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Comparative analysis for choosing a single gateway of seafreight in Scandinavia : a project for Schenker International

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COMPARATIVE ANALYSIS FOR CHOOSING A SINGLE GATEWAY OF SEAFREIGHT AND AIRFREIGHT IN SCANDINAVIA

- A project for Schenker International –

By

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Vietnam

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DECLARATION

I certify that all the material in this dissertation that is only my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: **Comparative analysis for choosing a single gateway of seafreight and airfreight in Scandinavia - A project for Schenker International**

Degree: **MSc**

The research paper is the study of the choice of location for a regional gateway/distribution center of sea-freight and airfreight, inbound and outbound cargo flows in the whole Nordic region of Germany-based freight forwarding, logistics service company Schenker International by analyzing a number of considerations and comparing possible alternative locations. The right choice of location will have significant meanings to the company since it affects the company's competitive advantages through optimized cargo routing and handling, cost-saving…

A brief look on fundamental concepts of logistics is introduced at the beginning to place academic grounds for the study. The question of whether it is advisable to have a single gateway/distribution center for the whole Nordic region is answered after examining current tendencies in European logistics and analyzing historical, economic and social perspectives of the Nordic region.

The research is then dealing with the issue of site selection for the regional gateway/distribution center. This is solved from two sequential levels: from general geographical area to specific site within the chosen area.

- ✔ In the first level, the *centre of gravity principle* is applied to pinpoint the general geographical area of the regional gateway.
- ✔ In the second level, *the minimum integration of total distance transport with relevant volumes principle* in combination with the *centre of gravity*

principle or *least total distribution cost principle* is deployed after analyzing the company's operating practices and data to build the excel-based simulation.

A number of recommendations will also be made in the last chapter concerning the application of the study for the best use of it.

KEY WORDS: logistics, distribution center, centre of gravity, Schenker International, Scandinavia, sea-freight, airfreight.

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LIST OF ABBREVIATIONS

APL	: American President Line
BIMCO	: Baltic and International Maritime Council
CoG	: Centre of gravity
DKK	: Danish Krone
EC	: European Commission
EU	: European Union
EUR	: Euro
GDP	: Gross Domestic Product
IATA	: International Air Transport Association
IT	: Information Technology
ITU	: Intermodal Transport Unit
LCL	: Less than container load
MSC	: Mediterranean Shipping Company
OECD	: Organization for Economic Co-operation and Development
PPP	: Purchasing Power Parity
R & D	: Research and Development
RDC	: Regional Distribution Center
RO/RO	: Roll on/Roll off
SEM	: Single European Market
TQM	: Total Quality Management
UK	: United Kingdom
USA	: United States of America
USD	: United States Dollar

CHAPTER 1

INTRODUCTION

1. 1. Background

Through the last decade Europe has been changing substantially. The European market itself has expanded not only to the East but also to the North and therefore placed Nordic countries as Sweden and Denmark in the primary geographical position for international companies planning their current and future regional distribution set-up for the whole region. In fact, the introduction and development of the European Union (EU) into a unified market has created a regional-based market structure where the Northern part of the EU is always seen as one region (Nordic region) in not only economy but also culture and society perspectives since the countries share common features. In turn, this regionalization of markets has created a demand for a centralized distribution system in each of these regions. The Northern region of Europe, or the Nordic region, is one the most interesting and quickest developing regions in Europe.

Taking this background into account, one of the main tendencies of logistics and distribution in the world and in Europe today is the regional consolidation of distribution centers. Schenker International as one of the biggest freight forwarding and logistics companies in the world is considering this trend to regionalize its distribution networks in the Nordic region for the sake of maximizing long-term profit, optimizing transport and minimizing the total logistics cost with given levels of customer service. Such a change in strategy is believed to bring about competitive

advantages for the company to exist and develop in the fierce competition environment in this field of business.

Formal research about this topic is, therefore, very essential to conduct a full, comprehensive understanding about the company's strategy in the new market environment, to define the best optimum location for the future regional distribution center, and to help the company in its decision-making process for gaining the mentioned business objectives. From an academic perspective, the research is very necessary to understand the importance of the issue of the location of warehouses and distribution centers in the whole logistics chain.

1. 2. Problems definition at Schenker International

''A problem defined is the problem half solved'' (Ma, 2000). With the background described in the above part, there were two main questions at Schenker International regarding the topic of this research:

✍ Is it reasonable for the company to place only one single gateway/distribution center of inbound and outbound sea-freight and airfreight cargoes flows for the whole Nordic region?

✍ If yes, where should it be located?

The future gateway/distribution center should be the best solution to optimize cargo handling, cargo routing in order to obtain present business objectives.

1. 3. Objectives of the study

The main objectives of this study can be described as follows:

✍ To analyze the main current tendencies of European logistics and distribution as the base for Schenker International's changing strategy of regional consolidation of warehouses and distribution centers in its distribution network.

✍ To analyze and explain the reasons why the Nordic region should be considered as a single market and can be served by a single distribution center.

✍ To diagnose, compare, analyze and shape the general geographical area for the future regional gateway/distribution center for Schenker International.

✍ To examine current operating practices of Schenker International, pinpoint main economic implications of such system, analyze and identify possible alternative locations for the required gateway/distribution center.

✍ To make a comparison of these alternatives based on an excel-file simulation model with different airports/seaports solutions in order to select the best location for the future regional gateway/distribution center.

The study is, by achieving these objectives, believed to be of significance for the company to gain competitive advantages.

1. 4. Scope of the study

The Nordic region mentioned in this study, to the world at large, will be understood as Scandinavia to comprise Sweden, Denmark, Norway and Finland to be suitable to current operations of Schenker International. The study is structured in six main chapters as follows:

✍ Chapter one: This is the introduction of the study. This chapter describes the background of the study, defines the problems of the targeted company, sets out main research objectives as well as states the research methodology and limitations of the work.

✍ Chapter two: In this chapter, a general theoretical framework about logistics and its main components will be mentioned and described to place firm grounds for the following research. The first question of the study regarding reasons for considering the Nordic region as a single market will also be diagnosed and analyzed.

✍ Chapter three: This chapter will answer the second question of the study from a general geographical area level. A theoretical model on the principle of centre of gravity will be introduced as the base for analyzing some considerations of population distribution and population growth for shaping the area of the future gateway/distribution center.

