplier is not responsible for the delivery and an on-time delivery can be guaranteed. Furthermore, accurate delivery times reduce the amount of inventory that must be kept in stock.[19]

There is a growing number of companies that are beginning to focus on inbound logistics, due to the economic environment and competitive landscape that are forcing companies to find new ways to reduce costs and improve productivity.[20]

[16] Deloitte Research & Stanford Global Supply Chain Management Forum, 2003, *Global Automotive Industry*, p 10.
[17] Shah Baljko, J., 2002, *Incoterms Help Trim Logistics Costs*, EBN.
[18] JoC Week, 2002, *Slicing Costs*, May 29, p 21.
[19] Ibid.
[20] Hannon, D., 2003, *Logistics optimization*, Purchasing Magazine, pp 103.

As the majority of manufacturing companies today, SKF puts a lot of focus on customer satisfaction, and the deep collaboration that the company has with its customers in, among other, product development area. Resources are also put on development of the future technologies and solutions that customers require now and might require in the future.

Logistically, customer satisfaction has been and still is the most important task for SKF Logistics Services, which handles the outbound flow of the SKF products. The customer should get the right product on time, in right quantity, at the right place and to an optimized cost. The customer needs should be met in every way and preferably exceeded.

However, the sort of commitment that is evident between the SKF and its customers is not applied upstream in the supply chain - towards SKF suppliers. The inbound flow did not get as much attention, even though the SKF Group purchases for approximately 23 billion SEK in 2002 and direct material stands for 48% or 11 billion SEK for the same year.[21] The main concern of SKF has been to obtain right quality goods from their suppliers.

SKF Logistics Services, from here referred to as SKF LS, is the part of the SKF Group that provides SKF and external customers with logistics solutions, such as warehousing, transportation, logistics competence and value added services.[22] The focus of SKF LS has previously been put on the processes related to the outbound logistics, however, with this thesis a further step has been taken towards the coordination of the inbound logistics flow.

SKF LS and SKF Group Purchasing Office, GPO, have come to a joint decision to perform a mapping of the inbound transportations as well as the evaluation of current terms of delivery. This in order to evaluate the potential of gaining competitive advantages in the future. The flows to be studied are the supply of components from external suppliers to SKF factories in Europe. There is an interest within the organization to benefit from the buying power of SKF LS and evaluate the potential of also including the inbound transportation in a similar system.

[21] SKF Annual Report 2002.
[22] www.skflogisticsservices.com 2003-10-06

It is difficult to get an overview of the inbound transportation and find out how these should be carried out in the most favorable way, since no standardized routines or common policies for decision of suitable terms of delivery have been used throughout all SKF purchasing offices in Europe. To achieve this, a mapping of current deliveries and terms of deliveries from suppliers and their components is to be done. Hence, following relevant questions are raised:

- Inbound flow characteristics: What are the main characteristics of the inbound logistics flow, from external suppliers to SKF factories, today?

More specific, the mapping of the current inbound logistics flows, quantities, frequencies, cost structure and terms of delivery used, is to be performed. It is important to map the characteristics of the inbound logistics flow in order to get an understanding of the logistics system and its performance.

- Terms of delivery: Which delivery and condition term is most advantageous for the inbound transportation from external suppliers to SKF?

The data obtained in the mapping part of the thesis is studied by comparing different alternatives and presenting a recommendation that enables SKF to establish a most advantageous policy for choosing most suitable terms of delivery for the inbound logistics flow.

This leads to the main problem definition, that is:

Evaluate potential for improvement of the inbound flows within the company, mainly with regard on terms of delivery conditions.

The inbound logistics flows are studied and the flows with most improvement and savings potential are identified and presented in this phase of the thesis.

1.3 Purpose

The purpose of the study is to map the current inbound flows of components from suppliers to SKF factories in Europe, evaluate the gathered data and determine the most advantageous Term Of Delivery for SKF factories. Furthermore, the purpose is to evaluate the improvement potential of using the most favorable Terms Of Delivery by identifying flows that have such possibilities of improvement. In addition, further possible improvements beyond delivery terms will also be analyzed and presented, such as consolidation of inbound flows, possibility to use the resources of the SKF LS and other improvements.

1.4 Delimitations

SKF purchases around 15 major component groups (direct material) from its suppliers, however, there are only 3 components included in this study, Component A, B and C. The number of components is limited due to the limited time period of this study and the complexity of the information needed.

There are 15 SKF factories around Europe that are included in this study. They are presented in detail in the Section *4, The Empirical Framework*. SKF factories in Cassino and Fontenay are not included, since no data was available from these locations.

In total 18 external suppliers to the SKF factories are included in the study and those are the external suppliers of Component A, B or C to the above named 15 SKF factories.

In this thesis flows with the most improvement and savings potential with regard on Terms Of Delivery are identified and presented. The obtained data is analyzed only from the cost perspective, i.e. the risks components (such as insurance, for instance) of the delivery terms are not presented nor analyzed in any way.

1.5 Layout of the Thesis

In *Chapter 2, Method,* the methods that are chosen, as well as the arguments for why they are chosen, are presented.

In *Chapter 3, The Theoretical Framework*, for the study relevant theory is presented.

Chapter 4, The Empirical Framework, consists of the empirical data collected during the study.

Chapter 5, Analysis, includes an analysis of the collected material and comparison with the theory. In this part, the potential for improvement by choosing the most interesting supplier - SKF factory relations is also evaluated.

In *Chapter 6, Conclusions*, the conclusions, as well as the answers to the problem definitions and recommendations are presented.

In the final chapter, *Chapter 7, Discussion*, experiences from the project and alternative work procedures, as well the suggestions for future studies are presented.

For those readers who do not have the intention to read the thesis in its entirety but are still interested in conclusions and findings, we recommend to read Chapter 1 - *Introduction*, Chapter 5 - *Analysis* and Chapter 6 - *Conclusions*.

2 Method

The following chapter describes different approaches of a study, such as analytical, actor and system approaches, case study as a research method, different methods for data collection, and credibility of the study, as these are of relevance to our study. As a conclusion of this chapter, our research model is presented.

2.1 Social Scientific Approaches

All people are unique and have therefore different perception of reality. On the basis on our background and our knowledge, a frame of reference is created, which contains a number of aware and unaware assumptions about reality.[23] This frame of reference reflects how the problem is approached. Arbnor & Bjerke mean that the researchers methodologies of carrying on research is depending on his or her perception of the reality, as this influences how the researcher sees the problem under study. Therefore, is it essential for the researcher to reflect over his or her fundamental perceptions about reality, and what consequences it has to the future research.[24]

To describe different perceptions of reality the concept of paradigm is often used. The word paradigm comes from the Greek and means "pattern" or "example". The philosopher Kuhn defines a scientific paradigm as: [25]

- *What* is to be observed and scrutinized.
- The kind of *questions* that are supposed to be asked and probed for answers in relation to this subject.
- *How* these questions are to be put.
- *How* the results of scientific investigations should be interpreted.

The paradigm is therefore the foundation of a scientific research. Arbnor & Bjerke, 1994, describe six categories of social scientific paradigm that consti-

[23] Lundahl et. al, 1992.
[24] Arbnor & Bjerke, 1994.
[25] http://www.wikipedia.org/wiki/Paradigm

tutes a coherent spectrum. In one extreme, reality described as concrete and regulated by the structure, which is independent from us. According to this perception the social world is equally concrete and independent as the world of nature. Thus, reality can be observed and measured in a concrete manner. Social study subjects assume to result in predicted and defined responses on extern stimuli. The subjects are precise products of external forces from the environment in which they exist. Phenomena that are too abstract and cannot be measured are being rejected.

In the other extreme of the spectra, the reality is described as a manifestation of the human intention. Followers of this paradigm mean that every individual perceives the world as a representation of the individual creative conception ability.

2.2 Methodology Approaches

When it comes to the science, it is important that researchers have become conscious about his or her fundamental conception of the world. But even more important is the researchers consciousness about which approaches that he or she will use when creating knowledge.[26] These approaches can be defined as fundamental perceptions on the structure of reality and science, which has importance for used methodologies in research. The approach can be seen as the link between the researchers paradigm and the research area.

According to Arbnor & Bjerke,[27] there are three main approaches that can be identified within business economics, and these are: analytical, actors and system approach. Further, Arbnor & Bjerke mean that all these can be deduced from different paradigms. See *Figure 2.2-a* below.

[26] Arbnor & Bjerke, 1994.
[27] Ibid.

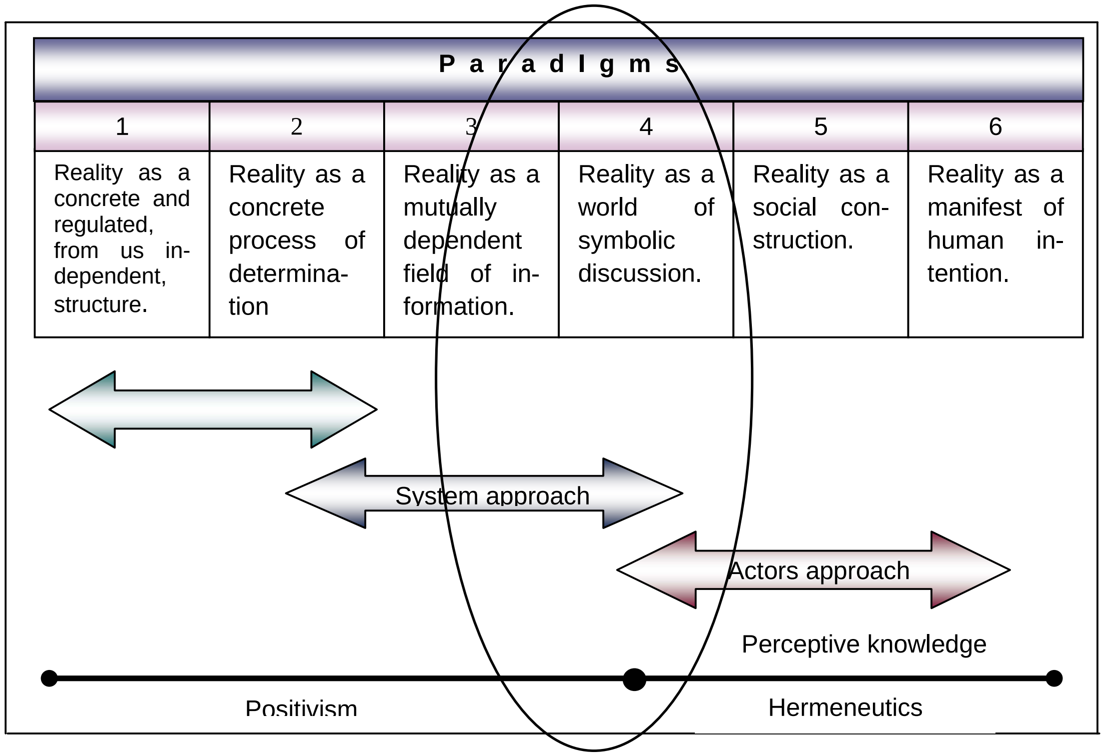

Figure 2.2-a: Different approaches. The circle marks our approach.

Source: Own modification of Arbnor & Bjerke, 1994, p 61-62.

The **analytical** approach, which is connected to the first two paradigms, explains reality objectively in a scientific matter. Existing theories and techniques are used to do the verification on the hypotheses. The effect, of an action, is explained by identifying the cause. The reality is divided in elements, which are studied separately. The entirety is obtained by the total sum of the elements. The result of such a study can result in theories or models of a generalized character useful to be used in other studies.[28] Logics and mathematics have an important role within this approach.[29]

The **actors** approach is based on the three last paradigms. This approach has no interest in explaining. Instead, it is interested in understanding social entireties.[30] The social characteristics of different actors are evaluated, and how the actors affect other actors that are also a part of the entirety are studied. The re-

[28] Arbnor & Bjerke, 1994, p 72.
[29] Ibid, p 97.
[30] Ibid, 1994, p 68.

searcher uses the dialogue as a tool with the different actors to create insights that he or she can evolve and enter more deeply into.[31]

The **system** approach, between the analytical and actors approach, is related to the second, third and forth paradigms. Existing system theories from similar systems are used, however not in the same generalized matter as in the analytical approach.[32] This is because the system approach makes the assumption that the entirety differs from the sum of the elements. The relations and interactions between the elements, but also external factors and varying conditions are essential and can affect the entirety. Identifying synergies is also important within the system approach when the sum of the elements can result in more or less depending on a specific situation. Within this approach factors are identified, that are affecting the system as an entirety and are shown to be more or less true to its purpose for this system[33].

In this thesis, our perception of reality is most closely described by the system approach, even though the actors approach is related to a certain extent, as shown in *Figure 2*. The reality, in our opinion, consists of components that are mutually dependent and therefore cannot be summarized. We will therefore in this thesis start from the available reality in order to be able to study the components of the same in a later phase. Since the interrelations between the studied activities and actors in the supply chain are of interest, the actors approach has also affected the methodology approach of this thesis.

2.2.1 Positivism vs. Hermeneutics

Positivism and hermeneutics are two main scientific directions. A pure positivistic approach is constructed on formal logics and facts, which are results from measuring. The formal logic system is based on accurate definitions differentiated through assumptions and clauses. Through these, theories can be constructed and used when testing hypotheses.[34] The positivists, or explainers as Arbnor and Bjerke prefer to call them,[35] assume that the very same methods

[31] Arbnor & Bjerke, 1994, p 147.
[32] Arbnor & Bjerke, 1994, p 72.
[33] Arbnor & Bjerke, 1994, p 81.
[34] Wiedersheim-Paul & Eriksson, 1999, p 197.
[35] According to Arbnor & Bjerke, 1994, there are few researchers how would like to call themselves positivists.

that have proved their value in analyses within classic science are also useful in social science, even if some adjustments must be done to the specific circumstances.[36] Within the positivism the world is assumed to be to complex, and simplifying and reducing this complex world are seen to be the main activities.[37]

While positivism is trying to describe and explain, the hermeneutics tries to obtain a comprehension of the entirety, an insight. The hermeneutical researcher uses the language as a tool to understand.[38] Through dialogues the researcher asks questions (to individuals, books, images, notes, observations of behavior etc.) and gets the impressions from the answers he or she receives.[39] The hermeneutical researcher, unlike the positivistic researcher, sees the world as already simplified with, among other things, schematic models, concepts and norms. So, this approach is devoted to problematize and taking the entirety of the reality into consideration.

The hermeneutical approach assumes that the researcher can get an understanding of the course of events through interpretation and to a meaningful entirety put together what exists in the humans mind. The social entirety is therefore assumed to be the sum of the different actors involved.[40]

The researcher that uses the analytical approach is according to Arbnor & Bjerke an explainer (positivist). As already mentioned this kind of researcher tries to explain and describe the phenomena using existing analytical theories as a base. Through data collection the researcher is interesting in the individual real knowledge, conceptions and ideas, which is objectively regarded.[41]

The researcher that applies the actors approach is according to the authors hermeneutical. This researcher uses the dialogue as a main tool to understand the different actors, which characterize the hermeneutics. The data collection process is active and mutual, and the researcher differentiates the knowledge ob-

[36] Arbnor & Bjerke, 1994, p 62.
[37] Ibid, p 63.
[38] Wiedersheim-Paul & Eriksson, 1999, p 220.
[39] Ibid, p 221.
[40] Wiedersheim-Paul & Eriksson, 1999, p 221.
[41] Arbnor & Bjerke, 1994, p 147.

tained by the different actors and the understanding the researcher himself/ herself states in his/her own, more scientific interpretation.[42]

On the other hand, the system approach researcher can be booth positivistic and hermeneutic as this approach can combine the two other approaches, as it tries to explain and understand the phenomena.

The combination of positivism and hermeneutics, within the system approach, agrees with how this research is conducted. This study is not purely positivistic or hermeneutical, our intention, however, is to be as objective as possible when analyzing different phenomena. Nevertheless, as we have, to a certain extent, chosen to study a limited part of the reality that we find relevant, and have tried to reach and objectively regard fact based information, we have taken a positivistic approach. Yet, some parts of this study have some aspects of hermeneutics, for example when we from our understanding need to interpret and be subjective.

2.3 Research Method

The research method used in a study is based on the problem on which the study is founded and the questions that arise along the way. The information used in the research has a great impact on the decision of the plan of the study and its extent. The choice of research method should be guided by the problem definition, chosen approach, the object under study and the purpose of the study.[43]

According to Merriam, it is important to determine which research method is appropriate to employ in a study, and the researcher should ask him/herself the following questions: What sort of questions are asked? How big is the degree of control over the studied situation? What is the desired result? And perhaps the most important question is if a limited system can be identified as a focus of the research.[44]

[42] Ibid, p 148.
[43] Wiedersheim-Paul & Eriksson, 1999.
[44] Merriam, 1994, p 2 -3.

If the researcher wants to know why or in which way the phenomena are in a certain way, if the researcher has little or no control over the variables within the study, if the results that will be presented will be a description and an interpretation of a modern phenomena, and finally, if a limited system is identified as a focus of the study; the case study should be chosen as the research method.[45]

Our study agrees with the above named characteristics, since the questions at issue, or problem definitions are focused on obtaining knowledge about the studied phenomena, in this case mapping of the inbound logistics flow. Furthermore, we do not have control over the studied situation since we cannot influence the current status of the inbound logistics flow in any way, and the results that will be presented are of descriptive and interpretative nature. In addition, the focus of our study is the limited system of chosen factories and their external suppliers, i.e. only the chosen components and some parts of the value chain are studied. Therefore, the case study is an appropriate research method for this thesis.

According to Arbnor & Bjerke[46], case studies are very common within the system approach. This is in accordance with Merriam[47], who claims that case studies can be both descriptive and comprehensive, i.e. positivistic and hermeneutical. By focusing on one occurrence or situation, this method is striving to illustrate the interplay between important factors, which distinguishes the relevant occurrence or situation.[48]

Another main reason we use the case study as a research method in our study is the fact that the case study has the unique ability to handle different types of empirical data, both primary and secondary, such as documents, interviews, observations, as well as both quantitative and qualitative data.[49]

[45] Merriam, 1994, p 24.
[46] Arbnor & Bjerke, 1994, p 318.
[47] Merriam, 1994, p 43.
[48] Ibid, p 25.
[49] Wiedersheim-Paul & Eriksson, 1999, p 23.

2.4 Data Collection

The data collection is a critical part of a study. Data can be based on primary data, which is collected through interviews, observations and experiments, and secondary data, which is collected through documented data from literature, articles, and documents from previous studies and statistics.[50]

In our study, we have chosen to use both primary and secondary data. Primary data is used in the form of questionnaires and interviews. The questionnaire is used in order to obtain the detailed information in the mapping part of the study and it was sent out to the Factory Purchasing Managers, responsible for purchase of components, for each SKF factory involved in the study. They provided us with the data that is presented in the empirical part of the thesis. The template of the Questionnaire is found in the *Appendix 2*.

Interviews, on the other hand, are used for gaining an understanding of the problem area and to get new angles of approach.[51] Therefore, we have interviewed several people in the SKF organization, as for example Goods Reception, Supply Chain and Group Purchasing, as well as other sources, as for example professors. We have chosen to use semi-structured interviews, i.e. interviews where we only used certain topics as guidelines, in order to enable the respondents to define their view of reality.

To use already existing information is a good way to start an investigation. The data collected in that way is called secondary data. This data can be obtained in libraries, databases, books, journals, articles, etc. For relatively recent topics that are under rapid development it is harder to find up-to-date information in the books than for older and more traditional topics. Therefore, according to Wiedersheim-Paul & Eriksson, it is recommended that greater focus be put on searches in journals, reports and databases.[52] Secondary data used in this study is mainly data from projects performed prior to ours within the SKF Logistics Services in the same problem area, and the data collected from journals, books and databases.

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[50] Wiedersheim-Paul & Eriksson, 1999, p 84.
[51] Merriam, 1994, p 88.
[52] Wiedersheim-Paul & Eriksson, 1999, p 80.

2.5 Credibility of the Study

The demand on quality and credibility of the information used in a study is very high. Therefore, according to Merriam, the goal of all research is to present durable results in an ethically acceptable way. Quality and credibility of the study are represented by its validity and reliability.[53]

Regardless of the kind of the research conducted, the validity and reliability are issues that can be attended to by a careful attention on the key concept of the research and the method in which the data was collected, analyzed and interpreted.[54]

2.5.1 Validity

The validity of the study depends on how the information is collected, analyzed and interpreted. Validity is defined as a measuring instrument's ability to measure what it intends to measure. For instance, if the efficiency is measured, the research should reflect that reality, or if political preferences are measured so as if there were elections today, the answer has to be trustworthy. There are two types of validity - internal and external validity. The internal validity is about how well do the obtained results concur with the reality. Internal validity can be achieved without collecting empirical data, while external validity can only be achieved by knowledge of the empirical data and how it has been collected. [55] High external validity indicates that the result of the research can be applied to other companies or occurrences. According to Merriam, it is difficult to define external validity when using a case study as a method, since case study is used to study an occurrence in depth. External validity is better achieved by quantitative methods, such as survey, for example.[56]

In our study, we aim to reach high validity, both internal and external by collecting empirical data with both questionnaire and interviews. Since the respondents who answered the questionnaires work with the information that we

[53] Merriam, 1994, p 174.
[54] Ibid, p 175.
[55] Wiedersheim-Paul & Eriksson, 1999, p 38-39.
[56] Merriam, 1994, p 189.

enquire on the daily basis, we are confident in their valid answers. When it comes to external validity, we are in no doubt that conclusions we make will most likely be applicable to other companies as well, due to the relatively unexplored area we are studying.

2.5.2 Reliability

Reliability of the study is the ability of the measuring instrument, for example a questionnaire, to give reliable and stable response. There are two questions that should be considered: Would other researchers come up with the same results if they used same method? And if someone else repeated this experiment on a different occasion and with the different selection, would they obtain the same results? A method should be independent of the researcher and the researched entity (persons, organizations, etc.) to contain high level of reliability.[57]

High reliability of a study is obtained when certain recommendations are followed. According to Wiedersheim-Paul & Eriksson, those recommendations are the use of several methods and sources of information to increase the reliability, as well as careful and extensive explanation of methods used. The researchers position should also be explained in relation to the study as well as researcher's underlying assumptions.[58]

We aim to follow the above recommendations, however, the time aspect as well as the constant changes both in the company under study and its surroundings influence the reliability of our study. Nevertheless, several sources of information have been used, both within and outside the studied company in order to comply with the reliability recommendations.

It is also important to point out that restrictions regarding the information disclosed in the empirical framework as well as the analysis part of the study was set by SKF Logistics Services. The specific information about quantities, frequency and in particular, the names of the suppliers involved, is not published after demands from SKF. Therefore, the data presented in the empirical frame-

[57] Wiedersheim-Paul & Eriksson, 1999, p 38-39.
[58] Ibid.

work and the analysis will be restricted. These restrictions will most certainly have an effect on the reliability of the study and the credibility in general.

Another important issue is the response frequency of the questionnaires, which has been relatively low, 64 percent of the questionnaires were answered and 34% had complete answers. This has affected the outcome in general, especially the analysis and the conclusions, since these parts of the thesis are directly based on the findings from the questionnaires. Nevertheless, we find the response frequency of 64% quite sufficient for our research, since we aim to identify and evaluate the improvement potential of certain flows in a broad perspective.