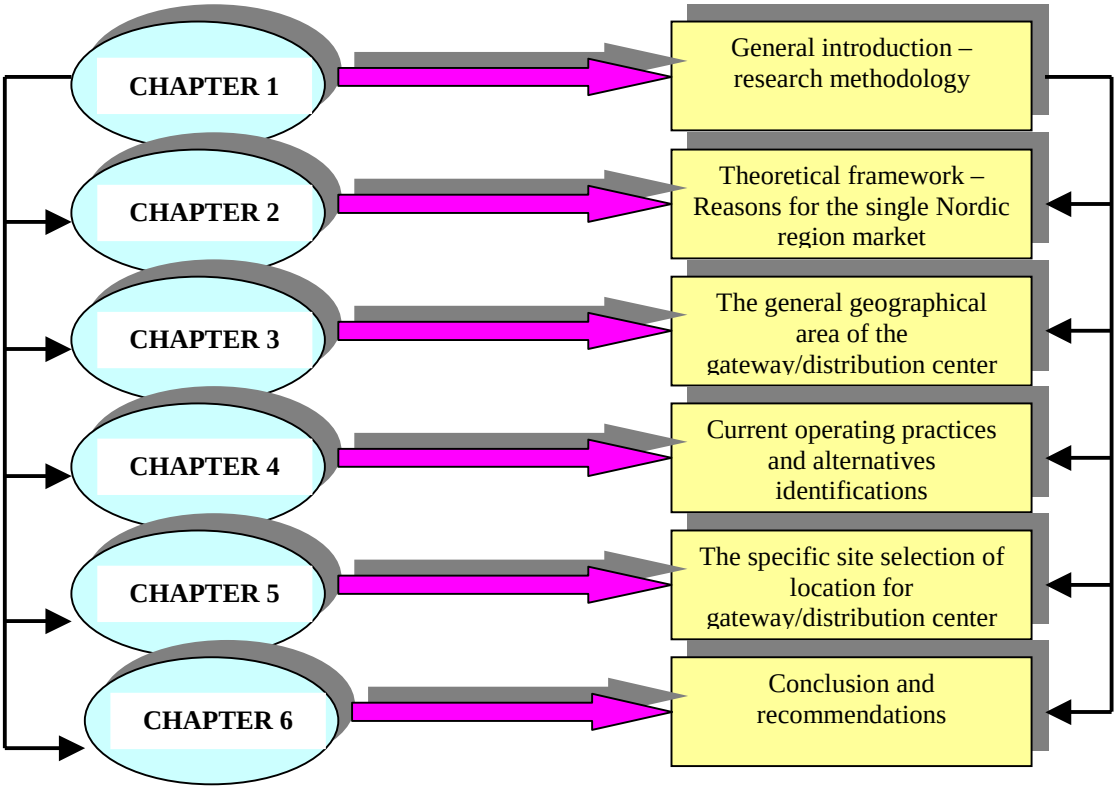
✍ Chapter four: First of all, some features about the company will be mentioned, followed by deep analysis of its current operating practices in the Nordic region. Based on that, economic implications of current system will be diagnosed

carefully. The chapter will end with possible alternative gateway's locations in relation with different airports/seaports used solutions identified after a number of considerations and analysis on some important indicators.

✍ Chapter five: With the preparation from chapter four, this chapter will answer the second question of the study from specific site selection level. A theoretical model on minimized the integration of total distance transport with relevant volume in combination with the centre of gravity principle and the least total distribution cost will be introduced first, followed by the excel-based simulation on this model to compare between alternatives and select the best solutions.

✍ Chapter six: This is the wrap-up chapter. General conclusion will be drawn out from the diagnosis, analysis and comparisons made. Possible recommendations will also be proposed for the best use of the study.

SCOPE OF THE STUDY



1. 5. Research methodology

In order to achieve objectives set out in the study, a number of research methodologies were deployed in which the near-far approach is the overwhelming strategy. Other methods can be described as follows:

✍ Literature review: This strategy is considered compulsory and extremely essential before the research work was begun. In this study, not only materials in the library of World Maritime University but also the library at 4ROOMS, a foundation owned by Schenker, were used as food for thoughts.

✍ Interviews: With the support from Mr. Jan Nordh, a number of interviews were made with some key staff of both Schenker International and Schenker-BTL to grasp the most necessary data for the empirical research. Interviews were also made with the Customs Office of Southern Sweden and the City Council in Malmö to understand and analyze the environment in which Schenker International is doing its business as well as advantages and disadvantages in choosing the gateway's location.

✍ Data processing and analysis: Data provided by Schenker International and Schenker-BTL, as well as from other sources (books, internet and so on) were then processed and analyzed to make the best usage for the research work.

✍ Comparison: Comparison was deployed not only by analyzing information on social, economic indicators but also by concrete calculation based on excel-file simulation on computer.

1. 6. Limitations

The combination between the scopes of a Master's thesis and practical issues of the company required lots of refined work. Nevertheless, the best essence and total quality mentality is always what the author has been searching for during this research. The author also widely welcomes all comments and contribution from readers in order to improve this research in the new socio-economic scenarios which may occur and in the due course of total quality management (TQM).

CHAPTER 2

TENDENCIES OF LOGISTICS AND DISTRIBUTION IN EUROPE AND THE NEED FOR A REGIONAL DISTRIBUTION CENTER FOR THE NORDIC REGION

This chapter aims at introducing the overall picture about logistics and distribution in Europe, especially in the Nordic region from the standpoint of logistics companies, and answering the question of the need for the future regional distribution center for the Nordic region. Some basic concepts about logistics and distribution will be introduced first, followed by analysis and assessment about tendencies of logistics and distribution in Europe. After that, the question of the need for the future regional distribution center for the Nordic region will be answered.

2.1. Basic concepts about logistics and distribution

2. 1. 1. Concept of logistics and physical distribution

2. 1. 1. 1. Logistics and logistics components

During the last few decades, the term logistics has been mentioned and studied many times with the increasing recognition about its importance to enterprises, organizations as well as national economy. For example, a recent study carried out by Michigan State University in the USA showed that logistics alone represented between 10-15% GDP of most major North American, European and Asian/Pacific economies (Rushton, Oxley & Croucher, 2000). In fact, there have been a lot of definitions about logistics, and one of them is listed here below.

Logistics is the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from point of origin to point of consumption for the purpose of conforming to customer requirements.

(The Council of Logistics Management).

The key components of logistics are also shown in the following figure.

KEY COMPONENTS OF LOGISTICS

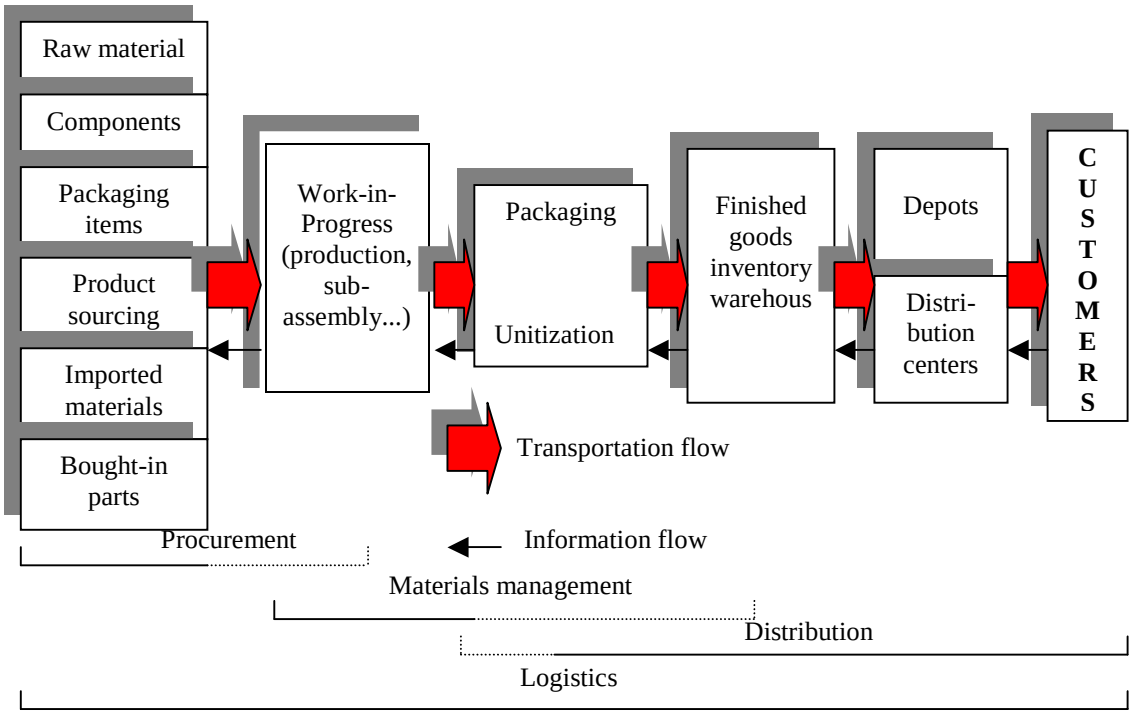


Figure 1

Source: Adapted from Rushton, A & Oxley, J & Croucher, P. (2000).

The basic of logistics is well understood as the management of the physical and information flows of materials or goods from the point of origin to the point of consumers. With the increasing demand from customers, it is important in a logistics chain to get ‘’the right goods to the right place, at the right time, in the right form and at the right cost’’.

In short, logistics plays a very important economic role for companies. To keep logistics cost to the minimum is always an essential target so that companies can gain their competitive advantage by minimizing the costs of products or services and increasing their quality.

2. 1. 1. 2. What is physical distribution?

The term ‘physical distribution’ describes a wide range of activities taking place after the production of goods and before they reach customers or end users. These activities include materials handling, storage and warehousing, packaging and unitization, transportation from plants to depots/distribution centers and later to customers/final users. Figure 1 in the previous part shows that physical distribution is a part of the whole logistics chain.

In fact, what physical distribution is aiming at is to ‘bridge the gap between the producer and consumer’ (Benson & Whitehead, 1985). If the task of marketing is to create customers demand, then the objective of physical distribution is to satisfy them. In order to achieve this, the companies will strive to reduce the *lead-time* (the time from when products are ordered until they are actually delivered to customers). Actually, as far as the physical distribution is concerned then during this period the companies will deal with a lot of activities from order processing, goods-picking/sorting, packing, etc, and transportation of goods to customers. It is very transparent to see that any improvement to reduce time in any of the above activities, for example goods-sorting by bar-coding or order picking lift-truck, rationalization of inventory and reducing transport time by good planning, will lead to reduction in total lead-time, and hence the companies can meet their customers’ requirements satisfactorily. Most of these activities are taking place in warehouses/distribution centers, and therefore a rationalization of them in terms of quantity as well as size, level of automation, equipment and handling techniques used etc will definitely affect the customers’ satisfaction.

2. 1. 2. The total distribution cost concept

So far the concept of physical distribution has been devised. However, the notion of total distribution cost is very important when assessing the whole physical distribution process for the sake of meeting customers’ requirements.

Basically, the total distribution cost includes warehousing (storage) cost, inventory cost, depots (warehouses or distribution centers) operating cost (order processing, information etc) and transportation costs (transport from airports or seaports to depots – trunking cost and transport from depots to customers – local

delivery cost). Each cost element in the total distribution cost has a close relationship with the number of depots concerned as shown in the following figure.

ELEMENTS OF TOTAL DISTRIBUTION COST

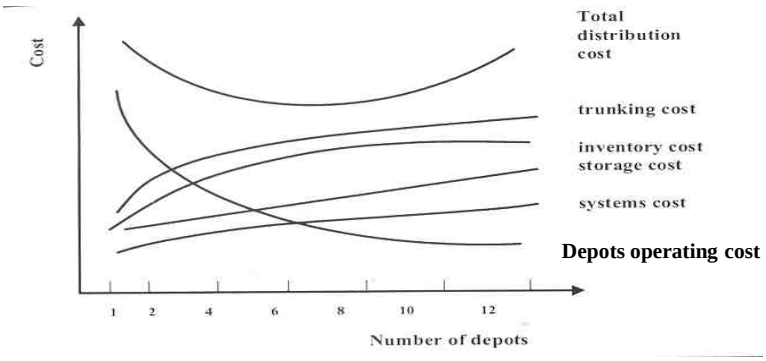


Figure 2

Source: Adapted from Rushton, A & Oxley, J & Croucher, P. (2000).

Therefore, the inventory, storage and depot operating costs will tend to increase when the number of depots increases whereas the transportation cost will decrease in the same situation: goods in many depots will reach the markets faster in shorter distances. It can also be seen from the graph that the minimum point of the total distribution cost curve represents the lowest cost solution in relation to the optimum number of depots.

In general, a few large depots will be internally large-scale and efficient because the companies can take advantage from economies of scale. However, the depots will be situated some distances from the customers. On the other hand, a greater number of depots will be not economies of scale, but they will reduce the distances from the depots to the customers. The matter here is to establish the best configuration of depots to achieve the least total distribution cost.

2. 1. 3. Nodes and links

For logistics companies, it will be insufficient and not thorough if physical distribution is examined without relation to the concept of *nodes* and *links*. According to the previous parts, it becomes clear that the activities taking place within the premises of warehouses or distribution centers such as order picking, storage, goods sorting, assembly, cross-docking etc have a very close relationship with the transportation activity. In fact, they are all major parts in a distribution network.

The physical distribution network of a logistics company comprises *nodes* and *links*, representing the movements of finished goods, information and resources (Hultkrantz, 1999). A *node* is a place where goods are stopped and added value by some additional activities such as warehousing, kitting and assembly, labeling, cross-docking etc before reaching the final customers. In this sense, a *node* can be a warehouse or a distribution center where there are postponed manufacturing activities following customers' demands. In order to connect the flow of goods from one *node* to another, *links* are used to provide the transportation process. By this perception, a *link* is understood as the transfer of flows of goods among *nodes* and involves both the transport assets (trucks, ships, airplanes etc) and the time spent to perform such transfer. Figure 3 shows *nodes* and *links* in the physical distribution system.