2.6 Research Model

Figure 2.6-a below describes the research model for this thesis. The purpose of the figure is to give the reader a structure guideline and to contribute to the understanding of the structure of the thesis.

First, a specification of the thesis has been provided by the SKF LS where main characteristics of the thesis and its contents are described. Thereafter, the theory was studied in order to identify those theories that are relevant for our field of research. In these early stages of the thesis we mainly focused on the theories about inbound transportation and delivery terms, since these theories are cornerstones of the entire thesis.

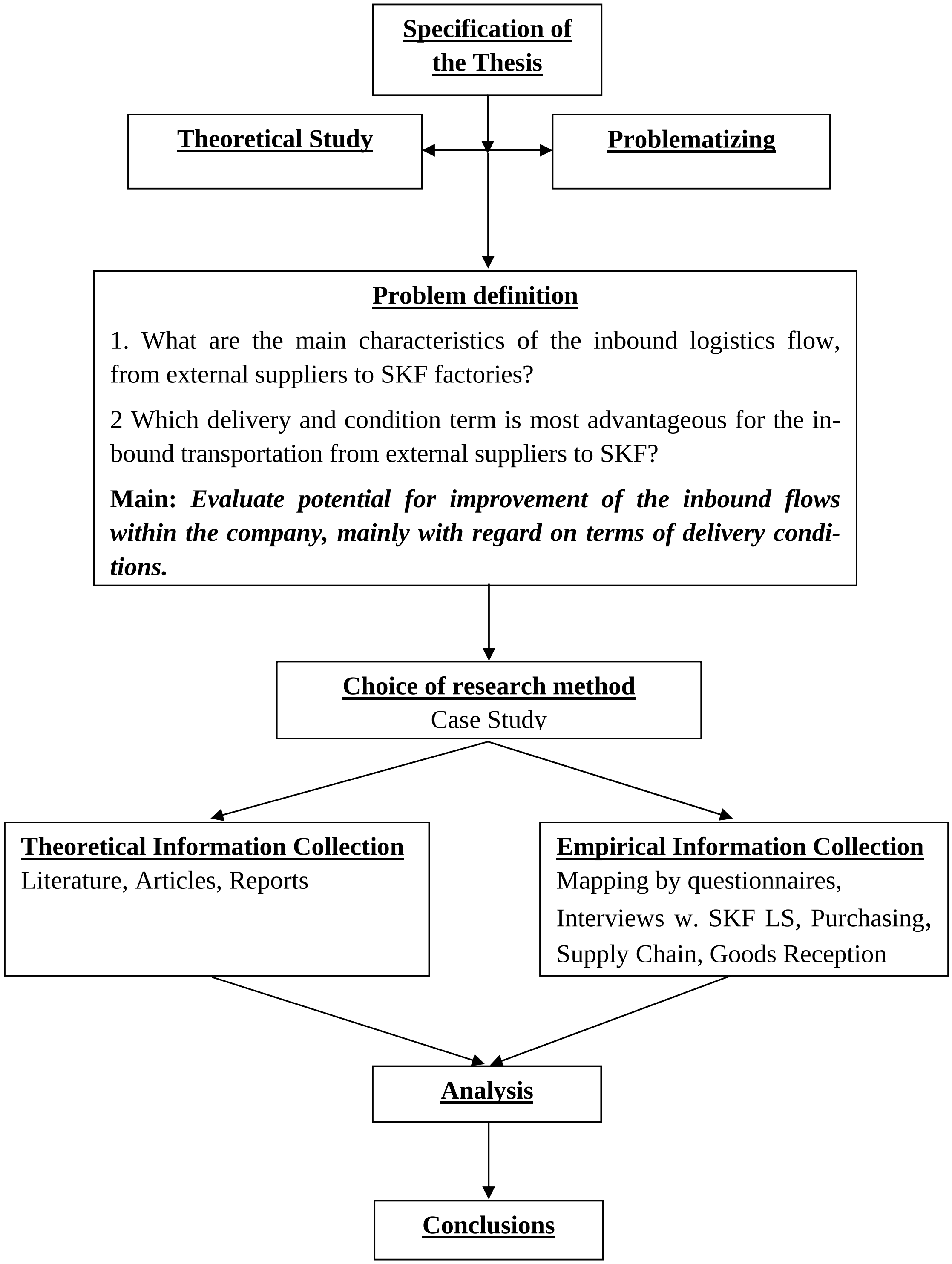

Figure 2.6-a: Our Research Model

Source: Own.

In order to elaborate a precise problem definition, deeper knowledge about the problem area as well as the literature was obtained in an iterative process. This resulted in three problem definitions, one main and two sub-problem definitions. In this phase of the thesis, the delimitations of the thesis are also defined.

The choice of the research method is based on the problem definition and based on the characteristics of the problem definition, a case study was chosen as an appropriate research method.

When the problem definitions were set, the collection of the empirical information was done. Questionnaires were sent out to the respondents at the 15 SKF European factories. Also, interviews with Group Purchasing, SKF LS, Supply Chain and Goods Reception were performed in order to obtain a better understanding of the inbound process in general. The information obtained in the empirical part of the thesis is complied in a database. All the findings obtained during the empirical part of the thesis are not presented in the empirical framework; nevertheless, the most important findings are presented in the *Appendices 3* to *17*.

The collection of the theoretical information is also adapted to the problem definition and contains more detailed theories about inbound transportation, transportation costs, as well as the information from different articles and reports. In this stage of the thesis it became clearer which theories are relevant and useful for our research.

Since all the information obtained in the empirical part of the thesis is complied in a database, it made it easier to compare with the theory in the analysis part of the thesis. In the analysis, the similarities and differences between the theory and the empirical findings are compared. In addition, based on these findings, three types of improvement suggestions are proposed. Due to the restrictions on the presentation of the exact numbers, the calculations are not presented in the thesis. However, the way in which the calculations are made are described in this part of the thesis.

Based on the analysis, the conclusions and results are presented in the Chapter *6 Conclusions*.

3 Theoretical Framework

This chapter discusses for the study relevant theory. Topics such as Inbound Logistics, Transport Modes, Logistics Costs and Terms of Delivery will be discussed and explained to the reader as they occur in the report. First, a description of the Demand and Supply Chain is presented.

3.1 Effective Logistics and Demand - Supply Chain

In recent years, effective logistics management has been recognized as a key element in improving both the profitability and the competitive performance of companies.[59] In order to make an improvement, it is often necessary to look outside the company's four walls and involve the suppliers and customers. Therefore, the concept of supply chain management has been given an important role. The supply chain includes the entire flow, from the raw material to the end consumer. A company can gain competitive advantages by concentrating on improvements of the whole or parts of its supply chain.

Logistics, as an integrated part of the supply chain, is about creating value. The value is created for customers and suppliers of the company as well as for the company's stakeholders. In logistics, value is stated in terms of time and place and "*products and services do not have any value if they are not in the possession of the customers when (time) and where (place) they wish to consume them.*" [60]

Bowersox et al. describe logistics as the work required to move and position inventory throughout a supply chain. The managing of the supply chain, sometimes called value chain or demand chain, according to Bowersox et al., consists of firms collaborating to leverage strategic positioning and to improve operating efficiency. The supply chain decision made, establish the operating framework within which logistics are performed. The operations require mana-

[59] Stock & Lambert, 2001, p 6.
[60] Ballou, 1999, p 11.

gerial processes that span across functional areas within individual firms and link trading partners and customers across organizational boundaries.[61]

There are different opinions about how the supply chain shall be managed, either by the market or by the suppliers. Christopher[62] means that the market shall manage the supply chain and therefore, he prefers to call it Demand Chain Management. One of the main reasons for this is the important focus on the customer and that the initiative takers of streamlining are often the customers.[63] According to Mattsson, the supply chain represents the entire chain, the whole way to the end consumer. From this ultimate customer perspective there is only a supply chain and not a demand chain. To use the definition of supply chain for the complete chain of actors that preceded the end customer is relevant according to Mattsson.[64]

Hoover et al. on the other hand, describe the purpose of demand chain as interpretation of the customer's desires and intentions to information, which the supplier can use when taking action. Furthermore, Hoover et al. mean that it is not necessary to keep the demand chain separate from supply chain since they can interact with one another and when this interaction occurs, the demand is synchronized with the supply in a demand-supply chain.[65] This latter definition of the supply and demand chain represents in the best way the approach of this thesis.

A company's supply chain consists of geographically dispersed facilities where raw materials, intermediate products or finished products are acquired, transformed, stored, or sold, and transportation links connecting the facilities along which products flow. There is a distinction between plants, which are manufacturing facilities where physical transformation of the product takes place and distribution centers, which are facilities where products are received, sorted, put away in inventory, picked from inventory and dispatched, but not physically transformed. The company may operate these facilities, or they may be operated by vendors, customers, third-party providers or other firms as they pass through its supply chain and transport them to geographically dispersed

[61] Bowersox et al, 2002, p 4.
[62] Christopher, 1998, p 18.
[63] Mattsson, 2002, 64.
[64] Mattsson, 2002, 64.
[65] Hoover et al., 2001, p 72.

markets in the correct quantities, with the correct specifications, at the correct time and at a competitive cost.[66] The *Figure 3.1-a* below shows a generalized Supply Chain Model.

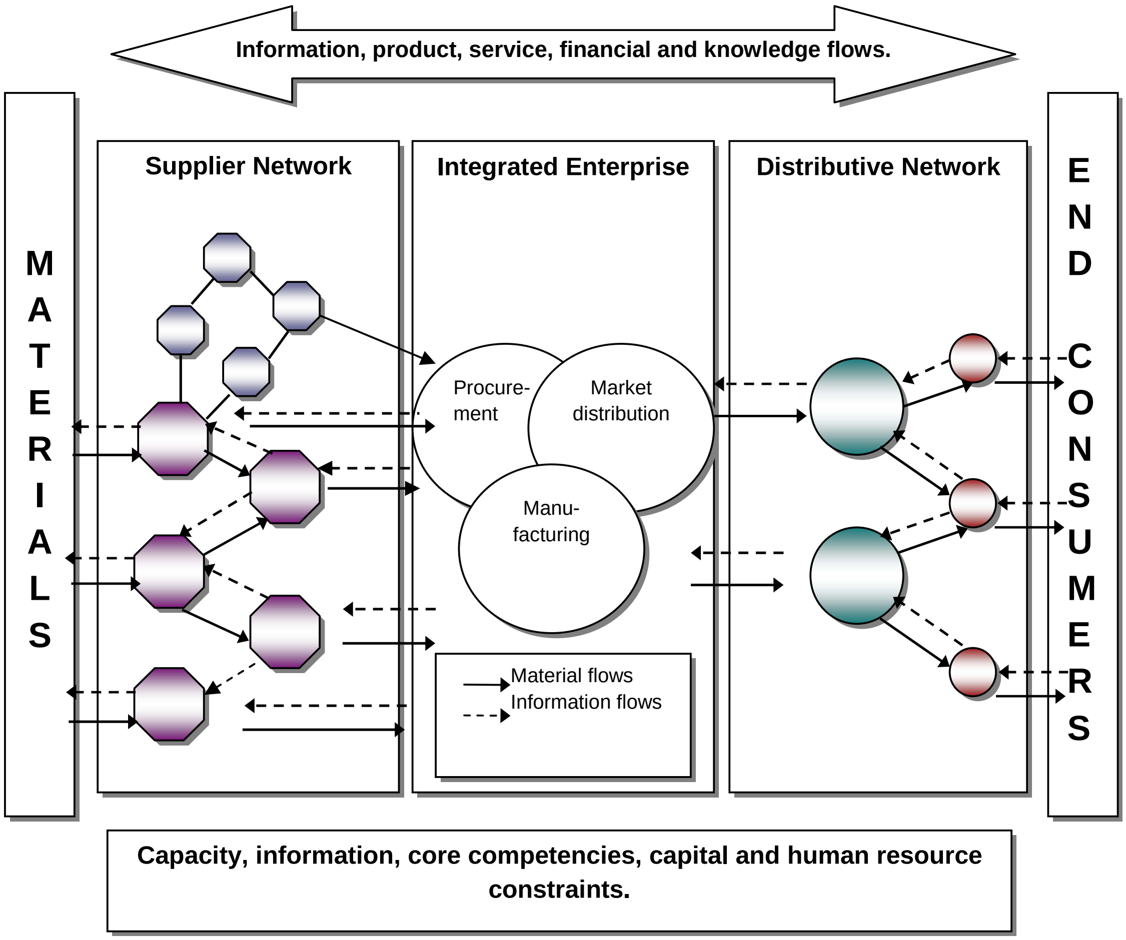

Figure 3.1-a: Generalized Supply Chain Model.

Source: Bowersox, Closs & Cooper, 2002, p 6.

A closely related definition to supply chain is the value chain.[67] The concept of value chain was first brought to a wider audience by Michael Porter. It illustrates a company's different functions and how the activities, which add value to the products and services to the customers, are connected to each other. By coordinating the activities a company can gain competitive advantages. Another way to gain competitive advantages is to optimize one or more activities. However, a consideration has to be taken so that optimization does not end in

[66] http://www.scm-models.com/intro.htm, 2003-09-19
[67] Porter, 1985, in van Weele, 2002, p 10.

that one function is optimized at the expense of the others - a sub optimization.[68]

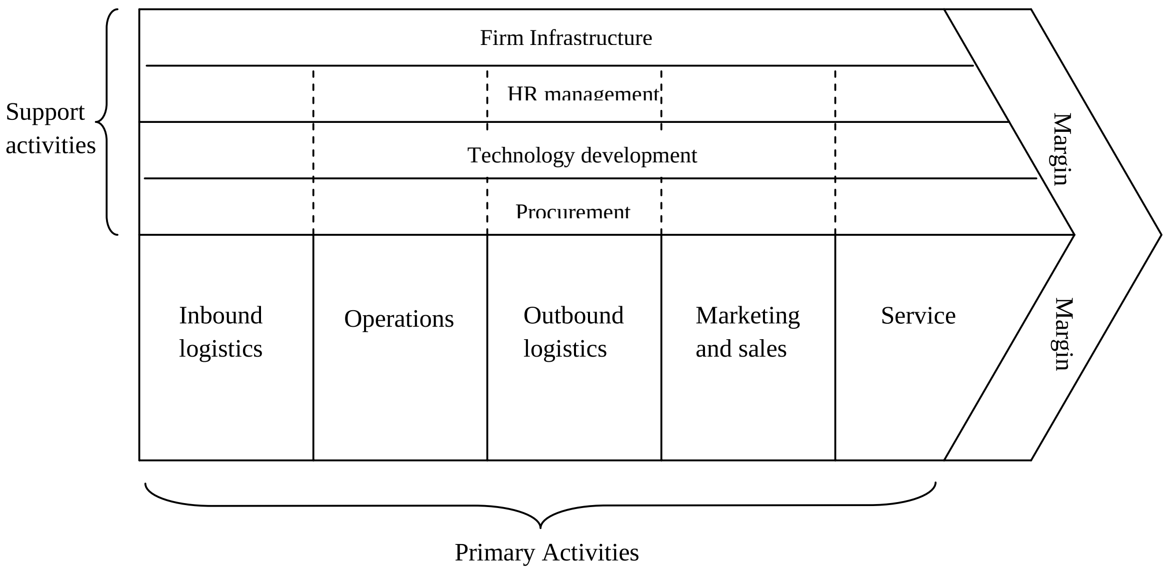

Figure 3.1-b: The value chain.

Source: By Porter, 1985, in van Weele, 2002, p 10.

These value-adding activities that are performed by the functions within each company are divided into two categories, primary activities and supportive activities, as shown in the *Figure 3.1-b*:[69]

Primary activities include inbound logistics, operations, outbound logistics, marketing and sales, and services, i.e. the direct value adding flow. Support activities, on the other hand, include all indirect value adding activities that are needed to secure the primary activities. They can be directed at supporting one primary activity as well as supporting the whole primary process.

3.2 Inbound Logistics

Inbound logistics is one of the primary processes and it is concerned with purchasing and arranging inbound movement of materials, parts and/or finished

[68] Lumsden, 1998, p 80.
[69] Mattsson, 2002, p 65.

inventory from suppliers to manufacturing or assembly plants, warehouses or retail stores.[70] Nevertheless, there is no uniform definition of inbound logistics. Some logisticians define inbound logistics as rather limited function that includes activities related to receiving, storing and distributing inputs to the product, such as materials handling, warehousing, inventory control, vehicle scheduling and returns to suppliers.[71] [*]

The acquisition of materials has long been an important aspect of materials management and will most probably continue to be so in the future.[72] Material management is directly responsible for the product flow into the company. The materials manager's customer is the manufacturing or the production department rather than the intermediate or final customer in the marketplace. One of the most important activities handled by the materials management is the inbound traffic and transportation function. Materials managers must be aware of the various transport modes and modal combinations available to their companies, any regulations that might affect the transportation carriers their firm uses, the decision of private versus for-hire, leasing, evaluating mode and carrier performance, and the cost/service trade-offs involved in the inbound movement of the product.[73]

According to Lambert & Stock, there are three major differences between the administration of inbound transportation and outbound transportation. First, the market demand that generates the need for outbound movement is generally considered to be uncertain and fluctuating. The demand with which the materials manager is concerned originates with the production activity, and is much more predictable and stable than market demand. Therefore, transportation decisions made by the materials manager are not subject to the same types of problems his or her counterpart in the outbound traffic area will encounter.[74]

Secondly, the materials manager is more likely to be concerned with bulk movements of raw materials or large shipments of parts and subassemblies. In addition, raw materials and parts have different handling and loss and/or dam-

[70] Bowersox et al, 2002, p 45.
[71] van Weele, 2002, p 11.
[*] In this study, the first named definition is used, since it is more suitable for this specific field of research, and since inbound logistics is in many cases closely linked to the purchasing.
[72] Stock & Lambert, 2001, p 276.
[73] Stock & Lambert, 2001, p 278-279.
[74] Stock & Lambert, 2001, p 279.

age characteristics, which will affect the entire mode/carrier selection and evaluation process.[75]

And third, firms generally exercise less control over the inbound transportation because purchasing procedures tend to look at total delivered cost. A separate analysis of the inbound costs is not performed as often or in as much depth. Thus, significant cost savings are possible.[76]

3.2.1 The Role of Purchasing

Every company relies to a certain extent on materials and services supplied by other firms. In most industries, companies spend 40 to 60 percent of their revenues for materials and services from outside sources. This process of acquiring materials and services to ensure the operating effectiveness of the firm's manufacturing and logistics processes is called procurement.[77]

From the purchaser's point of view, the supply chain includes internal functions, upstream suppliers and downstream customers. A firm's internal functions include the different processes used in transforming the inputs provided by the supplier network. This is usually referred to as operations. The coordination and scheduling of internal flows is challenging, particularly in large organizations. Some of the major functions include order processing, which is responsible for translating customer requirements into actual orders that are input into the system. Order processing may also involve extensive customer interaction, including quoting prices, possible delivery dates, delivery arrangements, and after-market service.[78]

Another important function is production scheduling, which translates orders into actual plans and schedules. This may involve working with materials, requirements planning and capacity planning systems to schedule work centers, employees and maintenance of machines.[79]

[75] Stock & Lambert, 2001, p 279.
[76] Stock & Lambert, 2001, p 279.
[77] Stock & Lambert, 2002, p 24.
[78] Monczka & Trent, 2002, p 5.
[79] Monczka & Trent, 2002, p 5.

The supply chain also involves upstream suppliers. In order to manage the flow of materials between all upstream organizations, firms employ an array of managers who ensure that the right materials arrive at the right time to the right internal user. Purchasing managers are responsible for ensuring that the right suppliers are selected, that they are meeting performance expectations, that appropriate contractual mechanisms are employed and that a good relationship is maintained. They may also be responsible for driving supply-based improvement and act as a link between suppliers and other internal supply chain members, such as engineering, accounting, etc. Material managers are responsible for planning, forecasting and scheduling material flows from the suppliers. They must work closely with production schedules to ensure that suppliers are able to deliver material to the required locations and that they have some advance warning as to future requirements so they can plan ahead.[80]

A firm's customers usually encompass downstream distribution channels, processes and functions that the product passes through on its way to the end customer. Within the downstream portion of the supply chain, logistics managers are responsible for the actual movement of materials between locations. One major part of logistics is transportation management, involving the selection and management of external carriers (trucking companies, airlines, railroads, shipping companies) or managing internal private fleets of carriers.[81]

3.2.2 Inbound Transportation

Transportation is the operational area of logistics that geographically moves and positions inventory. Because of its fundamental importance and visible cost, transportation has traditionally received considerable managerial attention. Almost all enterprises, big and small, have managers responsible for transportation. [82]

Transportation is the creation of place and time utility. When goods are moved to places where they have higher value than they had at the places from which they originated, they have place utility. Time utility means that this service occurs when it is needed. Time and place utility are for example, provided to pas-

[80] Monczka & Trent, 2002, p 9.
[81] Monczka & Trent, 2002, p 9.

sengers when they are moved from where they do not want to be to places they do want to be and at the demanded time. [83]

Transportation is a service to the user, but it has characteristics that make purchasing transportation similar to purchasing goods. One aspect of transportation is the movement service. This includes speed (whether it is door-to-door or terminal-to-terminal), reliability and the frequency of the service. Another factor is the equipment used, which is a major factor for both passengers and freight. For passengers, the equipment affects comfort and safety. For freight, equipment affects shipment preparation, the size of the shipment and loading and unloading cost.[84]

The third factor is the cost of the transportation service. Cost includes a charge or rate quoted by the primary carrier as well as any peripheral costs borne by the user. The latter may include pickup and delivery costs, packaging requirements, damage or detention charges and special service charges, such as refrigeration or heat.[85]

Transportation should not be viewed as the simple movement of persons or things through space. The user is actually purchasing a "bundle of services" from a carrier at a certain cost. The "bundle of services" varies among carriers and modes of transportation with different prices frequently in effect from the different services. If the user focuses on the simplistic version of transportation, that is, movement through space, the lowest-priced service will be selected. However, the higher-priced carrier may be the best choice because of the superior service, which will result in lower costs in other areas, such as inventory.[86]

There are three fundamental ways to satisfy the transportation requirement, namely by operating a private fleet or equipment, arranging contracts with transport specialists or employing services of a wide variety of carriers that provide different transportation services on a per shipment basis. Regardless of the chosen alternative, there are three factors that are fundamental to transporta-

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[82] Bowersox, Closs & Cooper, 2002, p 41.
[83] Coyle, Bardi & Novack, 2000, p 20.
[84] Coyle, Bardi & Novack, 2000, p 20.
[85] Coyle, Bardi & Novack, 2000, p 20.
[86] Coyle, Bardi & Novack, 2000, p 20.

tion performance from the logistical system viewpoint: cost, speed and consistency.[87]

The **cost** of transport is defined as "the payment for shipment between two geographical places and the expenses related to maintaining in-transit inventory." [88] It is important to indicate that using the solution that offers the least expensive method of transportation may not result in the lowest total cost of logistics, since the total cost of the service is to be considered.[89] The figure below describes the cost of transport as an "iceberg", where the part visible above the surface, the price, is the smallest part of the total transport cost. The major part of the iceberg is concealed and includes, among other things, consistency, support, delays and delivery performance, which all combined represent some of the characteristics of the total performance of the service. This issue will be discussed separately in this chapter.