NODES AND LINKS IN A PHYSICAL DISTRIBUTION SYSTEM

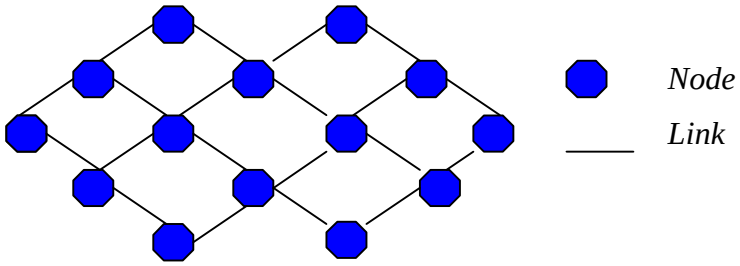


Figure 3
Source: Adapted from Hultkrantz, O. (1999)

2. 1. 4. Warehouses and distribution centers

Warehouses and distribution centers, or *nodes*, are one of the major parts in the physical distribution system and they need thorough study to place a firm ground for later chapters when the question of rationalization and location is raised.

2. 1. 4. 1. Definition of warehouses and distribution centers

In general, warehouses can be defined as the company's facilities where goods can be safely stored and cared for until they are required. Warehouses are integral parts of the whole logistics and supply chain because goods do not normally flow immediately from the suppliers to final end users without any stop. The term distribution centers is sometimes used interchangeably with warehouses.

The activity of warehousing is to store goods which may be necessary for companies for several reasons. First, companies want to take advantage of transportation economies when they can ship the goods in large quantities. Secondly, a warehouse is needed when companies want to buy a large quantity of goods to benefit from purchase discount. Maintaining a source of supply is very essential, and therefore warehouses are necessary for many companies for this purpose. Other reasons are to cover seasonal fluctuations, to provide a wide range of different products from different suppliers in one location or to cover for planned or breakdown production shutdown, to facilitate order assembly, kitting, cross-docking requirements etc.

A general conclusion that could be drawn is that distribution centers are often in the post-production process, whereas warehouses, with the basic function of storage, are normally used after the goods have been completed. Distribution centers, furthermore, play a very important role in managing the inventories to the minimum and creating more value added to finished goods, such as kitting and assembly, cross-docking etc as mentioned in previous parts. The following figure indicates such an important role of warehouses and distribution centers.

DISTRIBUTION CHANNEL

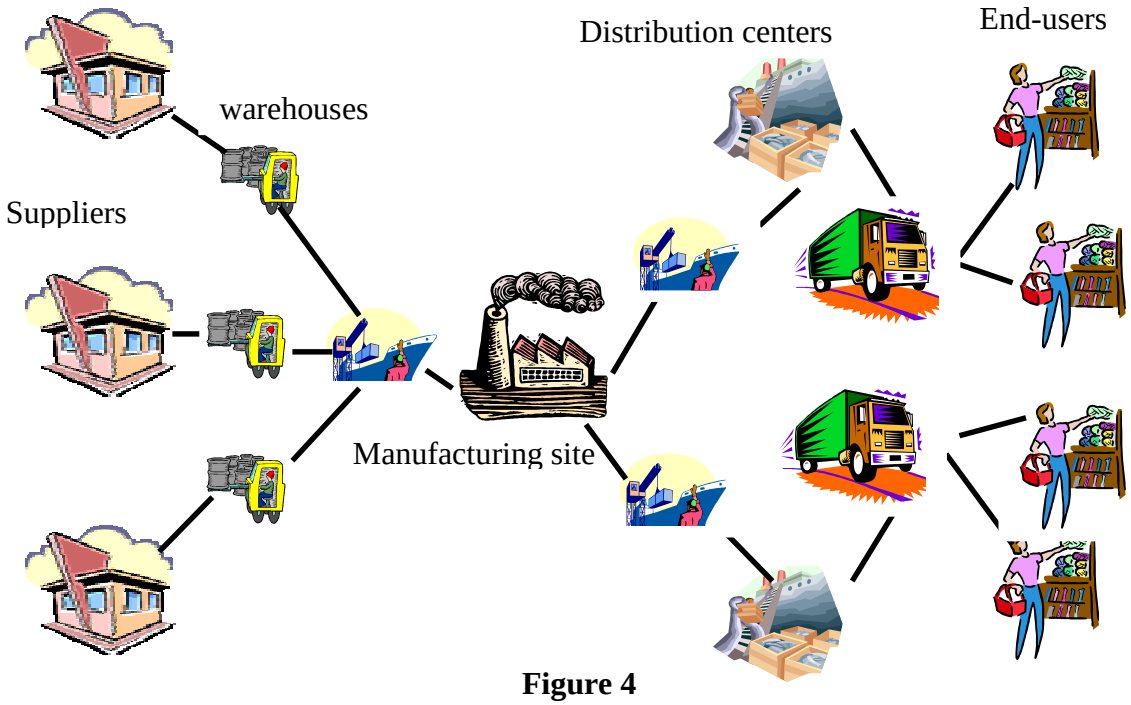


Figure 4

2. 1. 4. 2. The importance of depot rationalization and location

In the previous part about warehouses and distribution centers and their importance, it is clear that there are a number of reasons explaining their existence. The question of suitable number, size and location of depots in the companies' distribution network is always complicated, thus a variety of variables such as current distribution patterns, patters of product flows, customers analysis, costs analysis etc needs to be considered. However, it is widely recognized that this question is very important to all companies.

Although depots are an integral part in the whole logistics and supply chain, it does not mean that the distribution network will become both more convenient to customers and at the same time efficient to the companies when there are many depots surrounding the customers' region. It is easy to understand that such kind of network can reduce the local delivery cost, but on the other hand it makes other costs such as inventory, storage, depot operating and even trunking cost increase dramatically. It is therefore essential that the number of depots should be rationalized based on interrelated elements of the companies' distribution system as well as the cost elements attached to them. From the psychological point of view, it seems to be reasonable to place depots as close to customers as possible to have the best possible customer service. However, this would be a very expensive solution because the companies then have to hold adequate stocks of all the goods customers may require. For the sake of cutting cost and gaining efficiency in the distribution network, it is vital to rationalize the number of depots, size and their location.

It is worth noticing that not all companies consider this question at the beginning; the question has just arisen along with the development of a company' distribution network and that means the question is considered when there is an existing system. Clearly, the best solution is sometimes not the most reasonable one because companies have to change drastically the existing system (depots, vehicles etc), and it could be very expensive and uneconomical. Hence, it is necessary to have a compromise between the two with a given customer service level.