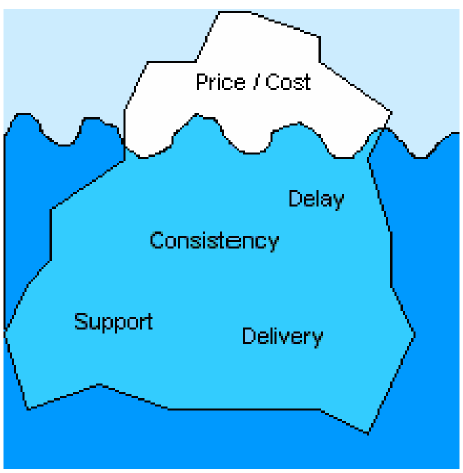

Figure 3.2.2-a: The Price/Cost Iceberg.

Source: Own adaptation from Baily et al, 1998, p 11.

Speed of transportation is the time required to complete a specific movement. Speed and cost of transportation are related in two ways. First, transport firms, capable of offering faster service, usually charge higher rates. Second, the faster the transportation service is, the shorter the time interval during which inventory is in-transit and unavailable. Therefore, a critical aspect of selecting

[87] Bowersox, Closs & Cooper, 2002, p 41.
[88] Bowersox et al, 2002, p 41.
[89] Bowersox et al, 2002, p 41.

the most desirable method of transportation is to balance speed and cost of service.

Consistency of transportation refers to variations in time required to perform a specific movement over a number of shipments. Consistency reflects the reliability of transportation. For years, consistency has been identified as the most important attribute of quality transportation. If a shipment between two places takes 3 days one time and 6 days the next, the unexpected variance can create serious supply chain operational problems. When transportation lacks consistency, inventory safety stocks are necessary to protect against service breakdowns, impacting both the seller's and buyer's overall inventory commitment. Speed and consistency jointly create the quality aspect of transportation.[90]

3.2.3 Just-In-Time Purchasing and Transportation

Just-In-Time, JIT, links purchasing and procurement, manufacturing and logistics. Its primary goals are to minimize inventories, improve product quality, maximize production efficiency, and provide optimal customer service levels.[91]

JIT can be seen as a philosophy of doing business. It focuses on the identification and elimination of waste wherever it is found in the manufacturing system. Typical JIT implementation involves the initiation of a "pull" system of manufacturing (matching production to known demand) and benefits include significant reduction of raw material work-in-process, and finished goods inventories. Other significant reductions are in throughput time and space required for manufacturing process.[92]

3.2.3.1 Logistics Implementation of JIT

Stock and Lambert mean that transportation becomes an even more vital component of logistics under a JIT system.[93] The demands placed on the firm's transportation network are significant and include a need for shorter, more con-

[90] Bowersox, Closs & Cooper, 2002, p 41.
[91] Stock & Lambert, 2002, p 291
[92] Stock & Lambert, 2002, p 489
[93] Stock & Lambert, 2002, p 294

sistent transit times, more sophisticated communications, use of fewer carriers with long-term relationship, a need for efficiently designed transportation and material handling equipment, and better transportation decision-making strategies.

According to Lumsden, JIT requires an increased precision for all sort of inbound flows, as a consequence of smaller production buffer and shorter advance planning.[94] Therefore, deliveries must, to a greater degree, arrive at the right time and within a time window. In JIT transportation the deliveries do not need to be fast or short deliveries, as long as the transportation planning is reliable. (For example, Volvo Trucks acquire truck cabins from northern Sweden via three-day-long railway connection).

The warehouse becomes a consolidation facility rather than a storage facility. Since many products arrive into the manufacturing operation at shorter intervals, less space is required for storage. At the same time the capability for handling and consolidating the items needs to increase.

According to Stock and Lambert there are in some cases problems associated with Just-in-Time.[95] For instance, smaller, more frequent order can result in higher ordering costs, which must be taken into account when calculating any cost savings due to reduced inventory levels. Suppliers incur higher production and setup costs due to the large number of small lot quantities produced. Generally, the result can be an increase in the cost of producing items from suppliers, unless suppliers are able to perceive the benefits they can receive from being part of a JIT system.

Also, if the distances between the firm and its suppliers increase, delivery times may become more erratic and less predictable. Transportation costs also increase as smaller shipments are made. Transit time variability can cause inventory stock-outs that disrupt production scheduling. When this factor is combined with higher delivery costs per unit, total costs may be greater than savings in inventory carrying costs.[96]

[94] Lumsden, 1998, p 77.
[95] Stock & Lambert, 2002, p 293.
[96] Stock & Lambert, 2002, p 293.

As the order quantities per delivery are decreasing the need of cross docking in specialized terminals is increasing. These terminals or consolidation points make it possible to optimize the transport capacity, which means that greater revenues can be made. According to Persson & Virum, the new material flow managements and new production technologies will result in lower order quantities. Especially within the retail and engineering industries. This means that each single shipment will result less and the need for consolidation points will increase.[97]

3.2.4 The Transport Modes

This study concerns mainly two transportation modes: road and rail, since both company, together with its factories, and its suppliers (with one exception) are located in Europe, and since the nature of goods is such that these two modes of transport are appropriate to use. In this section these transport modes are described more thoroughly.

According to Lumsden, the goods value is the basis when choosing the means of transportation. The railway competes with the sea transportation in the segment with the goods of low value, the road transportation dominates the middle segment and the air transports handle goods with the very high value. See *Table 3.2.4-a* below. The demand of transport mode is therefore expressed based on the value of the transported goods.[98]

Type of Transport	Goods Value
Ship	6 SEK/kg
Rail	6 SEK/kg
Road	22 SEK/kg
Air	>708 SEK/kg

Table 3.2.4-a: The value of the transported goods for different transport modes.

Source: From SIKA 1996 in Lumsden, 1998, p 51.

[97] Persson & Virum, 1998, p 79.
[98] Lumsden, 1998, p 50.

When it comes to competition between the different transportation modes, it can be said that rail transportation stands for the transport of quantities larger than 20 tons that are transported over distances longer than 200 km and mail over medium distances, sea and inland waterways stand for transportation where geography calls for ships and over long distances, as well as transportation with trailers, containers and bulk materials. The goods that are transported by air are usually goods of high value or time sensitivity (flowers, for instance), parcels and mail over long distances. The rest is transported by road.[99]

The *Figure 3.2.4-a* below shows the principle distribution of the transport work in relation to the distance for rail and road transportation. As the figure shows, the work increases for the rail transportation on the distances above 400 kilometers, while the transport work for the road transport is highest for the distances below 400 kilometers.

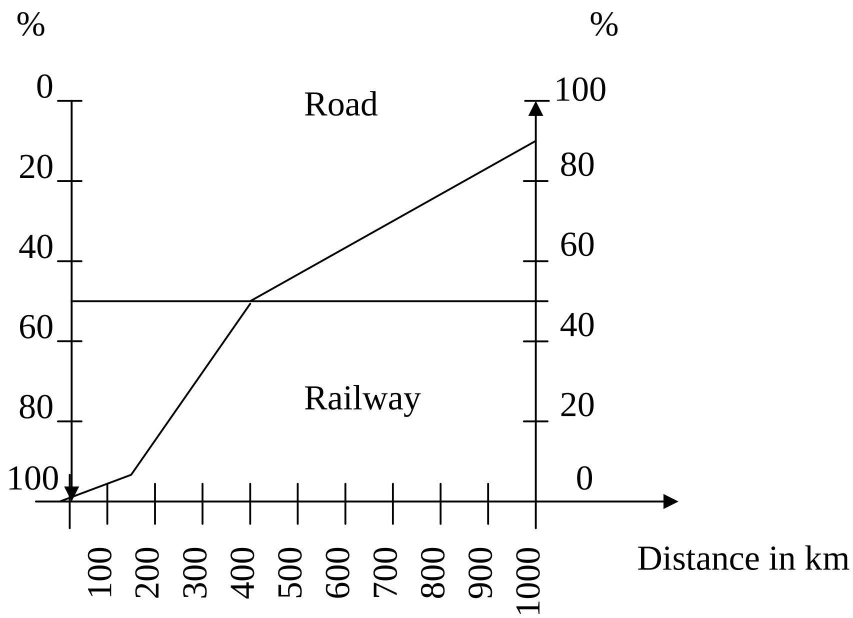

Figure 3.2.4-a: Principle distribution of the transport work in relation to the distance between rail and road transports.

Source: Lumsden, 1998, p 50.

[99] Woxenius, Lecture Material 2002.

3.2.4.1 Road Transportation

The industry's continuously growing demands for fast and efficient transports is the explanation to the increasing use of road transportation. Road transportation allows that larger quantities of goods such as part loads and above, more than one ton, can be transported from door to door. The number of re-loadings can also be reduced which leads to decreasing costs and less damage on the goods.[100]

Road transportation stands for 45% of total ton kilometers transported within the European Union and 54% in Sweden. [101]

Advantages and Disadvantages of the Road Transport

The conditions and characteristics that contributed to the growth of road transportation use are according to Lumsden the following:[102]

Small-scale qualities **-** The capacity of the vehicle is small compared to other means of transportation, which means that the vehicle can easily be adapted to the needs of a single customer. At the same time, this is a basic condition in order to be able to create efficient, and to the transport buyer, attractive direct relations.

Flexibility **-** The vehicle can relatively easily change direction during on-going transportation. At the same time there is a large flexibility in form of different combinations of vehicles and the possibility to temporarily increase the capacity by redirecting the vehicles.

Safety **-** Due to the fact that a relatively smaller amount of goods is transported with each vehicle and that the chauffeur accompanies the transported goods are safer regarding goods comfort, avoidance of damages, safety in the transport and avoidance of theft and losses.

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[100] Lumsden, 1998, p 87
[101] EU Commission, 2002, in Woxenius, Fundamentals of Logistics course material.
[102] Lumsden, 1998, p 88.

***Reliability* -** The combination of a vehicle and an accompanying driver automatically gives a high level of reliability, as the goods are constantly accompanied and as a stop for the goods also means a stop for the driver.

***Service* -** The presence of the driver creates a possibility to locally solve the transport buyer's problem, as the driver possess experience and has direct contact with the transportation company.

***Adaptability* -** As the vehicle often is an economically independent unit, it tries to solve its own economical problems, such as a small supply of goods, by locally searching additional load.

The **disadvantages** for the road transportation are the negative effect it has on the environment, nature and urban areas. Air pollution, noise and congestion problems are examples of negative effects, as well as the extensive land use of the road transportation infrastructure, poor working conditions of the drivers that might have a direct impact on the safety of the transport in general.

3.2.4.2 Rail Transportation

Rail transportation stands for 40% of the total transport work in ton kilometers within the European Union in 1999.[103]

There are five types of goods transports within the railway transportation: [104]

- Express goods
- Wagon load goods
- Unit loads
- Block train
- Full train

Express goods are normally transported with high frequency, with passenger trains. Volume and weight for this kind of transports are usually small, and therefore it is of relatively small importance.[105]

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[103] EU Commission, 2002, in Woxenius, Fundamentals of Logistics course material.
[104] Lumsden, 2002, p 76.
[105] Lumsden, 2002, p 76.

Wagon load goods are used when a customer to the rail transporter uses an entire wagon for the transport of his goods. However, to be able to use this service, loading that corresponds to a certain part of the capacity of the wagon is usually demanded, i.e. a certain fill rate has to be fulfilled.[106]

Unit loads are consignments in the shape of containers, swap bodies or other load units. These can in railway traffic be handled as special load carries with the equipment for efficient handling belonging to it. In general, it can be said that the consignment sizes that are as large or larger than a wagon, are big enough to allow the railway to be competitive. The competitive strength of the railway is mainly due to the fact that railway is suitable for transport of large quantities of goods. More specifically, the increase of the number of complete train sets from/to same client is very important, especially for the paper, car and mining industries that usually transport heavy goods. Another fact is that rail has great difficulties when competing with road transportation regarding the general cargo. [107]

A **block train** is a train that has been divided into a number of blocks, where each block consisting of one or more wagons is carrying goods for one client, from and to the same destination. This is useful when the flow of goods is not sufficient to support the full train traffic.[108]

Full trains or trains that transport goods from one sender to one receiver constitute a large and increasing share of the railway transports, 25% of the volume of the Swedish railway, excl ore transport. Full trains transport goods directly from the sender to receiver, without any marshalling[109] or shunting[110].[111]

The Railway Infrastructure in Europe

Europe has relatively well-developed railway network, however it is considerably more sparsely developed than the road network. Most of the railway infrastructure was built more than hundred years ago and it was adapted for the needs at that time. In addition, many parts of the railway network were closed

[106] Lumsden, 2002, p 76.
[107] Lumsden, 2002, p 76.
[108] Lumsden, 2002, p 76.
[109] For Glossary, see Appendix 1.
[110] For Glossary, see Appendix 1.
[111] Lumsden, 2002, p 77.

down due to insufficient profitability, which has resulted in the networks of to-day - a net between mainly larger cities, with certain minor networks connecting to this frame.[112]

Since railway can compete with other modes of transport only when transporting large quantities and flows, the railway network has been adapted to the general competition situation.[113]

One way to increase the utility degree of the railway is to increase the goods volumes with the help of another transport mode, as for instance road, by consolidating goods or combining transports. The goods from several senders is in that case transported by the truck and then collected at the railway terminal. All the goods to a specific area are transported by the railway to the terminal located in that particular area of destination. From the terminal, the goods are transported by truck to the final destination. This is one example of intermodal transportation.[114]

Advantages and Disadvantages of the Rail Transportation

Environmental advantages of the rail transportation are evident. The emission of CO_2, for example, are 0,070521 g/kWh for the train and 2,1 g/kWh for the truck, or 97% lower. The situation is similar for other emissions, such as NO_X, HC, PM, etc. These values are based on the electrified engines and the environmentally friendly electricity, as for example hydroelectric power. When diesel engines are used, the environmental affect is similar to the one of trucks.[115]

One of the main disadvantages of the international (in this case intra European) railway transportation has been the low speed. Due to many border crossings, different electric systems, different engines, different regulations and different gauges, the transport of goods within Europe has been very slow. Each country has its own rules and prior to the deregulation of railway transport, transporting goods by rail within the Europe has not been an easy task. The deregulations of

[112] Lumsden, 2002, p 78.
[113] Lumsden, 2002, p 77.
[114] Lumsden, 2002, p 78.
[115] Nätverket för Transporter och Miljön, www.ntm.a.se

the railway transport are today a fact, yet, there is much more that needs to be done.[116]

Another problem that railway transportation has experienced is the lack of competition and customer focus. This, together with low cost transparency has led to higher prices and low reliability. Traditionally, the priority of the railway transportation has always been given to the passenger transportation and there is an incompatibility between freight and passenger trains due to limited capacity of the tracks and reduced possibility to increase it.[117]

3.2.4.3 Combined Transportation

A generally increasing economic activity and a change towards more sophisticated logistics results in more transportation work. Augmented number of transportation implies, unfortunately, more traffic problems and environmental issues.[118] Woxenius means that if combined transport is used properly these problems and issues can be reduced without comprising the industry's demands.

Combined transport involves several transportation modes, in order to transport a consignment from supplier to customer. Since several transport modes take part in the logistic chain, the transfer between them must in different ways be facilitated and be made more efficient. This leads to the fact that the efficiency in combined transports is entirely based on the technique and the organization of how and where unit loads are utilized in these transport system.[119] The combined transports make possible several forms of logistics chains:[120]

- Transshipment transports - Goods transportation where several different transport modes and terminals take part
- Logistical solutions - The load carrier are used to make a combined transportation flow, storage etc more efficient

[116] Woxenius, 2003, Trafikslag i samverkan.
[117] Woxenius, 2003, Trafikslag i samverkan.
[118] Woxenius, 2003, p 7
[119] Woxenius, 1993, in Lumsden, 1998, p 486.
[120] Lumsden, 1998, p 486.

- Vehicle utilization - Different load carriers are used for special purposes in the combined transportation chain while the vehicles are of basic nature, such as load-bearing frames on wheels (e.g. trailer chassis)

When loading the goods in loose load carriers, the transshipment can be carried out in an efficient manner and the goods are protected against damages. The goods are loaded in the carrier the whole way from sender to receiver. The carriers most used today are containers, semi-trailers and swap bodies. Goods owners, shipping company and haulage contractors chose load carriers according to type of goods and destination.[121]

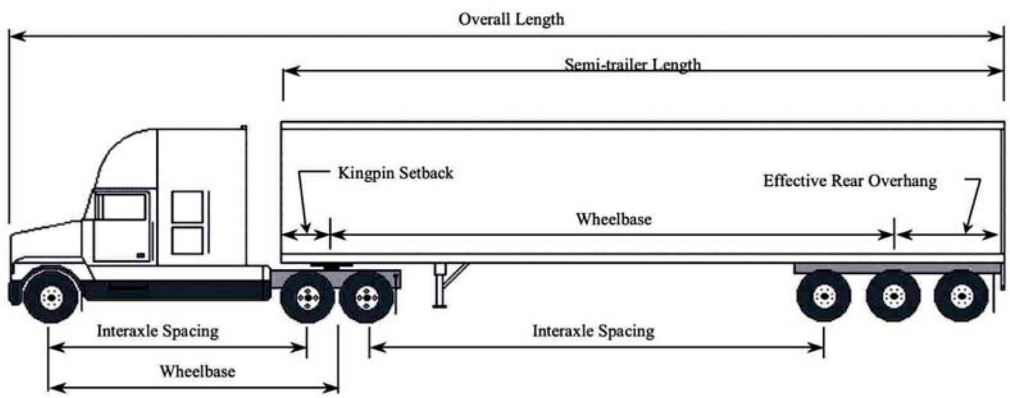

Figure 3.2.4.3-a: Truck Tractor and Semi Trailer

Source: http://www.gnb.ca/0062/regs/2001-67.htm

The Advantages and Disadvantages of Combined Transportation

Since several transportation modes are used, each one of them can be used where it is most efficient in point of customer benefit, resource utilization or environmental effects. Woxenius means that a number of advantages can be achieved throughout a combination of combined transportations and the utilization of unit loads:[122]

- Simpler, faster and less expensive transshipment between transportation modes.

[121] Woxenius, 2003, p 5.
[122] Woxenius, 2003, p 9.

- Large-Scale transportation modes with low transportation cost, little effect on environment can interact with small-scale and flexible transportation modes.
- Reduced terminal time for the transportation mode and therefore better resource utilization.
- Less damage on the goods alternatively reduced packaging weight and cost.
- Simpler to choose load carrier.
- Simplified documentation and regulation for responsibility and insurance.

The disadvantages are:

- The transportation modes must be adapted to the load carriers.
- Large and costly handling equipment that often is adapted to larger terminals.
- Transshipments results in costs and time loses.
- Higher total tare weight.[123]
- High local emissions around terminals
- High costs for load carriers and repositioning of empty units.

In some of the more important commercial relations as Benelux-Germany to Spain and Portugal and in to/from France, the combined transportation is used to a very small extent.

Combined Transportation in the Future

Woxenius means that the real challenge for combined transportation is to be able to compete with road transportation at distances shorter than 250 km. Despite the increased transportation distances due to the EU integration, the most important transportation market consists of short and medium long distances.

Four different development directions can be distinguished, so that the combined transportation will be able to compete with the road transportation in the future. It is important that the different alternatives can be coordinated to effi-

[123] For Glossary, see Appendix 1.

ciently cover a wide market with regard to geographic extension and concentration of flows. [124]

- *Large flows over long distances*: Will continuously be managed with direct full train. The frequency will increase to more daily departures, in order to use the rolling equipment and terminals more efficiently.

- *Large flows over short distances*: The short distances lead to a need for a higher frequency, as the time handicap toward the road transportation will not be to extent. With many stops along the corridors the trains can be filled in a satisfactory way. Transshipments are arranged between trains in places where the different corridors meet, in order to create a network.

- *Small flows over long distances*: The flows can be combined with the corridor flows, so that the minor flows between two endpoints are complemented by other flows along the central part of the corridors.

- *Small flows over short distances*: The biggest challenge for the combined transportation. It is important that the fixed costs is not elevated above all in the terminals handlings, as the cost will be divided on a small number of transshipments.

According to Woxenius, the West-East corridor will have an important role when the former East Europe is incorporated in the EU, as these countries rely on more rail transportation than road transportation and have available capacity on the railway tracks.

3.3 Logistics Costs

The costs that a company sustains for the physical supply and distribution often determine how frequently the logistics system should be modified. A company that produces high value goods, such as for instance electronics, will most likely give little attention to the optimality of the logistics strategy, since the

[124] Woxenius, 2003, p 56.

logistics cost represents a small fraction of the total cost of the product. However, when the logistics costs are high, as for example in food industry, logistics strategy is a key concern. With high logistics costs, even the small improvements caused by frequent modifications can result in substantial cost reductions. [125]

Total logistics cost stands for approximately 11,56% of the total turnover of the companies in Sweden, and 8,13% in Europe.[126]

When using logistics costs calculation to express the efficiency of the material flow, it is important that all relevant costs are taken into consideration.[127] Therefore, management must consider the total of all logistics cost. Reduction in one cost invariably leads to increases of other costs. According to Stock & Lambert, effective management and real cost savings can be accomplished only by viewing logistics as an integrated system and minimizing its total cost rather than focusing on each activity in isolation.[128]

3.3.1 Total Cost Concept

The Total Cost Concept is based on total cost analysis, which means that all cost changes, as a result of a measure, are studied.[129] The Total Cost Concept is one of the most important tools within the supply chain management, and its purpose is to create an efficient material flow by finding the optimal balance between high service level and low logistics costs.[130]
The major cost categories within the logistics process are: customer service, warehousing, order processing and information, lot quantity, inventory carrying and transportation. See *Figure 3.3.1-a* below.