In short, it can be said that through some major basic concepts about logistics and distribution as presented and analyzed above, a general overview of

logistics and distribution scenario was devised. To continue this flow of logic for a clearer scenario in a specific marketplace in Europe, the following part about trends of logistics and distribution will also be further studied.

2. 2. Tendencies of logistics and distribution in Europe

Nowadays, Europe is seen as a very important logistics and distribution marketplace especially since the European Union (EU) was formed in 1993. The completion of SEM (Single European Market), as a matter of fact, also leads to some tendencies of logistics and distribution in Europe including the Nordic region.

2. 2. 1. Growing concentration through mergers, acquisitions and alliances

Mergers, acquisitions and alliances are the current developing phenomenon in the world economy with the influential impact from globalization. In fact, there are many driving factors behind mergers, acquisitions and alliances and the most attractive for companies to follow this trend is to enjoy the economies of scale due to being big status. In the EU scenario, the following table devised a rough picture of cross-border merger and acquisition activities in 1988 and 1989:

Table 1: CROSS-BORDER MERGERS, ACQUISITIONS AND ALLIANCES

Buying region	$Billion	%	No. of deals	%
EC sales in 1988				
Other EC country	11.2	35	547	65
Total	**31.6**	**100**	**847**	**100**
EC sales in 1989				
Other EC country	24.0	53	770	61
Total	**45.5**	**100**	**1256**	**100**

Source: Cooper, J and Browne, M and Peters, M. (1991).

From the table above it can be seen that the number of international deals in the EC grew from 847 – worth $31.6 billion in 1988 to 1256 – worth $45.5 billion in 1989. Just seven years later in 1996 after the formation of EU these figures increased to 2857 deals with nearly $131 billion according to a survey of KPMG Corporate Finance. In fact, this trend is to continue with a faster speed and more substantial in terms of volume and value in the global scale. Also according to one recent survey of KPMG Corporate Finance, for example, the global cross-border mergers, acquisitions and alliances in 1998 rose by more than 60% over 1997 to a record US$544.31 billion comprised from over 5000 cross-border mergers, acquisitions and investments during this fiscal year alone.

This tendency has also been considered as one of many effective strategies to enter international markets. A recently revealed survey of the largest 18 third-party logistics companies in Europe showed this as follows:

Table 2: MULTIPLE STRATEGIES TO ENTER INTERNATIONAL MARKETS

Strategy	Number of companies
Direct investment	14
Alliances with foreign companies	13
Acquisition of foreign companies	10

Source: Containerization International, April 1999

Among logistics service providers, mail operators are the most predominant consolidators. In Europe, they have motivated aggressively the consolidation trend through mergers, acquisitions and alliances. The following table shows roughly the picture of what is going on today and the continuous trend tomorrow:

Table 3: SELECTED ACQUISITIONS BY EUROPEAN MAIL OPERATORS

Acquirer	Target	Date	Coverage
TNT post Group	TNT	1997	Global
	Technologisticia	1999	Pan-Europe
	Jet Services	2000	France
	CTI Logistx	2000	USA
	Taylor Barnard	2000	UK
Deutsche Post	GP Paketlogistik	1997	Switzerland
	Securicor Distribution	1998	UK
	Danzas-AEI-ASG	1998	Global
	Ducros Rapide	1998	France
	DHL	1998 & 2001	Global
	MIT	1999	Italy
	TransoFlex	1999	Pan-Europe
	Nedlloyd ETD	1999	Holland
	Guipuzcoana	2000	Spain
	Arcatime & Orgardis	2000	France
UK Royal Mail	German Parcel	1998	Germany
	Williams Group	1999	Ireland
	Pakke Trans A/S	2000	Denmark
	Nederlande Paket Dienst	2000	Holland
La Poste	Denkhaus AG	1998	Germany
	DPD GmbH	1998	Germany

Source:European Distribution & Logistics, January 2001

Today, companies once thought of as being “big” are being acquired by competitors twice or 3 times their size. In addition, giant companies once considered “untouchable” are in the process of merging. For example, Danzas and AEI, both of whom were billion-dollar companies on their own, were each acquired by the German Post within a 12-month period. Further just recently, the Ocean Group,

which owns MSAS, announced plans to merge with another UK-based giant logistics company, NFC.

The consolidation trend through mergers, acquisitions and alliances is not over. In fact, more mergers, acquisitions and strategic alliances in the logistics and distribution sector are on the way.

The above figures and illustrations may have little meanings if they stand alone. However, if putting them in close relationship between manufacturing and logistics and distribution, the implications of such a trend on logistics and distribution are tremendous as it impacts directly on the business of this sector. The mergers, acquisitions and alliances among manufacturers can be either opportunity or threat to logistics services providers, such as road hauliers, shipping lines or airlines. The big question mark here is that what will happen when there are two companies which have been using different transport companies so far merging together.

Very often the case is the new company will consider rationalizing its activities and reducing the number of current service suppliers, a move that allows companies to concentrate more volume with preferred providers, thereby maximizing leverage. It comes to the point that the company has to select its new transport companies or logistics services providers among the ones before the merger, and this means the business of those companies can be lost or retained according to the selection.

As analyzed above the concentration trend in manufacturing leads to the fact that manufacturers have to think and act globally and their strategy should be beyond the single country-based (rather along the production line than the country). As logistics and distribution go hand in hand with manufacturing, logistics services providers also have to follow this logic to meet all the necessary requirements by their customers, and this means that they themselves have to seek for co-operation and co-ordination in one form or another, including mergers, acquisitions and alliances, to rationalize their operations. In the EU scenario, this philosophy is even more obvious as logistics companies, both European and others placed elsewhere are making progress to build a Pan-European service network which serves Europe, including the Nordic region, on regional rather than country basis. A typical example

can be seen from the case of Schenker International. The cooperative relationship between Schenker International and its parent company, Stinnes AG, and Sweden's BTL AB has created a European logistics giant employing more than 20,000 people in over 30 European countries with annual revenues of more than $3.5 billion.

In short, the growing concentration through mergers and acquisition in the manufacturing sector has a direct effect and lead to the same trend in logistics and distribution, especially in Europe since the EU was formed in 1993. The logic of such a trend is that logistics companies will get bigger in size, more sophisticated and wide-range in service coverage and operate with global strategy taking into account the rationalized regional basis.

2. 2. 2. Tendency of outsourcing logistics and distribution from manufacturers

In the manufacturing sector, the willingness to outsource logistics and distribution together with a wide range of other non-core businesses is growing among manufacturers and retailers, and this tendency brings about great opportunity as well as challenge to logistics providers. Indeed, the trend of outsourcing, for one more time, reaffirms the fact that logistics companies will be freer and more self-control in the application of regional-based inventory and distribution policies.