[125] Ballou, 1999, p 38.
[126] TFK ,1992, in Lumsden, 1998. p 37.
[127] Mattsson, 2002, p 143.
[128] Stock & Lambert, 2001, p 28.
[129] Mattsson, 2002, p 143.
[130] Persson & Virum, 2001, p 67

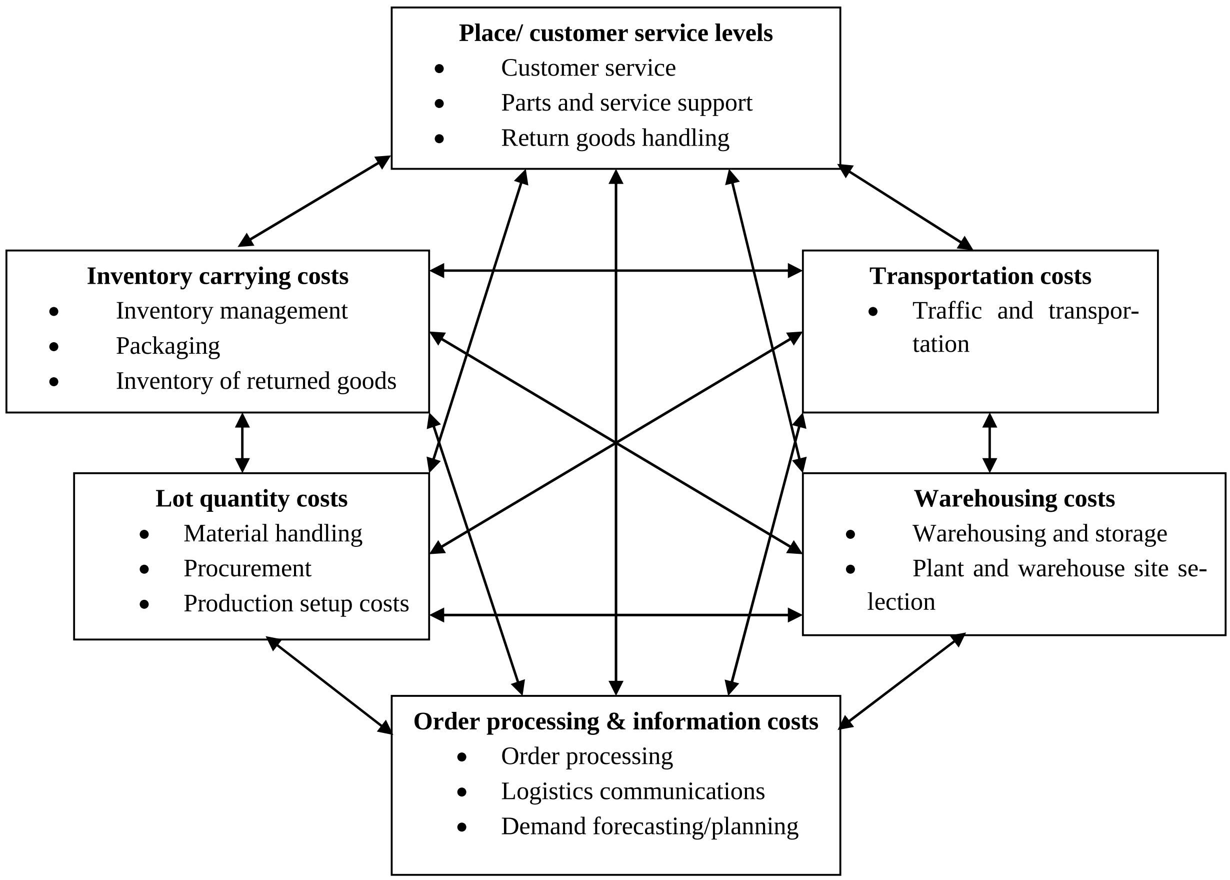

Figure 3.3.1-a: How Logistics Activities Drive Total Logistics Costs.

Source: Stock & Lambert, 2001, p 29.

Customer Service Level

The customer service is a key to gain competitive advantages, according to Stock & Lambert. By adjusting customer service levels to meet what the customer desires and is willing to pay for, the organization may simultaneously improve service level and reduce costs. Only when determining the customer service objectives, decisions about transportation, warehousing, inventory investment, ordering strategies or production can be made.[131] Because each of the other five logistics cost elements work together to support the customer service, the logistics managers need good data regarding expenditures in each category.[132]

[131] Stock & Lambert, 2001, p 97.
[132] Stock & Lambert, 2001, p 28.

Order Processing/ Information Costs

These costs are related to activities such as processing customer orders, distribution communications, and demanding forecasting. As mentioned above, information and order processing systems are of great importance for the support of the customer service level and control of the costs.[133] Investing in new technology and communication systems is therefore important to make it possible for the management to obtain the information required for strategic and operational planning of the logistics function.[134]

Lot Quantity Costs

The production and procurement activities are the major logistics lot quantity costs, and these vary with the changes in the production lot size or order size or frequency. *Production setup cost*, *Capacity cost* due to down time during changeover of line or changeover to a new supplier, *Material handling, scheduling, and expediting*, and *Price differentials* due to buying in different quantities are the including in the costs. [135]

Warehousing Costs

Warehousing and storage activities affect the warehousing costs.[136] The major activities are movement (receiving, transfer, order selection, and shipping), storage (temporary or semi permanent), and information transfer (the link between all of the activities taking place in the warehouse).[137] Even the number and the location of the warehouse, included in the plant and warehouse site selection process affect the costs.[138]

Inventory Carrying Costs

There are four major inventory carrying cost. The first is the *Capital cost* which is the return that the company could make on the money that it has tied up in

[133] Stock & Lambert, 2001, p 30.
[134] Stock & Lambert, 2001, p 181.
[135] Stock & Lambert, 2001, p 30.
[136] Stock & Lambert, 2001, p 29.
[137] Stock & Lambert, 2001, p 429.
[138] Stock & Lambert, 2001, p 29.

inventory. The *Inventory service cost* includes insurance and taxes on inventory. Space related costs that change with the level of inventory includes in the *Storage space cost*. Costs related to obsolescence, pilferage, movement within the inventory system, and damage include in the *Inventory risk cost*. [139]

A method that shows how the average inventory is affected by different delivery frequencies and quantities is presented by Persson & Virum:[140]

Quantity per shipment / 2 = Average inventory quantity.

Increased shipment frequency in order to reduce the average inventory quantity will increase other costs, as for instance transportation and warehousing costs.[141]

Transportation Costs

Costs vary considerably with the number of shipments, weight of shipment, distance, and points of origin and destination. Also the choice of transportation mode may vary the costs considerably. Depending on the unit of analysis, the costs that support transportation can be viewed in many different ways. The costs can, for example, be categorized by customer, by product line, by type of channel, by carrier, by direction (inbound vs. outbound).[142]

One measurement of the transport cost is the cost per performed transport work or ton kilometer, which stands for one ton of goods that is transported one kilometer. This measurement is satisfactory when handling the physical flow.[143]

[Transport cost (EUR/ton) x Quantity (tons)] / [Distance (km) x Quantity (tons)]
= EUR/tonkm

The issue of transportation cost will be discussed more thoroughly in the next section.

[139] Stock & Lambert, 2001, p 31.
[140] Persson & Virum, 1998, p 139.
[141] Persson & Virum, 1998, p 139.
[142] Stock & Lambert, 2001, p 29.
[143] Lumsden, 1998, p 38.

3.3.2 Transportation Costs

Transportation costs are driven by several factors. Even though each factor is not a direct component of transport tariffs, it highly influences rates. Some of the factors are:

1. Distance
2. Volume
3. Fill rate
4. Frequency
5. Stowability
6. Handling
7. Transport mode used

Distance is a major influence on transportation cost, since it directly contributes to variable costs, such as fuel, labor and maintenance. This relationship is perhaps best illustrated in the *Figure 3.3.2-a* below. The curve does not begin at the origin since fixed costs also have to be taken into consideration and those are independent of distance, as for example loading and unloading costs. Another observation is that the cost curve increases at a decreasing rate as a function of distance. This characteristic is known as tapering principle or economy of distance.[144] The basic principle of economy of distance is that the transport cost per unit of weight decreases as distance increases. The longer distances allow fixed costs to be spread over more kilometers, resulting in a lower per kilometer charge. [145]

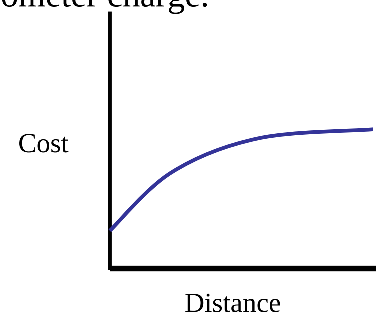

Figure 3.3.2-a: Generalized relationship between distance and transportation cost.

Source: Bowersox, Closs & Cooper, 2002, p 356.

[144] Bowersox et al, 2002, p 357.
[145] Bowersox et al, 2002, p 330.

Volume is the second factor that influences transportation cost. The relationship between transport cost and volume is illustrated in the *Figure 3.3.2-b* below. The figure shows that the transport cost per unit of weight decreases as the load volume increases. This due to the fact that the fixed cost can be spread over an incremental volume, the advantages of economies of scale can be obtained. However, the volume is limited by the capacity of the transportation vehicle or load unit (e.g. container). In order to benefit from the economies of scale, smaller shipments are usually consolidated into larger loads.[146] **Fill rate** is another related parameter that stands for the ratio between the total capacity and the used capacity.

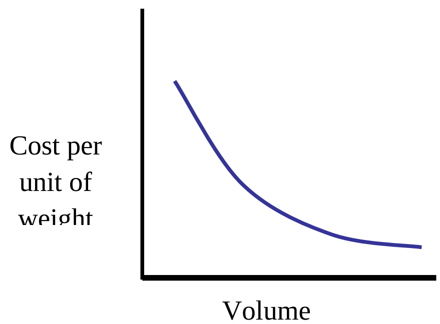

Figure 3.3.2-b: Generalized relationship between volume and transportation cost per unit of weight.

Source: Bowersox, Closs & Cooper, 2002, p 357.

Frequency is the number of shipments during a certain period of time. Higher service level usually implies increased number of shipments - higher frequency. Thereby, the transportation cost is affected.

Stowability is the ability of the goods dimensions to fit into transportation equipment, for instance container, truck or wagon. If the goods have unusual shape, size or weight, they could be difficult to load and space into the transportation equipment. Since the space in the transportation equipment cannot be utilized in the best possible way, the transport cost increases.[147]

[146] Bowersox et al, 2002, p 356.
[147] Bowersox et al, 2002, p 357.

Handling of the transported goods also affects the transport cost. If the transport requires special handling equipment, the transport cost rises. This is common when goods are loaded on ships, rail wagons or trucks.[148]

The choice of **transport mode** is affected by the nature of goods, infrastructure, service level required, lead-time aspect, etc. Thereby the choice of transport mode directly affects the transportation cost.

3.3.3 Transportation Cost Structure

Cost allocation is primarily the carrier's concern, but since cost structure influences negotiating ability, the shipper's[149] perspective is important as well. Transportation costs are classified into following categories:[150]

Variable costs change in a predictable, direct manner in relation to some level of activity. Variable costs can only be avoided by not operating the vehicle. Aside from exceptional circumstances, transport rates must at least cover variable cost. The variable category includes direct carrier cost associated with movement of each load. These expenses are generally measured as cost per kilometer or per unit of weight. Typical variable cost components include labor, fuel and maintenance. On a per kilometer basis, the motor carrier variable costs range from 0,9 EUR to 0,10 EUR[151] per vehicle kilometer.[152]
Fixed costs are expenses that do not change in the short run and must be serviced even when a company is not operating, such as during holiday or a strike. The fixed category includes costs not directly influenced by shipment volume. For transportation firms, fixed components include vehicles, terminals, rights-of-way, information systems and support equipment. In the short term, expenses associated with fixed assets must be covered by contribution above variable costs on a per shipment basis. [153]

[148] Bowersox et al, 2002, p 358.
[149] For Glossary, see Appendix 1.
[150] Stock & Lambert, 2001, p 358.
[151] Leif Enarsson.
[152] Bowersox et al, 2002, p 358.
[153] Bowersox et al, 2002, p 359.

Joint costs are expenses that are directly created by a decision to provide a particular service. A typical example is a cost of back-haul transport.[154] Joint costs have significant impact on transportation charges because carrier quotations must include joint costs based on considerations regarding an appropriate back-haul shipper and/or charges against the original shipper. [155]

Common costs include carrier costs that are incurred on behalf of all or selected shippers. Terminal costs and management expenses are typical examples of common costs and are often allocated to a shipper according to a level of activity like the number of shipments or deliveries handled. However, this sort of allocation may inaccurately assign costs. For instance, a shipper may be charged for delivery appointments when it does not actually use the service. [156]

3.3.3.1 Road Transportation Cost Structure

The cost structure of the motor carriers consists of high levels of variable costs, such as fuel, labor and maintenance, and relatively low fixed costs. Approximately 70 - 90 % of the cost is variable and the rest is fixed where vehicle interest, depreciation and interest on terminals, garages, offices and management are included. Main reason for the low fixed cost is the public investment into road infrastructure.[157]

3.3.3.2 Rail Transportation Cost Structure

The costs associated with rail transportation can be divided into fixed, variable and semi variable costs. The highest are the indirect fixed costs mainly due to the fact that most railroads are the only modes, together with the pipelines, that are maintaining their own network and terminals. Railroads are also operating their own rolling stock. However, in line with recent deregulations in Europe, more and more operators have emerged.[158]

[154] For Glossary, see Appendix 1.
[155] Bowersox et al, 2002, p 359.
[156] Bowersox et al, 2002, p 359.
[157] Coyle, Bardi & Novack, 2000, p 108.
[158] Coyle, Bardi & Novack, 2000, p 136.

Fixed costs of rail transportation stand for 30 percent of the total cost and they consist of operation, maintenance, ownership of rights-of way and extensive investments in terminal facilities. Rights-of-way describe what a carrier's equipment uses to provide movement.[159]

Semi variable costs consist of costs for maintenance of rights-of-way, structures and equipment and stand for more than 40 percent of the total costs.[160]

Variable costs consist of labor costs, which are the largest single element of variable costs for railroads, followed by the fuel and electricity costs.[161]

3.3.3.3 Combined Transportation Cost Structure

The core in combined transportation is that the railways' lower variable and fixed costs (rail track fees included) should compensate two terminal handlings. Similarly, it concerns the transport lead-time, as railway transportation is faster than the road transportation when the trains are in motion. This results in that the combined transportation becomes an interesting solution when the transportation distance is longer than a certain breakeven point distance.

The combined transportation market segment lays first of all on long distance transportations. The breakeven point for how long the distance needs to be in order for the combined transportation to be cheaper than then the road transportation, is described and illustrated in the following formula and diagram.[162, 163]

$$TC_{CT} <= TC_{RoH}$$

$$VC_{LroH1} * D_{LroH1} + FC_{TH1} + VC_{RaH} * D_{RaH} + FC_{TH2} + VC_{LroH2} * DL_{RoH1} <= VC_{RoH} * D_{Ro}$$

[159] Coyle, Bardi & Novack, 2000, p 136.
[160] Coyle, Bardi & Novack, 2000, p 136.
[161] Coyle, Bardi & Novack, 2000, p 136.
[162] Woxenius, 1994, p 26

[163] The formula is a simplification from a total calculation. According to Woxenius, the formula should be extended by ferry crossings costs in the case of combined transportation and pure road transportation. Loading and unloading costs are assumed to be equal for both local road haulage and long distance road haulage. Fixed costs in the various transport modes are assumed to be distributed over the distance covered by the vehicles and thereby a part of the variable cost.

Parameters: TC=Total Cost, VC=Variable Cost, D=Distance, FC=Fixed Cost
Indices: CT=Combined Transport, RoH=Road Haulage, LRoH=Local Road Haulage (1 and 2 refer to terminals), TH=Terminal Handling, RaH=Railway Haulage

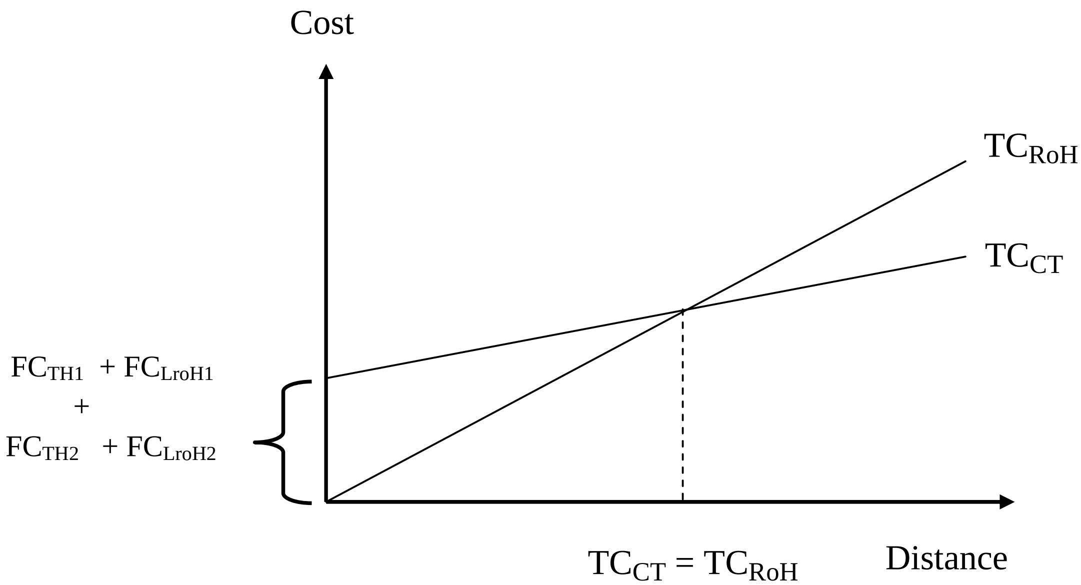

Figure 3.3.3.3-a: Cost comparison between combined transportation and road transportation.

Source: Woxenius, 2003, p 28.

According to Woxenius the shortest distance the combined transportation is competitive against pure road transportation is around 500 km. The combined transport can be competitive at shorter distances if the route includes handling in ports, as in transoceanic transportation, as also road transportation requires handling.[164]

Since the transportation costs are directly connected to the Terms of Delivery - they appoint who is responsible for the transportation part of the purchase and thereby who bears the costs and risks associated with the transportation - in the next section the Terms of Delivery are described more extensively.

[164] Woxenius, 2003, p 41.

3.4 Terms of Delivery

Incoterms are international rules for the interpretation of trade terms set by International Chamber of Commerce, ICC. Incoterms are accepted by governments, legal authorities and practitioners worldwide and used for the interpretation of most commonly used terms in international trade. Incoterms facilitate the conduct of international trade and they reduce or remove altogether uncertainties arising from differing interpretations of such terms in different countries. Incoterms 2000 is the latest edition that was made in order to bring the rules in line with current international trade practices. Reference to Incoterms 2000 in a sales contract defines clearly the parties' respective obligations and reduces the risk of legal complications.[165]

In this thesis by referring to Terms of Delivery, we directly refer to the Incoterms 2000 and use this set of rules will be used continuously throughout the thesis.

The Incoterms represent 13 different international trade scenarios. Each term specifies whether the buyer or the seller is responsible for arranging such necessities as export licenses, customs clearance, insurance, inspections and other obligations. They specify at which point the risk of loss and/or damage passes from seller to buyer as well as which party pays for specific activities. A buyer and seller who conduct their purchase and sale under one of the Incoterms, therefore, will have a mutual understanding of their rights, costs and obligations regardless of differences in language, and local business practices.[166]

Terms of Delivery are a very important part of the purchase agreement between the seller and the buyer. At the latest in the offer stage, the seller and the buyer must agree upon how the risks and costs associated with the movement of the product or Component should be divided. The price of a product or Component in an offer is incomplete if it is not clear what is included in the price. There are eight main questions that are answered by the term of delivery:[167]

- Who arranges the main transport?

[165] Incoterms 2000, p 129-132.
[166] Gooley, Logistics Management & Distribution Report, 2000.
[167] Exporthandboken, 1999, p 352.

- Who pays for the freight?
- Who pays other costs?
- Who must/can insure the goods?
- Who is responsible if the goods are damaged during the transport?
- Who is responsible if the goods are not on time?
- Who conducts a claim towards the transporter?
- Who should pay customs, value added taxes, etc?

In the latest edition (Incoterms 2000), Incoterms are grouped in four different categories:[168]

Group E - Departure

The "E" term Ex works, EXW, - the seller only makes the goods available to the buyer at the seller's own premises. The "E" term is the term in which seller's obligation is at minimum: the seller has to do no more than place the goods at the disposal of the buyer at the agreed place - usually seller's own premises. The transfer of the risk from the seller to the buyer occurs when the gods are available for the buyer and the buyer undertakes all transport formalities.

However, if the parties wish the seller to be responsible for the loading of the goods on departure and to bear the risks and costs associated with that loading, it should be made clear in the contract of sale by adding an explicit wording.[169]

EXW should not be used when the buyer cannot carry out the export formalities directly or indirectly. In such circumstances, the FCA term should be used instead. EXW can be used for all types of transport. [170]

Group F - Main carriage unpaid

The seller is called upon to deliver the goods to a carrier appointed by the buyer. The "F" terms require the seller to deliver the goods for carriage as instructed by the buyer. The "F" terms are:

[168] Incoterms 2000, p 133.
[169] Incoterms, 2000, p 151.
[170] Incoterms 2000, p 151.

FCA - Free Carrier (… named place) - The buyer and the seller agree upon the place where the goods are to be delivered by the seller. The seller delivers the goods, cleared for export to the carrier nominated by the buyer at the named place. If the delivery occurs on the seller's premises, the seller is responsible for loading. If the delivery occurs at any other place, the seller in not responsible for unloading.[171]

The transfer of the risk from the seller to the buyer occurs when the goods are submitted at the place and to the transporter assigned by the buyer. The seller stands for the freight cost to the assigned destination. The seller should also pay for the packaging of the goods that is needed for a designated transport mode. FCA can be used for all types of transport.[172]

FAS - Free Alongside Ship (…named port of shipment) - The seller delivers the goods "at the side of the vessel" at the dock. The seller should also provide the buyer with the documents or equivalent that shows that the goods are delivered there. The buyer is obliged to inform the seller about the name of the vessel used for the transport and the time in which the delivery is going to take place. The buyer pays for the transport and all the costs from the point the goods are delivered "at the side of the vessel". The transfer of the risk from the seller to the buyer occurs when the goods are delivered "at the side of the vessel". The buyer stands for all the document formalities as well. FAS term of delivery is only used for sea transport.[173]

FOB - Free On Board (…named port of shipment) - The seller is to deliver the goods on board the ship and provide the buyer with the customary documentation as a proof that the goods has been delivered. The documents usually consist of a clean on board Bill of Lading or equivalent. It is the buyer's responsibility to enter into a transport agreement and pay all the costs from the point the goods passes the railing of the ship. If the sea freight also includes the loading costs, then the buyer is to pay for those as well. The transfer of the risk from the seller to the buyer takes place when the goods pass the railing of the ship at the port of loading. FOB term of delivery is only used for sea transport.[174]

[171] Incoterms 2000, p 157.
[172] Exporthandboken, 1999, p 363.
[173] Exporthandboken, 1999, p 363.
[174] Exporthandboken, 1999, p 362-363.

Group C - Main carriage paid

The seller has to contract for carriage, but without assuming the risk of loss of or damage to the goods or additional costs due to events occurring after shipment and dispatch.

The "C" terms are:

CFR - Cost and Freight (…named port of destination) - It is the seller's responsibility to make the transport agreement, pay for the freight and deliver the goods passed the ship's rail in the port of shipment. The seller should also provide the buyer with the customary transport documents, including clearing the goods for export.[175] The buyer stands for all the costs from the point the ship arrives to the port of destination. The buyer should also pay for the unloading costs at the port of destination, if those are not included in the sea freight. The transfer of the risk from the seller to the buyer occurs when the goods passes the railing of the ship in the port of loading. CFR can only be used for sea transportation.[176]

CIF - Cost, Insurance and Freight (…named port of destination) - The seller delivers when the goods pass the ship's rail in the port of shipment. The seller must pay the cost and freight necessary to bring the goods to the named port of destination. The risk of loss or damage of the goods, as well as any additional costs due to events occurring after the time of delivery, are transferred from the seller to the buyer.[177]

However, the seller has to sign and pay insurance for the goods that can be transferred to the buyer. The buyer should note that the seller is required to obtain insurance only on minimum cover. The CIF term requires the seller to clear the goods for export. CIF can only be used for sea transportation.[178]

CPT - Carriage Paid To (…named place of destination) - The seller should sign the transport agreement, deliver the goods to the forwarder and pay the freight to the destination place. The buyer stands for all the costs from the point that

[175] Incoterms 2000, p 181.
[176] Exporthandboken, 1999, p 363.
[177] Incoterms 2000, p 189.
[178] Exporthandboken, 1999, p 363.

the goods arrive to the destination place. The buyer is also to pay the unloading costs, if those are not included in the freight. The transfer of the risk from the seller to the buyer occurs when the goods are handed over from the seller to the first freight forwarder. CPT can be used for all types of transport.[179]

CIP - Carriage and Insurance Paid To (…named place of destination) - This term of delivery is identical with the Carriage Paid To, CPT, however with an addition - the seller should sign and pay an insurance for the goods that can be transferred to the buyer. CIP can be used for all types of transport.[180] The buyer bears all the risks and any additional costs that occur after the goods have been so delivered. [181]

Group D - Arrival

The seller has to bear all costs and risks needed to bring the goods to the place of destination.

The "D" terms are:

DAF - Delivered At Frontier (…named place) - The seller should sign the transport agreement and put the goods at the buyer's disposal at the stated place of delivery at the frontier. This frontier can be any sort of frontier, even the country frontier. Therefore, it is of major essence to be clear and always state the place and the location at the frontier. The buyer is responsible for all the costs from the point the goods have been placed to buyer's disposal. The transfer of the risk from the seller to the buyer occurs when the goods has been placed to the buyer's disposal at the frontier location. DAF can be used for all types of transport, however it is intended to be used for road and rail transportation.[182]

DES - Delivered Ex Ship (…named port of destination) - The seller should sign the transportation agreement and put the goods at the buyer's disposal on board the ship at the port of destination. The seller should also provide the buyer with the delivery order and/or customary transport documents that are required for

[179] Exporthandboken, 1999, p 364.
[180] Exporthandboken, 1999, p 364.
[181] Incoterms 2000, p 205.
[182] Exporthandboken, 1999, p 364.

the buyer to take care of the goods. The buyer pays the unloading at the port of destination and stands for all the costs from the point the goods has been put to his disposal. The transfer of the risk from the seller to the buyer occurs when the goods have been put to the buyer's disposal at the port of destination. DES can only be used for sea transportation.[183]

<u>DEQ - Delivered Ex Quay</u> (…named port of destination) - The seller should sign transport agreement and put the goods at the buyer's disposal on the quay at the agreed port of delivery. The seller is also responsible for the customs and should pay the import charges. The transfer of the risk from the seller to the buyer occurs when the goods have been put at the buyer's disposal on the quay at the port of destination. DEQ can only be used for sea transportation.[184]

<u>DDU - Delivered Duty Unpaid</u> (…named place of destination) - The seller is responsible for the delivery of the goods to the location stated in the agreement in the country of import. The seller delivers the goods to the buyer, not cleared for import, and not unloaded from any arriving means of transport at the named place of destination. The seller has to bear the costs and risks involved in bringing the goods thereto.[185] The buyer pays customs, taxes and other import charges and fees as well as the costs and risks that the customs formalities result in. However, if the parties wish the seller to bear the costs and risks related to the duties, as well as the costs payable upon import of the goods, it should be made clear by adding explicit wording to this effect in the contract of sale. The transfer of the risk from the seller to the buyer occurs when the goods have been put at the buyer's disposal at the agreed place of delivery. DDU can be used for all types of transport.[186]

<u>DDP - Delivered Duty Paid</u> (…named place of destination) - This term of delivery implies the most obligation for the seller defined by Incoterms. It is similar to the Delivered Duty Unpaid, DDU, with the exception of that the seller should pay the import charges and possible taxes.[187] The seller is to deliver the goods cleared for import to the buyer, and not unloaded from any arriving means of transport at the named place of destination. The seller has to bear all

[183] Exporthandboken, 1999, p 365.
[184] Exporthandboken, 1999, p 365.
[185] Incoterms 2000, p 237.
[186] Exporthandboken, 1999, p 365.
[187] Exporthandboken, 1999, p 366.

the costs and risks involved in bringing the goods thereto. This term should not be used if the seller is not able to obtain the import license. If the parties wish to exclude from the seller's obligations some of the costs payable upon import of the goods, this should be made clear in the contract of sale. DDP can be used for all types of transport. [188]

On the next page a summary of all 13 Incoterms 2000 is presented in the *Table 3.4-a*, together with the obligations of the buyer and the seller.

[188] Incoterms 2000, p 243.

Incoterms and Services	**EXW**	**FCA**	**FAS**	**FOB**	**CFR**	**CIF**	**CPT**	**CIP**	**DAF**	**DES**	**DEQ**	**DDU**	**DDP**
	Named place	Named place	Named port of destination	Named port of destination	Named place of destination	Named place of destination	Named place of destination	Named port of destination	Named place	Named port of destination	Named port of destination	Named place of destination	Named port of destination
Warehouse storage at point of origin	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER
Warehouse labor charge at origin	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER
Export packing	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER
Loading at point of origin	BUYER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER
Inland freight	BUYER	BUYER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER
Port receiving charges	BUYER	BUYER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER
Forwarding fees	BUYER	BUYER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER
Loading on ocean carrier	BUYER	BUYER	BUYER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER
Ocean freight	BUYER	BUYER	BUYER	BUYER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER	SELLER
Charges in foreign port	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	SELLER	SELLER	SELLER	BUYER	SELLER	SELLER	SELLER
Delivery charges to final destination	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	SELLER	SELLER
Customs duties and taxes abroad	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	BUYER	SELLER	BUYER	SELLER

Table 3.4-a: The responsibility of the seller and the buyer in Incoterms 2000.

Source: www.nassco.com

3.4.1 Cost Undertaking

The Term of Delivery is an important management tool in a company. Since it has a legal significance, it is of major essence to be well acquainted with the Terms of Delivery and their impact. The economic consequences can be substantial if the distribution of the costs and responsibility was not known from the beginning.[189]

For example, if a buyer purchases goods or components and Ex Works, EXW, is a Term of Delivery used, it implies that the seller has minimized his undertaking and only makes the goods available for the buyer on his own (seller's) premises. If the Delivered Duty Paid, DDP, is the Term of Delivery used, than the seller maximizes his undertaking and stands for all the necessary measures, costs and risks until the goods or components are delivered to the buyer at buyer's premises.[190]

As a seller, it may be advantageous to use EXW, in order to avoid all the operations in relation to movement of the goods or components to the buyer, as well as it becomes easier to calculate and submit offers, since no consideration has to be taken to movement of the goods from the seller to the buyer. On the other hand, the seller declines the possibility of taking control and possibility to create his own competitive distribution solutions, since the buyer stands for the risk and costs and thereby decides how the goods or components will be moved. Therefore, choosing the right Term of Delivery is very important especially if the ambition is to control the flow and for example, be able to state the time of delivery to the customer.[191]

3.4.2 Choosing The Right Term of Delivery

The choice of Term of Delivery depends rarely only on the seller or the buyer. The Term of Delivery is included in the purchasing agreement, which is nego-

[189] Exporthandboken, 1999, p 352.
[190] Exporthanboken, 1999, p 344.
[191] Exporthanboken, 1999, p 344-345.

tiated by both parties. If the buyer is not explicitly demanding a specific Term of Delivery, then the seller usually proposes one.[192]

The choice of the right Term of Delivery usually depends on many circumstances, such as the flow of goods, customer service, the type of goods or components, and unfortunately, too many companies use the same Term of Delivery in a routine manner, despite the differences from case to case. In some industries, practices rule the choice of Term of Delivery, as well as trade restrictions or insurance discrimination. Insurance discrimination usually implies that the transport insurance must be signed in an insurance company in the buyer's country. Trade restrictions, such as flag discrimination can affect the choice of Term of Delivery in such manner that a country may have a law that prescribes that all or parts of the import should be managed by the domestic tonnage. This usually implies that the seller makes an offer with a F- Term of Delivery.[193]

In general, one Term of Delivery is not better than the other; the choice depends on various factors. A good Term of Delivery is the one that is decided after negotiations between aware and initiated buyers and sellers. The chosen Term of Delivery should give reasonable advantages for both parties involved and contribute to achieve the best solution at a given delivery situation.[194]

The different Terms of Delivery are intended for different transport modes. Some terms of delivery are defined for a specific mode of transport, for example ship. Other delivery terms are more flexible and can be used independent of the transport mode. It is important to follow the recommendations for each term of delivery. If a term of delivery that is only to be used for a sea transport, as for instance CIF, is used for road transport, the difficult situation may occur when a dispute about damaged goods or division of costs is to be solved. Incoterms 2000 indicate that when using the term CIF, the transfer of the risk from the seller to the buyer occurs at the rail of the ship. If the goods are transported by a truck, when should the transfer of the risk occur? There is no simple answer to that question.[195]

[192] Exporthanboken, 1999, p 345.
[193] Exporthanboken, 1999, p 354.
[194] Exporthandboken, 1999, p 354-355
[195] Exporthandboken, 1999, p 366.

3.4.3 Inbound Transportation Strategy - Terms of Delivery and Logistics

According to Stock and Lambert, the inbound freight decisions such as delivery and routing are frequently left to the supplier's traffic department. The terms of delivery offered by sellers to buyers have significant impacts on the logistics generally, and transportation specially. If the term of delivery is "free delivered", which is a common term used in inbound transportation, which means that the seller quotes a delivered price to the buyer's location that includes not only the cost of the product but also the cost of moving the product to the buyer.[196]

In this way, the buyer knows the final price prior to the purchase and does not have to manage the transportation activity involved in getting the product from the seller's location to the buyer's location. The buyer in this case loses the control of transportation decisions. The buyer's lack of control over the transportation function can potentially cause problems, according to Stock and Lambert.[197] The carrier selected by the shipper, for example, may provide poor services in the buyer's area, or may make deliveries at times that do not correspond to when the buyer would like to receive shipments. Stock and Lambert point out that the buyers should always know the specifics regarding all shipments that include delivery to ensure that optimal decision is being made on their behalf.[198]

Most companies aspire for the greatest possible control of the goods flow into the company, within the company and from the company. By having a control over the goods flow, a company can make the warehousing, production and transports more efficient, create routines and thereby cut costs. Terms Of Delivery as a control instrument play a significant role in the cost cutting process.[199]

The Term Of Delivery provides the seller and the buyer with different obligations and responsibilities, but Term Of Delivery can also create possibilities for

[196] Stock & Lambert, 2002, p 316.
[197] Stock & Lambert, 2002, p 317
[198] Stock & Lambert, 2002, p 317.
[199] Exporthandboken, 1999, p 370-371.

the part that has insight into the matter. It decides who controls the external flow of goods. If the seller for instance, wants to achieve this possibility of control, he would come to an agreement with the buyer that gives him that possibility. The more extensive a Term Of Delivery is for the seller, the more control he has over the flow.[200]

The Terms Of Delivery, and thereby the control and responsibility for the transportation, are in the majority of the cases important if the companies themselves decide how the goods will be transported.[201] According to a study done by Enarsson in 2003, the majority of the studied producing companies in south of Sweden (with varied inbound flows from abroad) purchase their components "free delivered". This means that the suppliers control the inbound flows to a higher extent. Only the largest companies, such as Scania, for example, buy "free house", which means that the buyer stands for the transportation arrangements.[202]

The inbound flow is different from the outbound flow in many ways, usually the inbound flow consists of raw materials or semi finished products, while the outbound flow mainly consists of refined, or finished products. As the goods in inbound transportation have a lower value than the goods in outbound transportation, the demands on time precision are not that high as on the outbound transportation. According to Enarsson it is, however getting more common with higher demands on precision on the inbound transportation.[203]

The most extensive Term Of Delivery described in Incoterms 2000 is Delivered Duty Paid, DDP. Using this term, the seller has theoretically maximum control possibilities, however, in reality this term is not always the best one. Using DDP, the seller is responsible for the payment of the customs, duties and import charges, fees and value added taxes in the country of import and this might not always be the best solution. For example, a Swedish company may experience difficulties in handling the value added taxes paid in another country in their bookkeeping. Therefore, delivery term DDU, Delivered Duty Unpaid is perhaps better choice in this case.[204]

[200] Exporthandboken, 1999, p 371.
[201] Enarsson, 2003, p 39.
[202] Enarsson, 2003, p 45.
[203] Enarsson, 2003, p 45.
[204] Exporthandboken, 1999, p 371.

DDP cannot be used in European Union due to the EU value added tax, VAT, directive which regulates which country's VAT should be charged on the transaction.[205]

Other Terms Of Delivery that make the control of the flows possible are CIF, CPT and CIP.[206]

When importing, the conditions are opposite. The buyer should try to purchase from the seller that is geographically closest. Examples of Terms Of Delivery used in that situation are FOB or FCA. Buyer has in this case greater control of the inbound goods flow. When the control is accomplished both over inbound and outbound flows, the conditions are achieved for the company to deal with the internal flow of the goods, the production and thereby the inventory. This is a very important part of the logistics.[207]

[205] Exporthandboken, 1999, p 371.
[206] Exporthandboken, 1999, p 371.
[207] Exporthandboken, 1999, p 371.

4 Empirical Framework

This chapter presents the empirical data obtained during the study. First, the studied company is described, SKF and SKF Logistics Services and thereafter the characteristics of the current SKF inbound flows are illustrated more thoroughly. Furthermore, the present Terms of Delivery and transportation cost will be presented.

4.1 SKF Group

SKF (Svenska Kullagerfabriken AB) Group is one of the leading manufacturers of roller and ball bearings in the world. SKF produces a variety of bearings, as well as seals and roller bearing steel.[208] The SKF Group is organized in five divisions: Industrial, Automotive, Electrical, Service and Aero and Steel division. Each division serves a global market focusing on its specific customer segment. Total turnover amount in 2002 reached 42,4 billion SEK.[209]

SKF was founded by Sven Wingqvist in 1907, and today the company has 83 manufacturing sites in 22 countries and around 39 000 employees worldwide. The organization is also supported by approximately 7000 distributors and dealers around the world. The most important market for the SKF is the Western Europe, which stands for 53% of total sales, where also the majority of SKF manufacturing activities take place, as the *Figure 4.1-a* below shows. SKF is exposed to hard competition, particularly from manufacturers in the USA, Germany and Japan. [210]

[208] www.hoovers.com, 2003-10-21
[209] www.skf.com, 2003-10-21
[210] www.skf.com, 2003-10-21

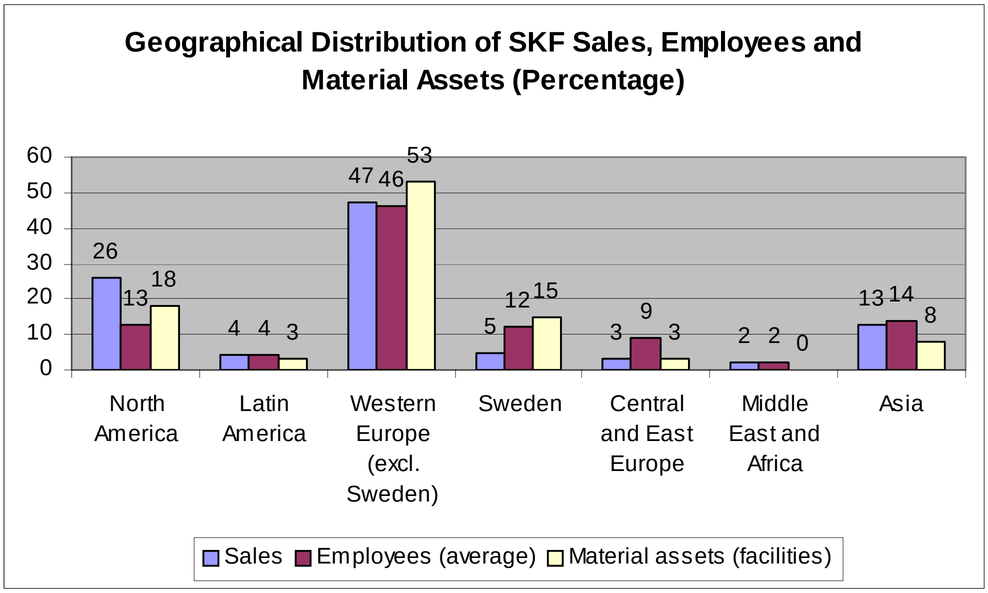

Figure 4.1-a: Geographical Distribution of SKF Sales, Employees and Material Assets (Percentage)

Source: SKF Annual Report 2002, p 9.

4.1.1 The SKF Products

SKF Group produces a variety of bearings, bearing units, bearing housings and seals and many other types of products used in a wide range of industry applications, as for example maintenance and lubrication products. However, SKF Group does not only manufacture bearings - through a dedicated entity called SKF Reliability Systems, SKF offers methods to help organizations reduce total machine related costs.

SKF Group provides solutions for several industries, such as aerospace, automotive, construction equipment, mining, plastic and rubber, pulp and paper and racing and skates industries.[211] An assortment of SKF ball bearings is presented in the *Figure 4.1.1-a* below.

[211] www.skf.com, 2003-10-30

Figure 4.1.1-a: An assortment of ball bearings

Source: SKF Intranet.

4.2 SKF Logistics Services

SKF Logistics Services, SKF LS, was established in 1995 as an independent business unit, that provides warehousing and transportation services for the SKF Group and external customers worldwide.[212]

SKF LS offers different services to their customers, such as inbound and outbound logistics, warehousing, inventory management, transportation, value added services, packaging, assembly, supply order handling and procurement, export handling and documentation and education and training, among others. The vision of SKF LS is " *To be a World Class Supplier of Integrated Logistics Services Worldwide for SKF and external customers*." [213]

SKF LS manages a worldwide transportation network called The Global Transport Network, which includes all transport modes, together with daily airfreight and weekly sea freight departures to all major markets worldwide. [214]

SKF LS has a dedicated European transportation network, combining cross border traffic with delivery to final customers. This network uses fixed timeta-

[212] www.skflogisticsservices.com, 2003-10-27
[213] SKF LS Intranet, 2003-10-21
[214] www.skflogisticsservices.com, 2003-10-30

bles and provides deliveries across the European continent. A similar system has been implemented in North America as well. SKF LS provide their customers with a Global Tracking Service (GTS), which enables the follow up of customer goods to the final destination. [215]

The Daily Transport System (DTS) is a distribution network that delivers products from the SKF Factories and international warehouses, so called Logistics Service Units (LSU), directly to the customers. There are different types of direct customer deliveries according to customer demand regarding delivery time. The delivery order type sets the priority on the delivery that will be transported in the DTS.[216]

The distribution structure contains transportations between Logistics Service Units, International Hubs[217] and Domestic Hubs. The main task for a hub is cross-docking[218] activities. There are 46 routes and the maximum transport time within Europe is 72 hours, which is almost always achieved. The number of trucks used on the routes per day varies between 1 to 4 trucks according to the quantities transported. If the quantities are low on certain route, the number of trucks could be as low as 1 to 2 trucks per week. To make the system operational, the trucks follow time schedules. The system is rather flexible and it allows calling in extra trucks when needed. Over the year, the DTS handles approximately 1 900 000 packages and has 15 000 full truckload, FTL, shipments.[219]

The Schenker Dedicated Services operates the DTS Network independently, i.e. without restrains from SKF LS, and the trucks used in the DTS are only transporting SKF supplied products. The transportation cost is negotiated between SKF LS and Schenker Dedicated Services for each route and the consideration is taken if the transportation regards FTL or LTL shipments.[220]

There are five European International Hubs located in Airasca, Gothenburg, Schweinfurt, Tongeren and Tours, as shown in the *Figure 4.2-a* below.

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[215] www.skflogisticsservices.com, 2003-10-30
[216] Axelsson & Dahlqvist, 1999, p 7.
[217] For Glossary, see Appendix 1.
[218] For Glossary, see Appendix 1.
[219] Axelsson & Dahlqvist, 1999, p 8.
[220] Axelsson & Dahlqvist, 1999, p 13.

<u>SKF Logistics Services International Hubs</u>

1 - Gothenburg	4 - Tongeren
2- Airasca	5 - Tours
3 - Schweinfurt	

Figure 4.2-a: SKF Logistics Services International Hubs

Source: SKF LS and map from *<u>http://www.3dworldmap.com/Europe.html</u>*

4.3 Characteristics of the Inbound Flows

The total purchasing volume of SKF existing business was 23 billion SEK in 2002. Direct material stands for 48% or 11 billion SEK for the same year.[221]

[221] SKF Annual Report 2002.

SKF purchases approximately 15 different components, and three of them are included in our study, Component A, B and C. The total purchased volume of the components included in the study is approximately 50 000 tons per year.

4.3.1 The Procurement Process

The purchasing of components is done by SKF Group Purchasing, more precisely Global Purchasing Material, GPMs, and SKF Supply Chain. The responsibilities between these two organizations are split in such way so that SKF Group Purchasing is responsible for finding suppliers and for negotiating commercial contracts, while SKF Supply Chain is responsible for all operations including supply chain contracts. SKF Supply Chain has direct contacts with the supplier for operational matters, such as transportation and frequency, as well as the follow up of the supplier delivery performance.

SKF has established policies that consider SKF suppliers and their processes. These policies involve, among other, demand for shorter lead times, increased requirements on the supplier shipment performance, increased delivery frequency and that the focus should be put on the total logistics cost, instead of optimizing transport cost alone.

The Goods Reception and Supply Chain at one of the SKF factories in Gothenburg were interviewed, and accordingly, the flows that are managed by the DTS network, are better performed than the flows from other inbound suppliers. The deliveries are on time and disruptions are seldom experienced. Important to mention is also that the goods reception often has problems with the inbound deliveries and according to the Goods Reception, higher demands must be put upon the inbound transportation delivery precision, especially when it comes to time aspects.

The Goods Reception experiences that problems occur with certain deliveries, where the supplier delivers to the wrong location on the factory premises. In some cases deliveries are made just outside the factory premises, which sometimes create complications for the Goods Reception. This is in direct connection with the agreement that is made between the supplier and the SKF. The Goods Reception expresses a wish for better communication between them and the SKF Group Purchasing and Supply Chain, in order to achieve a better solution for all the parties involved. The system that monitors the supplier's shipment performance is not currently used, even though some of the factories in Europe are applying it. Today, it is difficult to obtain detailed information about why the delivery is not satisfactory.

4.3.2 Component Characteristics

The components under study are classified as direct material and they are not purchased at every SKF factory included in the study. However, every factory purchases one or more of these components from external suppliers.

4.3.2.1 Component A

SKF purchases approximately 10 000 tons of Component A each year. There are five suppliers of this component, four are located in Europe and one is located outside Europe. The Component A is loaded in SKF half pallets (800 x 600 mm) and Euro pallets (800 x 1200 mm) and the weight of each pallet is approximately 300 - 400 kg.

4.3.2.2 Component B

There are two suppliers of Component B and SKF purchases approximately 20 000 tons of this component each year. Since Component B has specific measures, it is loaded in bundles that weight from 200 to 2000 kg. Component B requires special handling equipment for loading and unloading.

4.3.2.3 Component C

SKF purchases approximately 20 000 tons of Component C each year from eleven different suppliers. Weight of the Component C is from 100 to 1500 kg per load unit and this component requires specific wood support due to its particular features. However, one supplier uses Euro pallet as load unit.

4.3.3 SKF Factories

Factories under study are organized in a divisional way; Industrial, Automotive and Electrical divisions are represented in this study with 15 factories all around Europe. Each factory does not purchase every of the three components, however, each factory included in the study purchases at least one or more of the components. The *Table 4.3.3-a* shows the components purchased by specific SKF factories included in the study.