The nature of the trend is that manufacturing companies will just concentrate all their resources to some core businesses, and leave the non-core ones such as warehousing or distribution to third-party logistics providers. This can be seen as a strategy to make the best use of corporate assets, or in other words, simply to concentrate on what the companies can do best. In fact, the manufacturing companies may have a number of reasons to outsource the running of their own warehouses or distribution function, but the most special importance could be their need for financing for expansion. Indeed, when a company wants to expand rapidly the first thing it needs is all the internal capital to fund the growth. With the outsource of non-core activities the company can open up the internal sources of funds, for example, the capital will no longer be tied up in the trucking fleet or warehouses if the company contracts out these functions. In addition to allowing manufacturing and retail companies to concentrate on their primary areas of activities, logistics and distribution outsourcing also offer a cost saving in terms of not having to employ

large number of staffs on distribution requirements. With the regional perspective, the logistics companies will have to consider rationalization of all resources given by their customers.

If putting these elements in the EU scenario, the trend of outsourcing is seen clearly. The following figure indicates a comparison between the number of own-account and outsourced distribution centers for Europe of many non-European companies doing their business in this marketplace. The figure shows that the majority (60-65%) of American and Japanese companies' distribution centers were outsourced and they counted for a big proportion in the total number of distribution centers for Europe. It can also be seen from the figure that international companies have considered the EU as a whole which can be divided on regional basis, in that the Nordic region can be served by a regional distribution center.

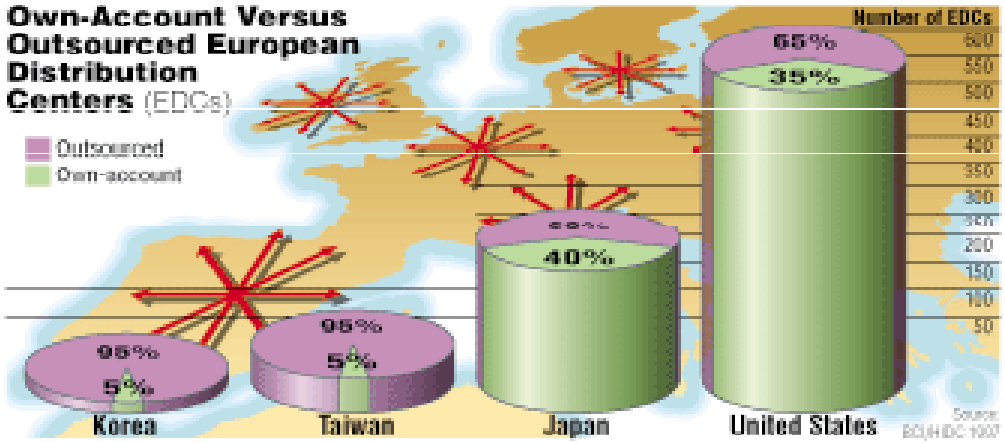


Figure 5
Source: Carding, T. (1998).

In fact, the trend of extending outsourcing functions beyond basic transportation and warehousing functions to the third-party logistics is rapidly growing. In 1999, the European third-party logistics market is estimated to be worth EUR 146 Billion in revenue, of which about 26% is outsourced to third-party providers. By the year 2004, this proportion will increase to 33% expressed as follows:

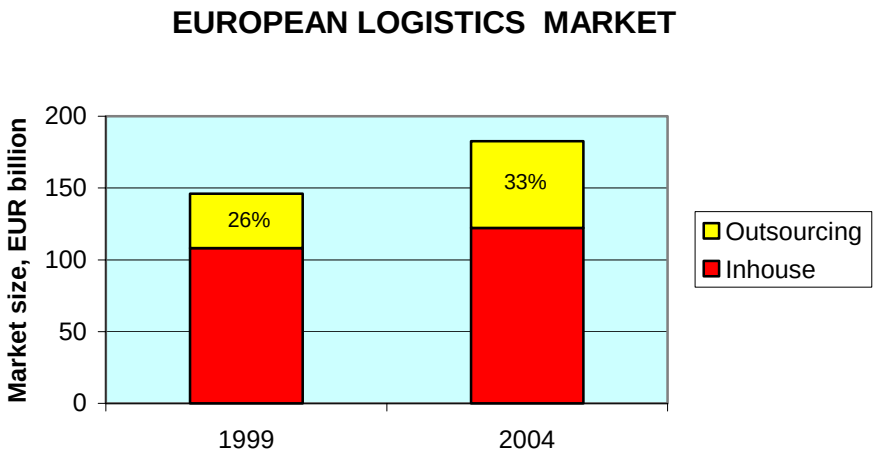


Figure 6

Source: Adapted from European Distribution & Logistics, January 2001

The logistics providers are, therefore, doing much more than transport and warehousing management. Indeed, they can carry out series of value-added services for their customers such as customizing, kitting and assembly, cross-docking, repair and testing of products etc and so much more. With the increasing trend of outsourcing from manufacturers, those functions are considered to be very competitive for logistics companies and hence they must have sufficient market coverage, expertise and flexibility to take care of all requirements from their customers. The flexibility can be understood in the sense that whenever the logistics company cannot provide the required service itself then it can go to other quality service providers and put the package in the same way required by their initial customers. It is therefore necessary to have the regional distribution centers where all functions supporting to cargo can be conducted in the most efficient and cost saving way.

The increasing trend of outsourcing from manufacturers has indeed impacted the business and strategy of logistics services providers, as can be seen from the analysis above. Together with the growing concentration through mergers, acquisitions and alliances, it opens a new way of thinking and doing for those companies to escape from the traditional strategy on specific country basis. The logic of this philosophy is especially right in the EU perspective.

2. 2. 3. Consolidation trend in production, logistics and distribution

It is said that the consolidation trend in production, logistics and distribution in Europe is the clearest and most predominant move of the economy in the reaction to the establishment of the EU. Before the EU, many manufacturing companies operated throughout Europe but without the benefits of scale due to complex transport and product regulations. The consequence was that there were too many stocks held in too many warehouses (Cooper, Browne & Peters, 1991).

In fact, legal and regulatory changes in the EU will undoubtedly drive large manufacturers to consolidate their European logistics operations. In Europe, it has become more common for companies to develop just several distribution centers on regional basis, for example, Northern (Nordic region), Eastern, Southern and Western Europe. The fact in Europe today is that there are many companies which historically have had country-based distribution centers and are now focusing on regional-based ones. Certainly, they no longer need to maintain manufacturing and distribution operations in every country in which they sell their products due to the harmonization of product standards across the EU, the elimination of most customs formalities between EU countries and the need for multinational manufacturers to manage inventory regionally or globally via a single information system.