Country	Factory	Component A	Component B	Component C
Austria	1. Steyr	Y	Y	-
France	2. St Cyr	Y	-	Y
	3. St Cyr DGBB	Y	Y	-
Germany	4. Leverkusen	-	-	Y
	5. Mühlheim	Y	-	-
	6. Püttlingen	-	Y	-
	7. Schweinfurt PDK	-	-	Y
Italy	8. Airasca	Y	-	-
	9. Bari	Y	Y	Y
	10. Massa	Y	-	-
	11. OMVP Villar Perosa	-	Y	-
Poland	12. Poznan	-	Y	-
Spain	13. Tudela	Y	-	-
Sweden	14. Gothenburg	Y	-	Y
Ukraine	15. Lutsk	-	-	Y

Table 4.3.3-a: The components purchased by each factory, Y (Yes) marks the factories that purchase components in question.

The *Figure 4.3.3-a* below shows the geographical distribution of the SKF factories in Europe. The factories are categorized by the location, i.e. one location may have several factories, as for example St Cyr has two factories included in the study, Industrial division and DGBB. The figure, however, for practical reasons, shows only one location. All factories are located in the European Union, except of Poznan and Lutsk, which are located in Poland and Ukraine.

1 - Steyr	9 - Bari
2 - Fontenay	10 - Massa
3 - St Cyr (DGBB & Industrial)	11 - Villar Perosa
4 - Leverkusen	12 - Poznan
5 - Mühlheim	13 - Tudela
6 - Püttlingen	14 - Gothenburg
7 - Schweinfurt PDK	15 - Lutsk

Figure 4.3.3-a: SKF Factories in Europe included in the study.

Source: Own modification from http://www.3dworldmap.com/Europe.html

4.3.4 Suppliers

There are in total 18 external suppliers of Component A, B and C to SKF factories in Europe included in this study: five suppliers of the Component A, two for the Component B and eleven for the Component C. The suppliers are presented in the *Figure 4.3.4-a* below. As the map clearly shows, there is a concentration of suppliers in mainly two regions, Northern Italy and Germany. One supplier is not located in the Europe, and is therefore not presented in the *Figure 4.3.4-a*. The relations between SKF factories and each supplier will be described further on in this chapter.

Figure 4.3.4-a: External suppliers to SKF Factories in Europe, listed in Table 4.3.3-a.

Source: Own modification from *http://www.3dworldmap.com/Europe.html*

There are in total 38 relations or flows between the external suppliers and SKF factories in Europe. Relations or flows are terms used and they mean that one supplier can be supplier for several SKF factories and 38 is the total number of relations or flows from all external suppliers to all SKF factories included in the study.

4.4 The Parameters

The parameters chosen for the mapping are the Terms Of Delivery that are currently used and transportation cost for each supplier - SKF factory relation.

The Terms Of Delivery, TOD, described in this study are based on *International Chamber of Commerce official rules for the interpretation of trade terms - Incoterms 2000*, since they are the most used and known all over the world. The Terms Of Delivery is an essential part of the purchasing agreement between the seller and the buyer and each agreement has a separate section that treats this issue. The Terms Of Delivery determine who bears the costs and risks associated with the transport. However, the focus of this thesis is the costs.

Transportation cost has several cost drivers that affect the total transportation cost. The cost drivers are:

1. *Quantities* of components A, B and C that are purchased,
2. The *frequency* in which they are purchased,
3. *Distance* from supplier to the SKF factory,
4. The *fill rate* of the vehicle (truck or a wagon), which is the ratio of used capacity and total capacity of the vehicle.
5. *Stowability* and *handling* of the load unit used are dependent on the characteristic of the components in question.
6. *Transport mode* used.

The transportation cost is expressed in EUR/ tonkm, since it facilitates the comparison between the different relations.

The description of how each cost driver affects the transportation cost is presented below.

4.4.1 Quantity, Frequency and Distance

Quantity or volume of the transported goods, frequency in which it is transported as well as the distance involved are major transportation cost drivers. Almost all transport tariffs are based on these parameters.

Since the components included in this study are of heavy nature, the quantity in this thesis is expressed in weight, rather than volume as one of the parameters. The reason is that the weight restrictions, for example in a truck, are easier to reach with this type of goods than the volume restrictions. The quantity is presented in tons per year and the frequency is presented in times per week or month.

It is important to point out that the factories that purchase the largest quantities of the Components A, B and C, Fontenay and Cassino, are not included in the study. Therefore, the quantities presented in this thesis would have been much higher if those factories were included as well.

As the information about specific quantities and frequencies in which they are purchased is of a sensitive nature, they have been classified into five categories: Very High, High, Medium, Low and Very Low, for the Quantity and Frequency and Very Long, Long, Medium, Short and Very Short for the Distance. The classification is presented below.

All the distances between the suppliers and SKF factories were calculated with the help of Via Michelin Maps.[222]

[222] www.viamichelin.com

Quantity per year

Very High	more than 2500 tons
High	1500 - 2499 tons
Medium	500 - 1499 tons
Low	100 - 499 tons
Very Low	0 - 99 tons

Frequency

Very High	more than 5 times / week
High	4 - 5 times / week
Medium	1 - 3 times / week
Low	1 - 3 times / month
Very Low	less than 1 time / month

Distance

Very Long	longer than 1500 km
Long	1000 - 1499 km
Medium	500 km - 999 km
Short	100 km - 499 km
Very Short	less than 100 km

4.4.2 Fill Rate

Fill rate stands for the ratio between the used capacity and the total capacity of the vehicle. The values are expressed in FTL and LTL terms, where FTL stands for full truckload and LTL stands for less than a truckload. The total capacity of the truck is assumed to be 25 tons for each supplier - SKF factory relation.

4.4.3 Handling and Stowability

Handling and Stowability of the components are highly dependent on characteristics of the component as well as the load unit that is used for each component. Components with unusual dimensions is commonly more difficult to handle and thereby more expensive to transport.

4.4.4 Transport Mode Used

The transport mode is highly relevant for our study, since the heavy nature of the components that are transported dictates the conditions for the transport mode that is used. The transportation cost is affected by the choice of the transportation mode and thereby it also affects the choice of the Term Of Delivery.

4.5 Findings for SKF Factories

In this section the specific findings for each SKF factory included in the study are presented. Detailed findings about Terms Of Delivery and transportation cost and its drivers (quantities, frequency, distance, fill rate, characteristics of the goods and its handling and stowability, as well as the transport mode used) are presented in form of tables in the *Appendix 3* to *17* and summarized below. Since some parts of information are not complete, in particular information about transportation costs, only the essential parts for each factory will be presented.

4.5.1 Austria - Steyr

Steyr is a SKF factory that purchases more than 2500 tons of the Components A, B and C in total each year. The frequency in which components are purchased is Medium to Low. When it comes to the Terms Of Delivery, as shown in the *Appendix 3,* Steyr uses four different delivery terms when purchasing from its external suppliers. Transportation cost is known for two of the relations, that also use EXW as a delivery term.

4.5.2 France - St Cyr

The SKF factory in St Cyr (Automotive Division) purchases only one component included in the study, Component C, from four different suppliers. The total purchased quantity is Very High, above 2500 tons per year. St Cyr uses DDP as a Term Of Delivery, which means that the transportation cost is included in the total component cost and the supplier is responsible for the transportation. Transportation cost is known for three of four supplier - SKF factory relations.

St Cyr factory has special demands on the delivery. This factory does not want any deliveries on Mondays, since they do not want the supplier to load on Friday; park the truck in a wet place during the weekend and deliver corroded Components on Monday. Apparently, this has previously been a problem. There is also a specific time window when the delivery should be made. For more details, see *Appendix 4*.

4.5.3 France - St Cyr DGBB

St Cyr DGBB is part of the Electrical Division and purchases in total between 1500 to 2500 tons of Components A and B each year. The frequency of purchases is, however, not known, nor is the transportation cost. See *Appendix 5* for details.

4.5.4 Germany - Leverkusen

Leverkusen purchases between 500 and 1500 tons of Component C each year from one single supplier. Transportation cost is 0,21 EUR/tonkm. The frequency is Medium and the Term Of Delivery is DDP. Leverkusen represents a typical SKF factory in this study, both when it comes to Term Of Delivery, quantity, frequency and transport mode. For more details, see *Appendix 6*.

4.5.5 Germany - Mühlheim

SKF Mühlheim purchases Very Low quantity, below 100 tons per year, from one supplier of Component A, as shown in the *Appendix 7*. The delivery term used is EWX and the transportation cost is 0,44 EUR/tonkm.

4.5.6 Germany - Püttlingen

The SKF factory in Püttlingen purchases only one of the components included in the study, namely Component B. The Term Of Delivery used is DDU, and the quantity and frequency per year are Medium, i.e. the quantity is between 500 and 1500 tons per year and the frequency is 1 to 3 times per week. It is interesting to point out that in the relation Supplier B2 - SKF Püttlingen rail is partially used as the transportation mode. This is however only for the 40% of the total quantity. Another interesting finding is in the column Transportation cost. The respondent has stated that the cost that represents the transportation is irrelevant since the delivery term used is DDU and thereby the supplier is paying for the transport. See *Appendix 8*.

4.5.7 Germany - Schweinfurt PDK

One of the factories in Schweinfurt, PDK, is only purchasing the Component C from three different suppliers. The total quantity is more than 2500 tons per year while the frequency is Medium, 1 to 3 times per week. Interesting in this case is the choice of Term Of Delivery. Namely, all three suppliers, C8, C1 and C7 are located in Germany and the components are transported by road. Nevertheless, CIF is used as a Term of Delivery in two cases out of three. Ex works is used in one case. Transportation cost is known for two relations and it is 0,05 and 0,07 EUR/tonkm respectively. See *Appendix 9* for details.

4.5.8 Italy - Airasca

Airasca factory has two suppliers of Component A. It seems to be rather unclear which Term Of Delivery is used in Airasca factory. "Landed Airasca" is the received answer and after further consultations with the respondent, the conclusion was made that this means that the transport price is included in the total Component price. In other words, "landed Airasca" is equivalent to DDP. Airasca purchases Very High quantity of Components A, B and C, more than 2500 tons per year. The frequency is High with one supplier, and there are other arrangements with the second supplier. The transportation cost is not known. Sea transport is used in combination with road transport with one of the suppliers. See *Appendix 10* for more details.

4.5.9 Italy - Bari

The SKF factory in Bari purchases components from five different suppliers. This factory purchases all three components included in the study and the total quantity is Very High. Bari stands for the highest purchased quantity of all factories included in the study.

For one of the components, Component A, there is a specific transport arrangement. The supplier A1 delivers the Component DDP to the SKF warehouse in Airasca and from there; SKF Logistics Services arranges the transport to Bari, which is situated approximately 1000 km south of Airasca. If the transport from supplier's premises to SKF site is taken into consideration, than the supplier is responsible for that part of the transportation. Transportation cost is known in two cases, for relation between suppliers B1 and B2.

Other Terms Of Delivery used are EXW and DDU with one supplier respectively and DDP for the remaining two suppliers. For more details, see *Appendix 11*.

4.5.10 Italy - Massa

Massa factory uses the same transport arrangement provided by SKF LS as the Bari factory, namely the components from supplier A1 are first delivered to SKF warehouse in Airasca and from there transported to Massa factory. For the other supplier, EXW is the delivery term used, as shown in *Appendix 12*. SKF Massa purchases relatively Low quantity of Components A, B and C. The transportation cost is not known.

4.5.11 Italy - OMVP Villar Perosa

Villar Perosa purchases only one of the components, Component B, from two suppliers. The total quantity is Very High, more than 2500 tons per year. DDU and CIP are the Terms Of Delivery used. It is interesting to point out that the Supplier B1 delivers using CIP, Carriage and Insurance Paid To the SKF factory in Villar Perosa. Transportation cost is known for both relations. The details are presented in *Appendix 13*.

4.5.12 Poland - Poznan

Poznan factory located in Poland purchases Medium quantity in total of the Component B, between 500 and 1500 tons per year from two different suppliers. Ex works is used as a delivery term in one case, DDU in the other. The transportation cost is 0,055 EUR/tonkm for the relation that uses EXW as a delivery term. See *Appendix 14* for more details.

4.5.13 Spain - Tudela

Tudela purchases Very High quantities of Component A, more than 2500 tons per year from the three different suppliers. The Term Of Delivery used is DDP and the frequency is Very High in two of three cases. Transportation cost is known for one of the relations, relation between Supplier A3 and SKF Tudela and stands for 0,062 EUR/tonkm. Interesting to point out is that the transportation cost in this case stands for 36,3% of the total commodity cost. See *Appendix 15* for more details.

4.5.14 Sweden - Gothenburg

Gothenburg only purchases Component C from one single supplier. The quantity purchased each year exceeds 2500 tons and the frequency is Very High. The Term Of Delivery used is DDP. Euro pallet is used as the unit of load, unlike other factories that use specific wood support for this particular Component. The transportation cost is the highest mapped in this study, 2,46 EUR/tonkm. See *Appendix 16* for details.

4.5.15 Ukraine - Lutsk

Lutsk is located in Ukraine and it is the only SKF factory included in the study that purchases using the delivery term Free Carrier, FCA. Another finding makes Lutsk even more unique; this factory has the entire flow from the Supplier C10 into the factory transported by rail, which stands for 0,7% of the total purchased quantity. Lutsk purchases only Component C. The transportation cost between the Supplier C10 and SKF Lutsk is the lowest mapped, namely 0,011 EUR/tonkm. See *Appendix 17* for details.

4.5.16 The Findings - Summary

In this section the summary of the findings for each SKF factory described above is presented. It will follow the same structure as earlier in this chapter, i.e., Terms of Delivery will be presented first, followed by the transportation cost and its cost drivers: quantity, frequency, distance, density, handling and stowability, and transport mode used.

4.5.16.1 <u>Terms of Delivery</u>

As the *Figure 4.5.16.1-a* shows, the Delivered Duty Paid is the Term Of Delivery that is used most frequently today, 40% of all external supplier - SKF factory relations use DDP as a delivery term. Out of 38 relations in total, 15 are DDP, 8 are EXW, 7 are DDU, 2 are CIF, 2 are FCA, 1 is CIP, 1 is FOB and 2 are "Landed Airasca". See *Appendix 3 - 17* for all the details about the each SKF factory.

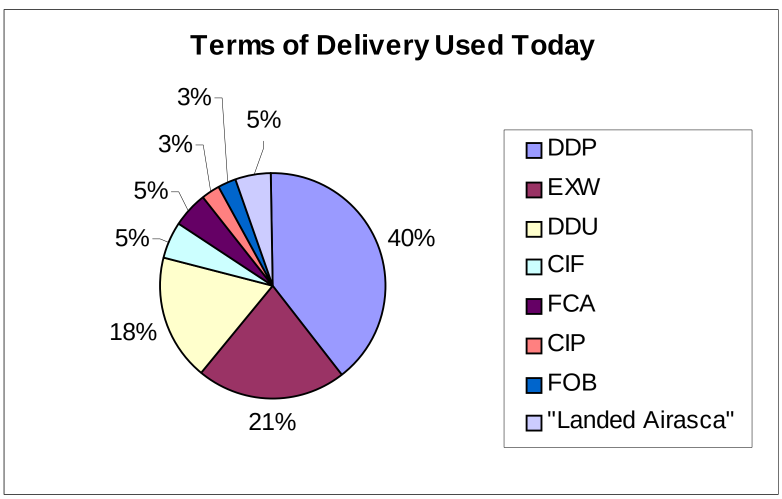

Figure 4.5.16.1-a: Terms of Delivery used Today

4.5.16.2 <u>Transportation Cost</u>

Transportation cost is known for 19 of 38 relations, or 50%. The findings for transportation cost drivers are presented below. For all the details about these findings, see *Appendix 3 - 17*.

Quantity

SKF factories purchase in total approximately 50 000 tons of Components A, B and C each year from the 18 external suppliers included in the study: 10 000 tons of Component A, 15 000 tons of Component B and 25 000 tons of Component C. *Table 4.5.16.2-a* below shows the number of relations for each category - Very High, High, Medium, Low and Very Low. As the table shows, the majority of relations tend to purchase Medium to Low quantity, i.e. between 100 to 1500 tons per year. *See Appendix 3 - 17* for details.

Quantity	Range	Number of relations	Percentage
Very High	More than 2500 tons	7	18%
High	1500 - 2499 tons	4	11%
Medium	500 - 1499 tons	10	26%
Low	100 - 499 tons	12	32%
Very Low	0 - 99 tons	5	13%
Total	-	**38**	**100%**

Table 4.5.16.2-a: The distribution of purchased quantity per each Supplier - SKF factory relation.

Frequency

When it comes to Frequency, the majority of Supplier - SKF factory flows purchase their components one to three times per week, followed by the Low frequency, where the components are purchased 1 to 3 times per month, as shown in the *Table 4.5.16.2-b* below. There are also five relations where the frequency is not known (as shown in *Appendices 3 - 17*) due to various factors, mainly the frequency variations from time to time.

Frequency	Range	Number of Relations	Percentage
Very High	More than 5 times / week	5	13%
High	4 - 5 times / week	4	11%
Medium	1 - 3 times / week	13	34%
Low	1 - 3 times / month	9	24%
Very Low	Less than 1 time / month	2	5%
Not known	-	5	13%
Total	-	**38**	**100%**

Table 4.5.16.2-b: The distribution of frequency in which the components are purchased for each Supplier - SKF factory relation.

Distance

The majority of the SKF factories purchase their components from the suppliers that are located between 1000 and 1500 kilometers from the factory, as seen in the *Table 4.5.16.2-c* below. However, other distances are also important and it can be summarized that SKF purchases goods from suppliers that are both relatively near, 100 to 500 kilometers and relatively long away, longer than 1500 km.

Distance	Range	Number of Relations	Percentage
Very Long	Longer than 1500 km	8	21%
Long	1000 km - 1499 km	11	29%
Medium	500 km - 999 km	8	21%
Short	100 km - 499 km	8	21%
Very Short	Less than 100 km	3	8%
Total	**-**	**38**	**100%**

Table 4.5.16.2-c: The distribution of the distance between Supplier and the SKF factories.

The quantity of the transported goods, the frequency in which they are transported as well as the distance involved, are the main influences on the transportation cost.

Handling and Stowability

There are mainly four different units of load used for the transportation of the Components A, B and C and they are: SKF Pallet (also known as SKF GSP 1 and 2) with dimensions 800x600x1200 (500) mm, Euro pallet with dimensions 800x1200 mm, a bundle with size and dimensions highly dependent of the Component in question and a specific wood support that is used for Component C in some factories. The Euro pallet and the SKF pallet are easier to handle while the Component B requires special handling equipment due to its specific features. *Figure 4.5.16.2-a* below shows the three studied components and their characteristics.

Figure 4.5.16.2-a: Components under study.

Source: Own pictures

Transport Mode Used

There are three modes of transport used when transporting between external suppliers and SKF factories - road, rail and sea. Road transportation is by far the most used one - it is used in all relations - except one. Rail transport is used only in two relations, entirely in one, Supplier C10 - SKF Lutsk and partially in the second - only 40% of the quantity in the relation Supplier B2 - SKF factory in Püttlingen is transported by train, which stands for 0,4% of total quantity of all purchased components. In total, rail transport stands for 1,2%[223] of the total purchased quantity by all SKF factories included in the study.

Sea transport is also used in combination with road transport and stands for approximately 1,6% of the total Component quantity. It is important to clarify

[223] The value is based on the obtained data; however, this percentage is probably higher, since one of the suppliers is using rail solution for its other products.

that both rail and sea transports are used only in combination with road transport, however with one exception.

Yet, attempts have been made within the SKF LS that included rail transport. The results from this experience were lower costs, higher capacity, and apparent environmental aspects but also longer lead-time and lesser flexibility. The rail solution implied a possibility of a longer delay than the road transportation, which is of very sensitive nature when it comes to outbound flows, mainly since the transport involved several transit countries.

5 Analysis

In this chapter the similarities and differences between the theoretical frame of reference and the results of the empirical investigation will be analyzed. This chapter is divided in three sections. In the first section, the characteristics of the inbound flow are analyzed by comparing the theory with the obtained empirical data. In the second part, the choice of the Terms Of Delivery is investigated and the flows that are analyzed with regard on delivery terms and transportation cost are presented. In the third part of the analysis, the flows with the most improvement potential with regard on Terms Of Delivery, as well as the transportation cost are identified and evaluated. In addition, the potential of coordination of the inbound flows is evaluated.

5.1 The Characteristics of the Inbound Flows

The focus of SKF has long been put on outbound movements of the goods - the movement from the manufacturing company to its customers. The customer satisfaction characterized and still is characterizing the logistics strategies within the company. The right product is to be delivered to the customer at the right time, place, in right quantity and to an optimized cost. The customer needs should be met and preferably exceeded. This is in accordance with the theory, as said by Stock & Lambert; the companies have put less focus on the inbound transportation flows, mainly due to the fact that the inbound flow usually considers raw materials or components that have significantly lower value than the outbound flow. The suppliers have traditionally arranged the inbound flows and carried all the risks and costs associated with the transport and thereby they had total control over the inbound flows. This clearly coincides with the current situation in the SKF where the supplier is responsible for the majority, 71% of the studied inbound flows.

When observing the frequency of the inbound transportation flows, which is rather high, together with the quantity described in the empirical framework, it can be said that the replenishment of the Components A, B and C is in general constant and frequent. The distances involved in the study are of long nature - the average distance for all relations is approximately 1000 km.

Due to the specific characteristics of the Components A, B and C, it is relevant to consider if the transportation mode used is the optimal solution. Since the components in the study are of a heavy nature, the rail transport appears to be a valid solution for the transportation of these components. In addition, the lowest mapped transportation cost per tonkm is the transportation cost between Supplier C10 and SKF Lutsk, and stands for rail transport. Even though this relation is between two locations in Eastern Europe, this can give an indication of the cost efficiency (in EUR/tonkm) of the rail transport. Admittedly, the service level of this particular flow was not been taken into consideration, nor was the performance of this flow in general.

Furthermore, the capacity of the railway wagon is higher than the capacity of a truck, which implies a reduced number of shipments in general. According to Woxenius, the distance where the rail transport is more cost efficient than road is approximately 500 km for combined transportation, which suggests that rail could be an alternative.

The inbound rail transportation to the SKF factories in Europe stands for barely 1,2% of the total transported quantity.[224] SKF LS already have made attempts on using the railway connection, in some outbound relations and the experience from these attempts shows that the railway transport has admittedly lower cost, the environmental benefits are higher, as well as the loading capacity. Nevertheless, the railway attempt showed that the lead-time was longer for these flows and that delays are an often occurrence, mainly due to the many border crossings involved.

Additionally, the rail transport is less flexible and a combi terminal is required for loading and unloading of the goods. Therefore, the rail solution is usually complemented by road transport. The SKF experience with the rail transport coincides with the Woxenius' findings that the main problems of the European rail transportation today are the many border crossings and the complications they imply.

The *Table 5.1-a* shows the percentage of total quantity of purchased components by each country where the SKF factory is located (first two columns from

[224] The value is based on the obtained data; however, this percentage is probably higher, since one of the suppliers is using rail solution for its other products.

left). The quantities purchased are divided per country where they are purchased, i.e. the country where the suppliers are located. For example, SKF factories in Italy purchase 30% of the total Component quantity of Components A, B and C from Sweden, 13,6% from Italy and 1% from Ireland.

Purchased quantity		**Country where the suppliers are located**							
SKF	**Quantity (% of total)**	**Italy**	**France**	**Germany**	**Sweden**	**Ukraine**	**Ireland**	**USA**	**Russia**
Italy	**45%**	13,6%	-	0,1%	30%	-	1%	-	-
France	**22%**	4%	7%	8%	3%	-	-	-	-
Germany	**14%**	-	-	12%	1%	-	-	-	-
Spain	**6%**	1%	-	-	-	-	5%	0,01%	-
Austria	**5%**	0,7%	-	1%	4%		0%	0,3%	
Sweden	**5%**	-	-	-	5%	-	-	-	-
Ukraine	**2%**	-	-	-	-	0,7%	-	-	1%
Poland	**1%**	0,3%	-	-	1%	-	-	-	-
Total	**100%**	**20%**	**7%**	**21%**	**44%**	**0,7%**	**6%**	**0,31%**	**1%**

Table 5.1-a: The Component quantities per SKF factory in Europe and the countries where the components are purchased.

The shadowed cells in the *Table 5.1-a* represent the percentage of the total Component quantity that is purchased within the same country, i.e. where both the supplier and the SKF factory are located in the same country. As shown in the table, the domestic purchasing stands for a rather high percentage in almost all cases. The SKF factories purchase from domestic suppliers, which shows a firm domestic anchorage - 38% of total purchased quantity of Components A, B and C is purchased domestically. However, other important Component flows can be distinguished, especially those between Sweden and Italy, and Germany and France. SKF factories in Italy, France and Germany purchase 81% of the total purchased quantity of Components A, B and C.

The average distance between the suppliers and SKF factories is long, around 1000 km, and the purchase of direct materials is, according to SKF, expected to be even more international and from markets that are located even further away, especially in the East Europe and Asia. Today, the international purchasing stands for approximately 62% of the total purchased quantity. At the same time, SKF manufacturing demands more frequent and smaller deliveries, high delivery precision and high service level of the inbound flows. In order to comply with these demands, efficient management of the inbound flows is required, in order to make the right decisions when it comes both to transportation and total logistics costs. By having control over the goods flow, a company can make the warehousing, production and transports more efficient, create routines and thereby cut costs. According to the Exporthandboken, Terms Of Delivery as a control instrument play a significant role in the cost cutting process.

5.2 Revising the Terms Of Delivery

Choosing the right Term Of Delivery is of major essence and the right delivery term should provide advantages for both the seller and the buyer and it should be agreed upon by negotiations. Since it has both legal and economic significance for the parties involved, it is important that the Term Of Delivery is well analyzed and thought through within each company involved.

As the Empirical Framework shows, the transportation costs are easier to identify if the Term Of Delivery represents the most obligation for the buyer, in this case SKF. 53% of the transportation costs are not identified where the Terms Of Delivery used are DDP, DDU, CIF or CIP, compared to 20% where the delivery term is EXW or FCA. This shows a connection between the degree of the control of the transportation and the transparency of the costs. In addition, detailed information about the cost structure of the transportation cost does not exist in a compiled form. This clearly coincides with the theory where Stock & Lambert claim that an in-depth analysis of the transportation costs for the inbound transportation is not performed as often as for the outbound equivalence. Also, it is in accordance with Stock & Lambert and Enarsson that claim that the supplier is in control of the inbound flow to the higher level and inbound freight decisions are left to the supplier's logistics department.

5.2.1 Terms of Delivery at SKF

As seen in the Empirical Framework, Delivered Duty Paid, DDP, is the most widely used Incoterm by the SKF factories in Europe. 15 of 38 or 40% of the supplier - SKF factory relations use this Term Of Delivery. DDP is the delivery term that maximizes the seller's responsibility and maximizes his risks and costs until the goods are delivered to the buyer. It means that the seller has full control of the flow if DDP is the delivery term that is used.

Another interesting fact is that all 15 relations that use DDP as a delivery term between suppliers and SKF factories are located in the European Union. According to the Exporthandboken, DDP cannot be used in the European Union due to the EU value added tax, VAT, directive that regulates which country's VAT should be charged on the transaction.

Whilst the DDP term represents the maximum obligation for the seller, EXW represents the minimum - the obligation is transferred to the buyer. Ex works, EXW, is used in 21% of the supplier - SKF factory relations. This implies that SKF is bearing all the risks and costs associated with the transportation.

CIF, or Cost, Insurance and Freight is used in two relations between the two suppliers and SKF Schweinfurt, where all parties are located in the same country and the goods is transported by the truck. This is perhaps the clearest example where the practice highly argues with the theory. According to the Incoterms 2000, CIF is only to be used for sea and inland waterway transportation and a problem might occur if a "sea" delivery term is used with another transport mode. Since CIF is to be used only if the goods pass the ship's rail, it might be difficult determining responsibility if a damage of the goods occurs.

5.2.2 Analyzed Flows

In this section all the supplier - SKF factory relations (flows) where the transportation cost in EUR/tonkm is known will be analyzed. The transport cost between the relations that use C or D Terms Of Delivery is compared with the flows that use E or F terms, i.e. the comparison between the transport cost where the supplier is responsible for the transportation and transport cost when SKF is responsible for transportation is done. This, in order to find connections and differences between the transport cost and the Term Of Delivery that is used.

The transportation cost in this thesis is presented in EUR/tonkm, i.e. the cost is adapted so that it can be compared between the different relations, since the distance and quantity play a major role in the transport cost.

[Transport cost (EUR/ton) x Quantity (ton)] / [Distance (km) x Quantity (ton)] = EUR/tonkm

If the cost is expressed in for instance EUR/ton, than it cannot be comparable for the relations with the different distances since it only describes the cost per transported ton at that particular distance. In that case, the distance, that greatly influences the transport cost, is not considered. The table below shows the transport cost values for the supplier - SKF factory flows.

No.	Supplier	SKF factory	Transport cost EUR/tonkm	Fill rate	Term Of Delivery
1	C9	SKF Gothenburg	2,49	LTL	DDP
2	A4	SKF Mühlheim	0,438	LTL	EXW*
3	C1	SKF Leverkusen	0,214	LTL	DDP
4	B2	SKF Bari	0,168	FTL	DDU
5	A2	SKF Steyr	0,112	LTL	EXW*
6	B1	SKF Villar Perosa	0,103	FTL	CIP
7	A1	SKF Steyr	0,096	LTL	EXW*
8	A1	SKF St Cyr DGBB	0,094	LTL	EXW*
9	C3	SKF St Cyr	0,08	FTL	DDP
10	C1	SKF Schweinfurt	0,07	LTL	CIF
11	C5	SKF St Cyr	0,065	FTL	DDP
12	A3	SKF Tudela	0,062	LTL	DDP
13	B1	SKF Poznan	0,055	LTL	EXW
14	C8	SKF Schweinfurt	0,047	FTL	CIF
15	C1	SKF St Cyr	0,045	FTL	DDP
16	B2	SKF Villar Perosa	0,04	FTL	DDU
17	B1	SKF Bari	0,037	FTL	EXW
18	C11	SKF Lutsk	0,023	FTL	FCA
19	C10	SKF Lutsk	0,01	100 %	FCA

Table 5.2.2-a: Transportation cost in EUR/tonkm for SKF factories in Europe.

* The flows within the DTS Network.

As shown in the *Table 5.2.2-a,* flow 1 has the highest cost, 2,49 EUR/tonkm. This is mainly due to one reason, namely the distance involved in this relation is extremely short. Therefore, the fixed costs that are usually spread over the distance are higher for this relation. Since this relation is rather extreme and different from the rest of the flows and similar flows, with which it could be compared, do not exist, it will be excluded from further calculations in this section.

The relation nr 19, from supplier C10 to SKF Lutsk is another extreme; the transportation cost in this case is 0,01 EUR/tonkm, which represents the lowest mapped cost. However, since this cost stands for the rail transport, it will also be excluded from further calculations, as all other relations consider road transport.

The average transport cost for four types of Terms Of Delivery is calculated in order to make a transport cost comparison between different delivery terms. The table below shows the average transport cost in EUR/tonkm for the different types of delivery term, E, F, C and D terms for the above-presented relations. The lowest cost have those relations that use FCA delivery term and the highest average transportation cost is for those relations who use EXW as a delivery term, as shown in the *Table 5.2.2-b*. However, there is another aspect that should be considered, namely the fill rate for these relations.

Term Of Delivery	The average Transport Cost (EUR/tonkm)
EXW	0,139*
DDP/DDU	0,096
CIF/CIP	0,073
FCA	0,023

Table 5.2.2-b: Transport cost in EUR/tonkm for each Term Of Delivery

5.2.2.1 Transportation Cost and Fill Rate

If the fill rate is considered, which stands for ratio of capacity used and max loading capacity of the vehicle, the results show that EXW delivery term is

* Includes the flows within the DTS Network.

mainly used for less than a truckload, LTL, shipments while DDP or DDU is mainly used for the FTL, full truck load, shipments, see *Table 5.2.2.1-a* below.

Fill rate in relation to the Terms Of Delivery (percent of total number of flows with identified transport cost)				
Fill rate	**DDP/DDU**	**CIF/CIP**	**EXW**	**FCA**
FTL	27%	11%	6%[**]	6%
LTL	17%	6%	27%	0%

Table 5.2.2.1-a: Fill rate in relation to the Terms Of Delivery - the percentage of total number of flows with identified transport cost.

When transporting full truckloads, FTL, the advantages of economies of scale can be obtained and the fixed costs can be spread over an incremental quantity. Interesting to point out is that in this case, EXW is used for LTL shipments where, according to Bowersox et al., the cost per unit of weight (in this case EUR/tonkm) is higher due to the lower quantity that is transported and the fact that the fixed costs need to be spread over the lower quantity. Therefore, the buyer, since he is carrying all the costs of transportation, is usually trying to consolidate this type of shipments with other LTL shipments, where possible. In addition, the LTL shipments require extra handling, usually due to consolidations with other LTL shipments, which also augment the total transportation cost per unit of weight. Therefore, the LTL segment usually implies higher transportation cost.

In this study, the buyers, SKF factories, are responsible for two full truckload flows, or 12%, where the delivery term used are EXW and FCA. There is a clear tendency that shows that SKF factories use DDP or DDU when purchasing full truckload, TL, shipments and EXW when purchasing LTL shipments.

If the average transportation cost is categorized by the Terms Of Delivery used and Fill rate, the FCA and EXW delivery terms stand for lowest transport cost in EUR/tonkm, while the DDP/DDU stand for the highest for the FTL fill rate. The opposite is when the LTL shipments are considered, as shown in the *Table 5.2.2.1-b* below.

[**] The assumption is made that this flow is a FTL due to the low transport cost.

The average transport cost in EUR/tonkm categorized by the Term of Delivery and Fill rate				
Fill rate	**DDP/DDU**	**CIF/CIP**	**EXW**	**FCA**
FTL	0,0796	0,075	0,037	0,023
LTL	0,138	0,07	0,159	-

Table 5.2.2.1-b: The average transport cost in EUR/tonkm categorized by Term Of Delivery and Fill rate.

5.2.2.2 Comparison Between Similar FTL Flows

There are two comparable flows that are showing similar results regarding the cost and the fill rate. In this case, the supplier is the same and the components are transported to two different factories in the same country, SKF Bari and SKF Villar Perosa, as shown in the *Table 5.2.2.2-a* below. However, the delivery term is different, EXW is used in the first and CIP in the second case. The flow that uses EXW is approximately 64% less costly than the flow that uses CIP as a delivery term.

Supplier	SKF factory	TOD	Fill rate	Transport Cost (EUR/tonkm)
B1	SKF Bari	EXW	FTL	0,037
B1	SKF Villar Perosa	CIP	FTL	0,103

Table 5.2.2.2-a: The transportation cost and Terms Of Delivery for flows between Supplier B1 and SKF Bari and Villar Perosa.

Nevertheless, the comparison between these two flows can be unjust, since the characteristics of these flows differ in certain aspects, regarding quantities and distances involved in particular. However, since the product is the same in both cases and the supplier is also the same, and the costs associated with handling are the same, this comparison can give an indication about the cost relation between these two flows.

If the flows that have similar characteristics, i.e. similar quantities, distances and fill rates are compared, the following flows are identified:

Supplier	SKF factory	TOD	Fill rate	EUR/tonkm
B1	SKF Bari	EXW	FTL	0,037
C5	SKF St Cyr	DDP	FTL	0,065
C1	St Cyr	DDP	FTL	0,045

Table 5.2.2.2-b: The Transportation cost comparison between flows with similar characteristics and different Terms Of Delivery.

The *Table 5.2.2.2-b* above shows a flow that uses EXW as a delivery term and two other flows that use DDP as a delivery term. These flows have quite similar characteristics, namely the quantities, distances and the fill rates are very similar. Nevertheless, the transportation cost is 43% respectively 18% lower for the EXW flow.

5.2.2.3 <u>Transportation Cost Comparison Between Different Terms Of Delivery</u>

The EXW flows that use the services of SKF LS and its Daily Transport Service, DTS, network have more elevated transport cost per tonkm, since the goods is LTL (very small quantities per shipment) and needs to be consolidated with other DTS flows and the transports are seldom direct and usually take a detour via hub where the goods is consolidated. Also, the service level of the DTS network is offered, with among other, daily deliveries. Thus, these flows cannot entirely be compared with the other analyzed flows that are DDP/DDU, CIF/CIP, since the EXW DTS flows have specific characteristics and much higher service level. The table below shows the costs if those flows are separated from other EXW flows, as shown in the *Table 5.2.2.3-a* below.

Term Of Delivery	Average Transport Cost (EUR/tonkm)
EXW (DTS)	0,185
DDP/DDU	0,096
CIF/CIP	0,073
EXW	0,046
FCA	0,023

Table 5.2.2.3-a: Transport costs when the EXW DTS flows are separated.

As the *Table 5.2.2.3-a* shows, the average transportation cost is 0,096 EUR/tonkm for flows that use DDP or DDU as a delivery term and 0,046 EUR/tonkm for the flows that use EXW. Hence, the transportation cost is 52% lower for the flows that use EXW as a delivery term.

5.3 Coordination of Inbound Flows

In this section the inbound flows with most improvement and savings potential are identified and presented. The improvement suggestions are divided in three different categories. The first suggestion is prerequisite for the other two, i.e. Suggestion 1 has to be implemented in order for the Suggestion 2 or 3 to function. The specific flows in each of the suggestions are identified, as well as the influence these changes might have on the total logistics cost. The Suggestions are:

Suggestion 1: <u>Change of Term Of Delivery</u> - Change from DDP, DDU, CIF or CIP to EXW or FCA, i.e. the transfer of responsibility for transportation from the seller to the buyer, SKF. Renegotiation of contracts and use of buying power are done in order to cut total logistics costs. This suggestion treats primarily full truckload flows, FTL; however, the transparency of the transportation cost is essential for revising all the mapped flows, including LTL flows.

Suggestion 2: <u>"Milk runs"</u> - The components are collected from suppliers located in the same geographical area are transported to the same factory. One main flow with high frequency and high quantity, almost full truckload that picks up other, LTL flows with lower frequency.

Suggestion 3: <u>The Consolidation with Outbound Distribution Flows</u> - Long distance, LTL flows, in order to have a high frequency delivery the LTL shipments are consolidated in SKF LS terminals. Many different flows, detailed planning required.

5.3.1 Suggestion 1 - Change of Terms Of Delivery

Based on the findings from the previous section, *5.2 Revising the Terms Of Delivery*, the FTL flows where the supplier is responsible for the inbound transportation showed to be more costly than the EXW or FCA equivalents. Therefore, the Suggestion 1 is to change the Terms Of Delivery for the FTL flows from DDP/DDU or CIF/CIP to EXW or FCA, when the contract with the supplier is negotiated. The FTL flows that have known transportation cost are shown in the *Table 5.3.1-a* below.

No.	Supplier	SKF factory	Transport cost EUR/tonkm	Fill rate	Term Of Delivery
4	B2	SKF Bari	**0,168**	FTL	DDU
6	B1	SKF Villar Perosa	**0,103**	FTL	CIP
9	C3	SKF St Cyr	**0,08**	FTL	DDP
11	C5	SKF St Cyr	**0,065**	FTL	DDP
14	C8	SKF Schweinfurt	**0,047**	FTL	CIF
15	C1	SKF St Cyr	**0,045**	FTL	DDP
16	B2	SKF Villar Perosa	**0,04**	FTL	DDU

Table 5.3.1-a: The DDP/DDU/CIF/CIP full truckload flows with known transportation cost in EUR/tonkm.

By renegotiating the contracts and taking control of the inbound transportation for these FTL flows the transportation cost per ton kilometer could be lowered by 54%, as shown in the *Table 5.3.1-b* below. The table that shows the average transportation cost for FTL shipments in EUR/ton categorized by the Term Of Delivery used. Important to add is that these values are based on the EUR/tonkm transport cost and it does not necessarily have to imply the same result if the cost is calculated in another measurement unit.

The average transportation cost for FTL shipments in EUR/tonkm categorized by the Term of Delivery used				
Fill rate	**DDP/DDU**	**CIF/CIP**	**EXW**	**FCA**
FTL	0,0796	0,075	0,037	0,023

Table 5.3.1-b: The average transportation cost for FTL shipments in EUR/tonkm categorized by the Term Of Delivery used.

5.3.2 Suggestion 2 - "Milk Runs"

Earlier in this chapter it has been pointed out that the SKF factories purchase their components domestically, but also that the majority of the factories purchase from suppliers that are located in other countries, which will probably increase even more in the future. At the same time, the higher demands will be put upon the deliveries. By consolidating smaller shipments that are to be delivered over longer distances, several advantages can be gained. In this section the focus is put on studying the potential coordination of inbound flows as an improvement suggestion.

Based on the previous sections in this same chapter, the flows that use DDP, DDU, CIF or CIP as a delivery term and have known transport cost, are identified. Also, it is considered how the already existing infrastructure, resources and knowledge that exist within the SKF LS distribution network could be utilized.

Another important factor is the geographical position of the suppliers in relation to the already existing SKF LS distribution facilities, as well as the component involved. The choice of component is based upon the characteristics of the component itself, i.e. it should be able to fit the standard handling equipment that exists at the SKF LS facilities. In addition, other transportation cost parameters are taken into consideration - purchased quantity and frequency. The fill rate is especially considered, since, based on the previous sections, the full truckload flows tend to have lower transportation cost.

There are two main flows to two SKF factories that can be used for coordination with smaller flows - Supplier C1 - SKF St Cyr and Supplier C1 - SKF Schweinfurt. These two Main Flows have high quantities and high frequency of the studied components. There are also two Complementary Flows that go from different suppliers to the same SKF factory as these two Main Flows do. The frequencies and the quantities involved in the Complementary Flows are smaller than the ones of the Main Flows, the fill rate is FTL for the first and LTL for the second Complementary Flow. Both Main and Complementary flows are presented in the *Table 5.3.2-a* below:

Flow	Supplier	SKF factory	Transport cost EUR/tonkm	Fill rate	Term Of Delivery
Main flow 1	C1	SKF St Cyr	0,045	FTL	DDP
Complementary flow 1	C2	SKF St Cyr	Not known	FTL	DDP
Main flow 2	C8	SKF Schweinfurt	0,05	FTL	CIF
Complementary flow 2	C1	SKF Schweinfurt	0,07	LTL	CIF

Table 5.3.2-a: The Main Flows and the Complementary Flows for the Suggestion 2.

For detailed information about quantities, distances and frequencies for each flow, see *Appendix 4* for SKF St Cyr and *Appendix 9* for SKF Schweinfurt.

By coordinating these Main and Complementary Flows with each other, the frequency increase is 20% for the Main Flow 1, and 500% for the Complementary Flow 1. This increase is calculated in such way that the total quantity for both flows is summed up and divided with the capacity of a full truckload, FTL. The obtained value represents the new frequency and it is compared with the previous frequency value. When it comes to the Main Flow 2 and its coordination with Complementary Flow 2, the frequency increases with 9% for the Main Flow and 292% for the Complementary Flow.

The increased frequency has an impact on the customer service level, since the demand for more frequent deliveries with smaller quantities is an important customer request, according to the SKF Group Purchasing and SKF Supply Chain. Higher frequency is one way in which the customer service level can be increased.

The capacity of the truck will not be optimized for the Main Flow 1 during the entire shipment time for the both flows, and the detour that has to be taken is approximately 15% longer than the original distance. The Main Flow 2 on the other hand, has a less significant detour that is 5% longer than the original route. Both distance and frequency affect the transportation cost directly.

If the Main Flow 1 is taken into consideration, the average inventory quantity at the SKF factory in St Cyr would decrease with 17%, if the frequency increases with 20%, given that the consumption is even throughout the year. For the Complementary Flow 1, the average inventory quantity at the factory would decrease with 83% if the frequency increases with 500%, given that the consumption is even throughout the year. For the Main Flow 2, the average inventory quantity will decrease with 20% and with 78% for the Complementary Flow 2, if the frequency increases with 9% respectively 292%. These values consider the quantity and thereby also occupied warehouse or factory floor space.[225]

Order processing and information costs will probably increase, since more planning and communication between the supplier and the SKF is needed in order to coordinate the transport.

An alternative to the Suggestion 2 could be that the goods from the suppliers that are located nearby the SKF LS International Hub in Tongeren are transported to the Hub, consolidated with all the goods that have SKF factory in St Cyr as a destination. There are 3 suppliers that are located approximately 200 km from the SKF HUB in Tongeren and that are appropriate for this suggestion. Tentatively, the flow between Supplier C1 and SKF St Cyr could be used as a Main Flow.

5.3.3 Suggestion 3 - Consolidation with the Outbound Distribution Flows

As a Suggestion 3, three flows have been identified. These flows do not have known transportation cost, however, these relations are worth revising, due to other benefits they can create, together with a possible cost reduction.

First two flows consist of the flow from one supplier to two different SKF factories, Steyr and Tudela. The supplier is located approximately 300 km from the SKF LS distribution center located in North America. Since both flows are LTL flows and can be coordinated into the SKF LS network, the existing resources should be utilized in this case. See *Table 5.3.3-a*.

Concerning the transoceanic transport from Supplier A5 to both SKF factories, the quantities per shipment are very low in both cases; in fact, the quantities are extremely low when the distance is considered. By consolidating these flows

[225] The calculations are based on actual values for each parameter involved. The calculation method is presented in the *Section 3.3.1 Total Cost Concept* subsection *Inventory Carrying Costs*.

already in North America with the SKF outbound distribution flows, the transportation cost is assumed to be lower.

The total transport lead-time in this particular case could be shortened with 30% and 65% respectively if SKF LS solution is used.[226] Since the consolidation is possible, the deliveries can be even smaller in quantity and more frequent. The load units are Euro pallets and SKF GSP 2 pallets, which does not imply any extra handling costs.

Supplier	SKF factory	Transport cost EUR/tonkm	Fill rate	Term Of Delivery
A5	SKF Steyr	Not known	LTL	FOB Hamburg
A5	SKF Tudela	Not known	LTL	DDP

Table 5.3.3-a: The flows from Supplier A5 to SKF Steyr and Tudela included in the Suggestion 3.

The transportation cost in the third flow, shown in the *Table 5.3.3-b below*, is not known. What makes this flow interesting is that the Supplier A2 already has flows within the SKF Logistics Services DTS network for other SKF factories, while supplier still manages this particular flow.

A suggestion is that this flow also uses the SKF DTS flow, even though the transportation cost of the DTS flow is shown to be higher than for the DDU flows. Nevertheless, the service level would increase and the deliveries would be more frequent with smaller quantities and less inventory.