Besides, the consolidation of production, logistics and distribution will facilitate better quality control, create more opportunities for more rapid product innovation due to centralized Research and Development, and above all else, the company will benefit from economies of scale and lower total cost. According to Gooley (1999), for example, an American manufacturer of medical equipment which used to operate 13 warehouses in Europe, but then changed to manage all its inventory, warehousing, and distribution functions in Europe from a single purpose-built, highly automated distribution center in Belgium. The positive result is that in the first two years after the new operation pattern, inventory levels dropped by nearly half, stock-outs were reduced by more than 75% and total distribution cost fell by more than 20%. The case of the Netherlands-based Philips describes this trend clearer. When the company changed its strategy after the formation of the EU, the number of inventory holding sites was reduced dramatically as shown in Figure 7.

CONCENTRATION OF INVENTORY BEFORE & EXPECTATION AFTER 1993 OF PHILIPS

Figure 7
(a) Stock warehouses organized on a national basis
(b) Expected stock warehouses after 1993 – concentration and rationalization
Source: Cooper, J and Browne, M and Peters, M. (1991).

Generally speaking from the theory of logistics and distribution, the consolidation of production at fewer sites will increase transport cost because products have to be carried further to markets. In this case, the transport operation will need to be faster and more reliable to maintain the customer service levels. However, the principle of cost trade-off will be applied here. First of all, due to the fact that the number of depots/distribution centers is reduced, the storage cost will also be lower. Secondly, the consolidation will lead to the saving in inventory cost as the greater consolidation of inventory implies a smaller overall inventory requirement (Cooper, Browne & Peters, 1991), the overall cost of operating the warehouses tends to fall due to economies of scale in warehousing (Lambert, Stock & Ellram, 1998), the administrative costs (order processing, invoicing etc) will tend to decline when inventory is held in fewer places and the capability to apply Information Technology in supporting distribution. Furthermore, saving can be achieved through better consolidation of outbound shipments and better vehicle's utilization or the transfer of some final assembly tasks to the regional distribution

center to significantly reduce the inventory levels. With the increasing trend of outsourcing from the manufacturing sector analyzed in the previous part, the logistics companies will have more chances to enhance their business by taking the parts contracted out by their customers and for the sake of optimizing their customers' resources.

As manufacturers have close relationship with logistics services providers, the consolidation trend in the former can also be observed in the latter. In order to satisfy their customers' requirements, third-party logistics providers today also have to consider possibilities to apply the regional distribution centers strategy instead of the country-specific basis and minimize the total distribution cost.

To conclude due to the trends of concentration through mergers, acquisitions and alliances, outsourcing and consolidation of logistics and distribution the importance of logistics service providers is increasing substantially together with their new strategy of locating distribution centers on regional basis as devised in Figure 8. This should be applied as guidelines when the Nordic region can be considered as a single market and therefore a regional distribution center can be placed there to serve this marketplace.

TENDENCIES OF LOGISTICS AND DISTRIBUTION IN EUROPE

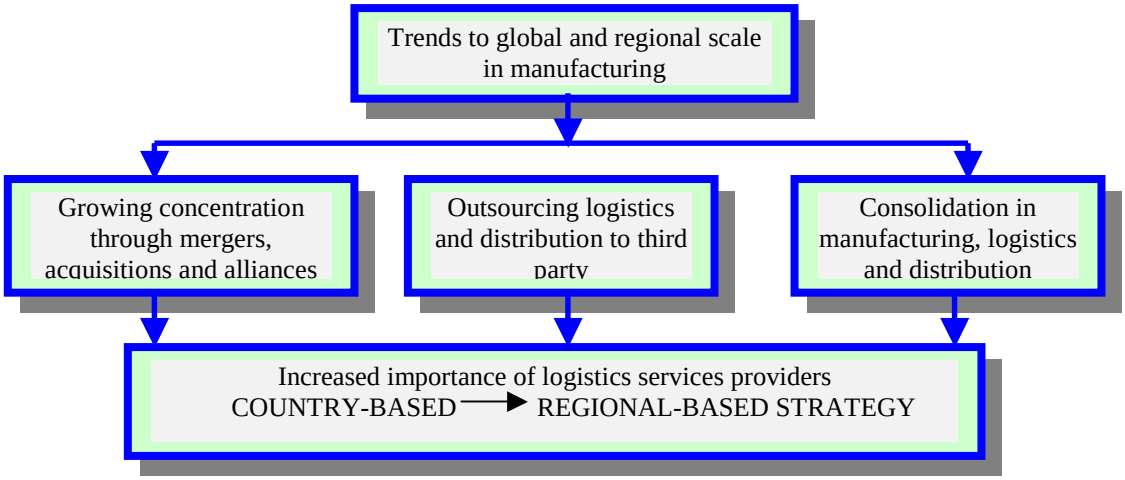


Figure 8

2. 3. Nordic region as a single market

So far, some basic concepts and notions about logistics and distribution, as well as current trends of logistics and distribution in Europe have been explained.

Because Europe, as being seen so far, is considered as a single market, the Northern part of it (Nordic region) cannot be studied separately from country to country. Moreover, because logistics companies today are changing their strategy from country-based to region-based, there is growing practice that the Nordic region should be considered as a single market seen under the angle of the logistics and distribution chain. The *nodes* in the physical distribution network of logistics companies should therefore be established for the use of the region instead of any specific country.

The question then is where the future distribution center(s) for the Nordic region should be placed. This will be answered based on a number of considerations within the Nordic region, and the issue of site selection will be dealt with later in coming chapters when it comes to the case study of Schenker International.

The philosophy and strategy of considering the Nordic region as a single market are growing among international logistics companies doing logistics and distribution in this region. In fact, there are a number of reasons explaining this from historical, economical and social perspectives.

2. 3. 1. From historical perspective

One of the reasons to consider the Nordic region as a single market is that Nordic countries in the past have had historical bounds and more than once established some forms of union, alliance and the like. Although it seems not to be the main deciding factor, it does place a necessary and firm ground for other considerations because it is really a pre-requisite for co-operation and co-ordination in many other areas among countries in the region.

It may be ironical that in the past there were many struggles and wars among neighboring countries in the Nordic region, such as a long period from 1523 to the early 19th century when the Nordic region was split between Sweden and Finland in an alliance and Denmark, Norway, Iceland, Greenland and the Faroe Islands in another one[1]. However, there were many times they displayed a willingness to co-

operate and reinforce the common Nordic entity. The earliest action in that respect is the Kalmar Union (1397-1521) between three Nordic kingdoms (Sweden, Denmark, Norway). The union treaty stated that the countries in the union would act as a single kingdom vis-à-vis other countries and assist each other. Another clear example of the historical bounds among Nordic countries is the Currency Union among Denmark, Sweden and Norway in the period 1873-1914[2]. By the end of 19th century, trade increased drastically within the region thanks to developments in railway traffic and shipping. In order to facilitate trade, it was decided that the three countries would use a common currency unit, and the krone was applied as a result of the co-operation for joint-development among Nordic countries at that time. Another example can be mentioned here is the formation of the Nordic Council in 1952[3] between Denmark, Sweden and Norway with later participation of Finland in 1956. The Council was established to enhance the co-operation in the future legislation in the region and allow Nordic parliamentarians to play a larger role to do that. And last but not least, a symbol of co-operation for development among Nordic countries for the sake of a single Nordic entity is the existence of the Nordic Council of Ministers since 1971 up to now following the adoption of the Helsinki Treaty[4]. It was clearly said in the treaty that the Council would act as the official joint-operation body for the Nordic governments for further integration among countries in the region in all aspects of politics, economics, social activities.