Supplier	SKF factory	Transport cost EUR/tonkm	Fill rate	Term Of Delivery
A2	SKF St Cyr	Not known	Not known	DDU

Table 5.3.3-b: Another flow included in the Suggestion 3: Supplier A2 - SKF St Cyr.

[226] This value is based on the comparison between actual lead-time and solution offered by DTS.

The order processing and information costs will in this case not increase significantly, since Supplier A2 already has communication with the SKF LS when planning the other flows that are already included in the DTS network.

6 Conclusions

The conclusions and recommendations based on the empirical framework and the analysis will be presented in this chapter.

Today's business environment forces the companies to revise their processes in order to stay competitive in the marketplace. Revising the inbound logistics flows is not an exception. Increased focus on coordination of inbound logistics flows is a prerequisite for securing the quality in form of the delivery performance as well as the total logistics cost perspective.

Knowing how to apply the current trade standards, Terms Of Delivery, is one way of analyzing the inbound logistics flows. This in order to understand what affect the inbound flows have on the total cost of the product. The choice of the right delivery term depends on many circumstances, such as the flow of goods, type of goods or components and customer service required.

By choosing the delivery term that provides the company with the most responsibility and cost undertaking when it comes to inbound transportation, a company obtains the greatest possible control of the goods flows into and from the company. By having control of the goods flow, a company can make warehousing, production and transports more efficient, create routines and thereby cut costs.

A main advantage of having the supplier that is in control of the transportation by using some of the C or D delivery terms is that the buyer does not have to manage the transportation activity - the buyer can concentrate on his core business. This solution could be preferred when the seller has a better agreement with the forwarder and competence to manage the particular flow to a lower cost. This is especially important if the goods that are transported require a special type of transportation due to its characteristics or if the transportation involves a location or a country where the seller has superior experience and knowledge about.

However, to be able to compare if the seller indeed has the better agreement with a forwarder, a cost transparency is required and the buyer should always know the cost structure of the transportation, i.e. the transportation cost should be specified and separate from the total Component cost. This, in order to, for the buying company, to consider the trade-offs when analyzing the risks, insurance and costs that the transportation implies.

The disadvantage of using the C or D Terms Of Delivery is that the possibility to influence the transportation procedure itself diminishes and the transportation is generally adapted to the seller's needs and specifications. The buyer loses the possibility to affect the inbound transportation decisions that affect other areas of the company, such as inventory carrying costs, transportation costs, customer service level costs, warehousing costs, lot quantity costs and order processing costs.

The opposite can be said about the E and F Terms Of Delivery, EXW, FCA, FAS and FOB. The major advantage of using these delivery terms is that the buyer can organize the transport according to the needs that exist within the company and take a full consideration about the inventory carrying costs, transportation costs, customer service level costs, warehousing costs, lot quantity costs and order processing costs.

The most commonly used delivery term between SKF factories and its suppliers of Components A, B and C is DDP and in total, supplier bears all the risks and costs of the transportation in 71 percent of the relations. This shows that SKF has let the suppliers take control of the inbound flows.

In our opinion, SKF should use the E and F delivery terms more than is currently the case. SKF is a global company that should make use of its full potential and resources such as the legal and transportation expertise that exist within the company. An example of the expertise that already exists within the SKF is SKF Logistics Services that operates an extensive network for the outbound distribution.

It is also important to point out that the risks associated with the inbound transportation are minimal, especially within the European Union. Both infrastructure (road) and import and export legislation facilitate the transportation within the EU, in contrast to, for instance, other parts of the world where hijacking of trucks and poor infrastructure with long and insecure transport lead-times give other considerations regarding the choice of Terms Of Delivery.

The array of the delivery terms used in SKF factories around Europe shows that SKF does not have a consistent Group practice when choosing a Term Of Delivery. In general, the supplier is responsible for the transportation. SKF Factory Purchasing Managers have not focused on the inbound transportation, since the transportation cost is often included in the total component price and the negotiations are done by the Group Purchasing Material, GPM. Therefore, due to the mix of responsibility, the awareness of the transportation cost and its significance is minimal.

SKF should revise the use of certain delivery terms that are applied today. In particular, the use of DDP and CIF is, according to the theory, not applicable for those transport conditions that are currently used by SKF.

As the empirical study shows, the knowledge about the transportation costs of the inbound transports is poor. The transparency of the costs as well as the cost structure of the transport cost is in many cases difficult to obtain and the routines for follow up of these costs are insufficient. By not having the transparency of the costs involved in the inbound transportation, the basic data that is needed for decision-making is not always available and thereby it is very difficult to present numerically what the possible changes of the delivery terms would have for an impact on the total transportation cost.

One of the reasons is that this information is available in some form and in some parts of the organization, however, in most of the cases, it is not extracted from the invoices and put together in some sort of record and the understanding where this information is found is not always an easy task. There are no clear routines within the SKF Group Purchasing organization about follow up and monitoring of the transportation cost structure from the invoices received from their suppliers, which could be used for evaluation and decision about the use of delivery terms.

Since the suppliers have the control of the inbound transportation, such as delivery and routing, their focus is evidently put on optimizing their own transportation costs, without considerations how these decisions might affect buyer's inventory, production process and quality aspects. This is clearly seen in the *Table 5.2.2.1-a: Fill rate in relation to the Terms Of Delivery - the percentage of total number of flows with identified transport cost* in the section *5.2.2.1 Transportation Cost and Fill Rate,* where the table shows that the majority of the DDP flows are full truckload flows, FTL, i.e. the supplier is optimizing the load capacity of the vehicle, at his own convenience.

To return to the problem definition and the three questions raised in the Section *1.2 Problem Definition*, the following recommendations are presented:

The first question, mapping of the characteristics of the inbound flows has been the elemental process and prerequisite for getting the understanding of the inbound logistical system and its performance. It is presented in the Section *4, Empirical Framework* and analyzed in the Section *5, Analysis*. Important to mention is that the response frequency of the questionnaire has been 62% and the "complete answers" were received from 34% of the respondents. This has directly affected the obtained results.

The second question, namely choice of the most advantageous Term Of Delivery, can be seen from two different perspectives, the cost perspective and the customer service level perspective. The risk and responsibility associated with the transportation were not analyzed in this thesis. Nevertheless, the risk and responsibility aspects are very important part of the Terms Of Delivery that has to be considered when choosing the delivery terms. The inbound flows that have the lowest transportation cost, presented in Section *5.2.2, Analyzed Flows*, are the flows where EXW is used as a delivery term, excluding the EXW flows within the DTS network. Regarding the customer service level, the most advantageous delivery terms are those EXW flows within the DTS network, due to the high flexibility, precise deliveries and high customer service in general. However, these flows are shown to be more costly than other inbound flows.

The main problem definition, evaluation of the potential improvements with regard on Terms Of Delivery, has the coordination of the inbound flows as a focus. Three different suggestion alternatives are presented in the Section *5.3 Coordination Of Inbound Flows*, where the flows with most improvement and savings potential are identified and presented.

Higher demands that are put upon inbound logistics flows, such as delivery precision (timing and quantity) and smaller and more frequent deliveries will require a greater need for coordination of these flows.

We recommend SKF to complete the mapping of the inbound flows and also include other components, besides Component A, B and C. Further, the information about transportation cost needs to be mapped in more detail, where all cost components are clearly identified. This, in order to have a stable foundation for decision making and finding an optimal solution for each inbound flow and for the total logistics cost aspect. Furthermore, the demands from the manufacturing organization need to be clearly defined, as for instance if a need for more frequent deliveries exists.

SKF needs to get more involved and have better control of the process of choosing the delivery terms and not to let old practices rule the choice of Terms Of Delivery today. By having more control of the choice of delivery terms, SKF can also have a better control of the inbound flows.

When it comes to the choice of transport mode, rail transport appears to be more suitable, due to the heavy nature of the Components A, B and C. However, the road transportation is the most used transport mode today, as the shown in the Section *4.5.2.2 Transportation Cost*, subsection *Transport Mode*. The main reason for this is the superior flexibility, shorter lead-time and delivery precision of the road transport, while the cost, which is higher for the road transport, is not as important.

Nonetheless, development in several European countries where freight fees will be introduced for heavy truck transport, which could increase the cost of road transport with as much as 10%, have to be taken into consideration. Also, the environmental aspect will probably play bigger role in the future. In our opinion, SKF needs to be updated about the recent developments of the rail and combined transportation and actively explore the possibilities that this transport mode offers.

In our opinion, there are advantages with the SKF Logistics Services taking more control of the inbound logistics flows. In that way, SKF LS will have an overall picture of the entire transportation activity, both inbound and outbound transportation, which among other enables finding possibilities in coordination, as well as the use of knowledge and expertise about the transportation market and buying power that the SKF LS has. By doing so, the purchasing organization will be able to concentrate on their core business; at the same time as the transportation cost and the total logistics cost of the inbound flows could be minimized. In order for this solution to work, SKF Group Purchasing organization, Supply Chain and SKF Logistics Services need to work more closely.

Below, the summary of recommendations is presented:

- **Cost transparency** is necessary for the decision of the right Terms Of Delivery. Therefore, transportation cost always needs to be known, regardless of who is responsible for transportation.

- It is also important to **increase Term of Delivery awareness and knowledge** within the organization in such way that, for instance, current EU policies are taken into consideration.

- **Continued mapping** of the rest of the Components is required in order to obtain a whole picture of the entire inbound flow.

- **Review of the risks and responsibilities** is necessary for the decision of the appropriate delivery terms, which are not revised in this thesis.

- **Review** all the flows separately, also taking into account special demands for each commodity flow, and examine which flows can **change** the delivery terms to E or F terms. Review of the Terms Of Delivery on a **regular basis** is necessary.

- **Use more E and F delivery terms** in general - As the results of the thesis show, higher customer service level for LTL shipments, lower transportation cost for FTL shipments and higher cost transparency overall can be achieved when using E and F delivery terms.

- **SKF Logistics Services should have greater control** over the SKF logistics flows, including inbound flow, due to already existing expertise, buying power, resources and competence. In this way, finding coordination possibilities, as the suggestions presented in this thesis, is possible to a greater extent. By giving more responsibility over the inbound logistics flows to SKF LS, SKF LS can achieve a better overview over inbound and outbound logistics flows, at the same time as SKF Group Purchasing can focus on their core business - purchasing.

7 Discussion

In this final chapter, the comments and thoughts we had during the study are presented. The suggestions for further research are also presented.

7.1 The Data Used in the Thesis

The importance of the revising of the inbound logistics flows has already been identified within the SKF and there is awareness within the organization that this area needs more attention. This gives a positive impression, since findings of this thesis imply that such need exists.

The critical phase of this thesis has been the data collection. As mentioned in the Section *2.5.2 Reliability*, 64% of questionnaires that were sent out were also answered, 34% had complete answers, which means that the 34% of the total answers had transportation cost stated. The transportation cost structure has been the most difficult to obtain, most probably due to the lack in follow up routines in this matter. Yet, some cases were more difficult than others and with the help of previous projects that have taken place within SKF, the data needed for the thesis was compiled.

Since the percentage of the complete answers is rather low, the low population used in the calculation part of the analysis has affected the results. Therefore, the results of the calculations can only be seen as tendencies, rather than concrete results.

The quality of the answers has varied; some answers were more detailed than other. Nonetheless, apart from the transport cost structure, the answers have been satisfying.

7.2 Alternative Work Procedures

An alternative work procedure in this thesis could have been the focus on a few or a single SKF factory or flows. In that way, these flows could be studied in more depth. The missing data could have been collected manually by filtrating supplier invoices, since the focus would have been limited.

However, this alternative would give a limited picture of the entire SKF inbound flow and few conclusions could have been drawn about the inbound transportation in general.

7.3 Suggestions for Future Studies

Having started this study, it came to our attention that few theories about inbound logistics exist. The inbound transportation is usually left to the supplier, for whom this is the outbound transportation. Therefore, more studies in this field are needed, since inbound logistics is becoming more important.

An interesting suggestion for further studies is the mapping of <u>all</u> SKF inbound flows, from all the suppliers for all the purchased components. This in order to have a firm basis for the future decisions on inbound logistics and revising of the possible coordination possibilities for all types of components.

In addition, the rail alternative needs to be explored in more depth, as well as the impact that the potential changes would mean for the suppliers and their processes.

Terms Of Delivery is a very broad area that besides costs also treats the risks involved with the transportation. The risks are another area that needs to be explored in more detail.

When it comes to SKF Logistics Services, an interesting suggestion for further studies is the affect on the organization if SKF LS is to arrange the inbound transportation and how the work procedures could be organized between the SKF Group Purchasing Organization, Supply Chain and SKF Logistics Services.

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www.vtwood.forprod.vt.edu/sardo/pds/img/euro.jpg (Pallet Design Systems, PDS)

www.hoovers.com (Hoovers Online - The Business Information Authority)

www.akeri.se (Svenska Åkeriförbundet - Swedish Road Haulage Association)

http://www.wikipedia.org/wiki/Paradigm (Wikipedia - The Free Encyclopaedia)

http://www.gnb.ca/0062/regs/2001-67.htm http://www.gnb.ca/0062/regs/2001-67.htm (Motor Vehicle Act - Department of Justice, Canada) www.nassco.com (National Steel and Shipbuilding Company)

http://100megsfree4.com/dictionary/car-dict.htm#TareWeight (Dictionary of Automotive Terms)

http://fisher.osu.edu/supplychain/pdf_files/SChGlossary.pdf (Supply Chain Management Research Group, Marketing Department, Max M. Fisher College of Business, Ohio State University)

http://people.hofstra.edu/geotrans/eng/glossary.html (Transport Geography Glossary)

Appendix 1: Glossary Of Terms

Carrier - Any person who, in a contract of carriage, undertakes to perform or to procure the performance of transport by rail, road, air, sea, inland waterway or by a combination of such modes.[227]

Cross-docking - Direct flow of merchandise from the receiving function to the shipping function, eliminating any additional steps in between, including the need for storage.[228]

Hubs - A central connection point in a network. All transportation flows meet in this main mixing point where the goods can be switched to other flows to any other point of the network.[229]

Marshalling - Operation of moving a rail vehicle or set of rail vehicles inside a railway station or other railway installations (depot, workshop, marshalling yard, etc.)[230]

Shipper - The person who is handling over goods for carriage or the person who makes the contract with the carrier. [231]

Shunting - Operation of moving a rail vehicle or set of rail vehicles inside a railway station or other railway installations (depot, workshop, marshalling yard, etc.)[232]

Tare weight - The weight of truck, exclusive of its contents, but including gas, oil, etc., ready to roil. (Also called chassis weight or curb weight)[233]

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[227] Incoterms 2000, p 157.
[228] Supply Chain Glossary, Ohio State University, http://fisher.osu.edu/supplychain/pdf_files/SChGlossary.pdf
[229] Coyle, Bardi & Novack, 2000, p 454.
[230] people.hofstra.edu/geotrans/eng/glossary.html
[231] Incoterms 2000.
[232] people.hofstra.edu/geotrans/eng/glossary.html
[233] Dictionary of Automotive Terms, http://100megsfree4.com/dictionary/car-dict.htm#TareWeight

Appendix 2: Questionnaire Template

Name of the supplier:
Location of the supplier:
SKF Factory:
Name of the respondent:

General Information

1. Distance in km (Supplier - SKF factory)
2. Quantity per year (tons)
3. What are the Terms Of Delivery used?
4. Number of shipments per year?
5. The transport mode used? (Road, rail, sea, air)
6. Maximum capacity of the transport mode used?
7. Filling degree (fill rate) of the container/truck/railway wagon? (Ratio of capacity used and max loading capacity)
8. Who is responsible for transportation booking, you or your supplier?
9. Which forwarder are you using currently?
10. Present order lead-time for the Component
11. Present transport lead-time for the Component.

Component/ pallet characteristics

1. Load unit used (EUR pallet, SKF half pallet, bundle, carton box, etc.)
2. Weight and dimensions of the load unit. Weight shall be specified in dimensions and real weight.
3. How many units of the Component are loaded on the load unit?
4. Stacking (piling) possibilities - Is it possible to stack the components on top of each other?

Cost Structure

1. Total transportation cost per ton of the Component. (Please state the currency used)
2. Total Component cost per ton. (Incl. transport) Please state the currency used.

3. What is the present cost structure for transportation? Please state all the cost components for the transportation per shipment (shipment=delivery). For example: freight, terminal handling charges, customs clearance, BAF/CAF, etc. Please state average cost per shipment for each cost component in as much detail as possible.

Requirements

1. Are there any specific demands on lead-time?
2. Are there any specific demands on delivery precision?
3. Are there any specific demands on reliability?
4. Are there any special demands on handling and delivery from receiving factories?
5. Are there any other requirements?

Other Comments

General remarks on the inbound transportation. Feel free to comment anything you find interesting to add.

Appendix 3: Findings for SKF Steyr

Supplier	Term Of Delivery used	Transport cost EUR/tonkm	Transport cost (% of total Component cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
A1	EXW	0,096	Not known	LTL	Low	Medium	Medium	EUR Pallet	Road
A2	EXW	0,11	Not known	LTL	Low	Medium	Short	EUR Pallet	Road
A3	DDU	Not known	Not known	LTL	Very Low	Low	Very Long	EUR Pallet	Sea and Road
A5	FOB	Not known	1,5%	LTL	Low	Low	Very Long	EUR Pallet	Sea and Road
B2	DDP	Not known	Not known	LTL	Low	Low	Long	Bundle	Road
B2	DDP	Not known	Not known	TL	High	Medium	Long	Bundle	Road

Appendix 4: Findings for SKF St Cyr

Supplier	Term Of Delivery used	Transport cost (EUR/tonkm)	Transport cost (% of total Component cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
C3	DDP	0,08	Not known	TL	Very High	Medium	Short	Specific wood support	Road
C1	DDP	0,045	Not known	TL	High	Medium	Medium	Spec. wood support	Road
C5	DDP	0,065	Not known	TL	Medium	Low	Medium	Spec. wood support	Road
C2	DDP	Not known	Not known	TL	Medium	Low	Medium	Spec. wood support	Road

Appendix 5: Findings for SKF St Cyr DGBB

Sup-plier	Term Of De-livery used	Transport cost (EUR/ton km)	Transport cost (% of total Component cost)	Fill rate	Quantity tons/year	Fre-quency	Distance	Load Unit	Trans-port mode used
A1	EXW	0,094	Not known	Not known	Medium	Not known	Medium	SKF Pal-let	Road
A2	DDU	Not known	Not known	Not known	Medium	Not known	Long	SKF Pal-let	Road
B2	DDU	Not known	Not known	Not known	High	Not known	Very Long	SKF Pal-let	Road

Appendix 6: Findings for SKF Leverkusen

Sup-plier	Term Of De-livery used	Transport cost (EUR/tonkm)	Transport cost (% of total Compo-nent cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
C1	DDP	0,21	Not known	LTL	Medium	Medium	Very Short	Specific wood sup-port	Road

Appendix 7: Findings for SKF Mühlheim

Supplier	Term Of Delivery used	Transport cost (EUR/tonkm)	Transport cost (% of total Component cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
A4	EXW	0,44	3%	LTL	Very Low	Medium	Medium	SKF GSP2	Road

Appendix 8: Findings for SKF Püttlingen

Sup-plier	Term Of Delivery used	Transport cost (EUR/tonkm)	Transport cost (% of total Compo-nent cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
B2	DDU	Not relevant - TOD is DDU	Not known	LTL	Medium	Medium	Very Long	Various	Road (60%) and Rail (40%)

Appendix 9: Findings for SKF Schweinfurt PDK

Supplier	Term Of Delivery used	Transport cost (EUR/tonkm)	Transport cost (% of total Component cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
C8	CIF	0,05	4,3%	TL	Very High	Medium	Medium	Specific wood support	Road
C1	CIF	0,07	4,4%	LTL	Low	Medium	Short	Specific wood support	Road
C7	EXW	Not known	Not known	LTL	Low	Low	Short	Specific wood support	Road

Appendix 10: Findings for SKF Airasca

Supplier	Term Of Delivery used	Transport cost (EUR/tonkm)	Transport cost (% of total Component cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
A1	Landed Airasca	Not known	Not known	LTL	Very High	High	Very Short	SKF GSP2	Road
A3	Landed Airasca	Not known	Not known	LTL	Low	According to consignment stock level agreed.	Very Long	SKF GSP2	Sea and Road

Appendix 11: Findings for SKF Bari

Supplier	Term Of Delivery used	Transport cost (EUR/tonkm)	Transport cost (% of total Component cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
C6	DDP	Not known	Not known	LTL	Low	High	Long	SKF full pallet	Road
C4	DDP	Not known	Not known	LTL	Very Low	High	Long	SKF full pallet	Road
A1	DDP Airasca - SKF LS	Not known	Not known	LTL	High	Very High	Long	SKF half pallet	Road
B1	EXW	0,04	Not known	LTL	Medium	Not known	Medium	Bundle	Road
B2	DDU	0,17	Not known	TL	Very High	Very High	Short	Bundle	Road

Appendix 12: Findings for SKF Massa

Supplier	Term Of Delivery used	Transport cost (EUR/tonkm)	Transport cost (% of total Component cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
A1	DDP Airasca - SKF LS	Not known	Not known	LTL	Low	Medium	Short	SKF Pallet	Road
A2	EXW	Not known	Not known	LTL	Very Low	Low	Long	SKF Pallet	Road

Appendix 13: Findings for SKF OMVP Villar Perosa

Supplier	**Term Of Delivery used**	**Transport cost (EUR/tonkm)**	**Transport cost (% of total Component cost)**	**Fill rate**	**Quantity tons/year**	**Frequency**	**Distance**	**Load Unit**	**Transport mode used**
B2	DDU	0,04	Not known	TL	Very High	Very High	Short	Bundle	Road
B1	CIP	0,10	Not known	TL	Medium	Medium	Short	Bundle	Road

Appendix 14: Findings for SKF Poznan

Sup-plier	Term Of Delivery used	Transport cost (EUR/tonkm)	Transport cost (% of total Com-ponent cost)	Fill rate	Quantity tons/year	Fre-quency	Dis-tance	Load Unit	Transport mode used
B1	EXW	0,055	6,1%	LTL	Low	Low	Long	Bundle	Road
B2	DDU	Not known	Not known	LTL	Low	Medium	Long	Bundle	Road

Appendix 15: Findings for SKF Tudela

Supplier	Term Of Delivery used	Transport cost (EUR/tonkm)	Transport cost (% of total Component cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
A1	DDP	Not known	Not known	Not known	Medium	Very High	Long	SKF GSP 2	Road
A3	DDP	0,062	36,3%	LTL	Very High	Very High	Very Long	SKF GSP 2	Road
A5	DDP	Not Applicable	Not known	LTL	Very Low	Very Low	Very Long	SKF GSP 2	Sea and Road

Appendix 16: Findings for SKF Gothenburg

Supplier	Term Of Delivery used	Transport cost (EUR/tonkm)	Transport cost (% of total Component cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
C9	DDP	2,49	1,6%	LTL	Very High	High	Very Short	EUR Pallet	Road

Appendix 17: Findings for SKF Lutsk

Sup-plier	Term Of De-livery used	Transport cost (EUR/tonkm)	Transport cost (% of total Compo-nent cost)	Fill rate	Quantity tons/year	Frequency	Distance	Load Unit	Transport mode used
C10	FCA	0,010	4%	100%	Low	Very Low	Long	1600x1400x1200 Coil	Rail
C11	FCA	0,022	9,4%	TL	Medium	Low	Very Long	1100x200mm Coil	Road