Clearly, it can be seen from the above that with historical and traditional bounds existing in the past, the Nordic countries are moving ahead in the integration process, making the region itself a single entity in terms of political and environmental forum, and especially marketplace. Analysis from a historical perspective is therefore valid to consider the Nordic region as a single market.

2. 3. 2. From economic perspective

The second important reason to consider the Nordic region as a single market is from the advantageous economic scenario existing in the region.

[1,2,3,4] *Nordic Council of Ministers, http://www.norden.org*

In the previous parts, it became clear that the EU nowadays is moving ahead in the process of integration, and the EU itself is being considered to be a single marketplace from the viewpoint of many international companies because there are common product standards, no customs barriers and other tendencies in the manufacturing and logistics and distribution sectors.

As Sweden, Denmark and Finland joined the EU, they are also benefiting the advantages brought about by the Union, in that requirements about products harmonizing with the EU standards, customs administration and regulations are uniformed with the ones of the EU. As far as the Customs issues are concerned, interviews were made at both the Swedish Customs Authority in Malmö, and Danish Customs specialist of Schenker A/S in Copenhagen[5]. The general outcome of these interviews is the harmonization of customs requirements in the Nordic countries with the EU. For example, if a company has five containers coming into the EU, it is much easier to customs clear the lot at one point rather than at four different locations in four different countries. Once cargo is cleared in one of the EU member states, then it can move freely within the EU borders without any stop. For instance, a container imported from China through the port of Rotterdam and bound for Finland, which is an EU member, after being cleared at Rotterdam can be cross-docked at a distribution center in Copenhagen or Malmö, and then shipped to various customers in Helsinki or elsewhere. Although Norway is not yet an EU member, cargo bound for this country can still be easily dealt with transit status and without any cumbersome documentation. Moreover, there has been very close co-operation between customs authorities and companies, facilitating the companies' business. For example, the interviews revealed that all warehouses and distribution centers can be connected by network directly with customs office, and all declarations can be done through the system.

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[5] *Interviews with Ms. Marie-Louise Schildt, Customs Information Department, Customs office of Skåne region and Ms. Lotta Söderberg Larsen, Logistics consultant and customs specialist, Schenker-BTL A/S, Copenhagen, Denmark.*

Another angle which can be seen from is the transportation infrastructure of the Nordic region. In fact, this region has a sophisticated transportation system including road, rail, sea and air. The transport within countries and between countries in the region is facilitated with a massive infrastructure of motorways, railways, airports and seaports. In the region, Copenhagen and Stockholm airports are the major ones in Europe in that Copenhagen airport is the largest in the Nordic region. The Port of Göteborg and the Port of Copenhagen are the major gateways to the region with state-of-the-art handling equipment ensuring fast transit time for cargo moving in the Nordic countries. The Port of Trelleborg is also the most important RO/RO port in the region serving the ferry traffic from Sweden to Germany and other Baltic states such as Poland, Estonia, Lithuania and Latvia. Figure 9 shows a rough picture of transportation infrastructure in the Nordic region.

SHUTTLE AND BLOCK TRAIN SYSTEM IN THE NORDIC REGION

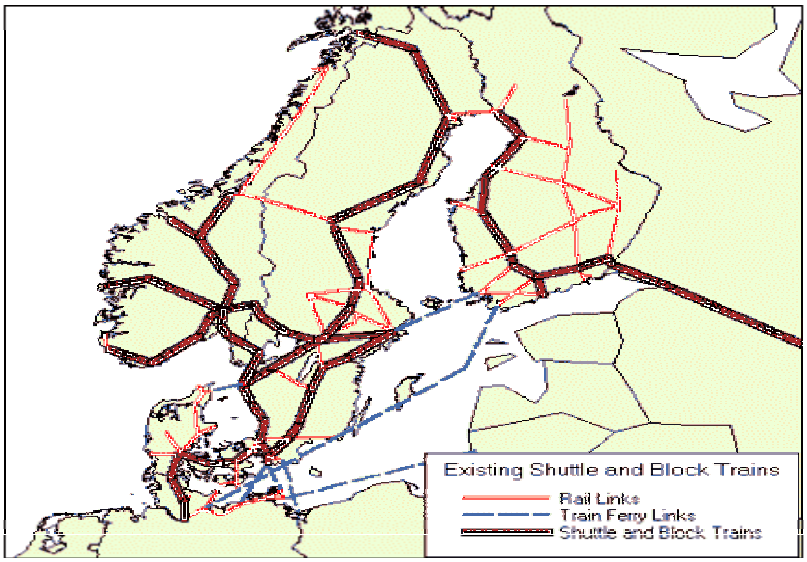

Figure 9

In the past, the Nordic region except Denmark was said to be separated from the European continent because there was no link between Denmark and Sweden over the Öresund Strait. By July 2000 when the Öresund fixed link linking Copenhagen in Denmark and Malmö in Sweden was opened, it also opened a new era in the history of the Nordic region as it facilitates the transportation between the European continent and the Northern European countries. A lot of papers have been studied and examined the effect of the fixed link, and the general conclusion is that

the link will facilitate trade through fast and safe transport, bridging the gap between the main continent and the rest of it, integrating faster Nordic countries into a single marketplace. Other infrastructure projects contributing to this process can be mentioned here, such as the Store Belt Bridge connecting Denmark's mainland to its capital and the fixed link at Fehmarn belt connecting Greater Copenhagen and the Öresund region to Germany (Rödby-Puttgarden). Together with the Öresund fixed link, they contribute to making transportation of goods from the European continent to the Nordic region all land-based and hence the transit time will be much faster.

In short, the excellent transportation infrastructure together with its open and advantageous customs environment in the Nordic region form the economic reason why this region should be considered as a single market in the strategy of international companies. In order to make the assessment full, the following social perspective will also be studied.

2. 3. 3. From the social perspective

As far as the social perspective is concerned, Nordic countries are moving fast in the integration process to form a single region. For example, there has been a lot of co-operation in politics, science, research and development and labor force among these countries to reach the common features. They also have mutual agreements on these areas and related ones. Social matters such as environmental issues, education, social welfare receive equal attention and priority within the Nordic countries. On the international level, the Nordic countries often stand together to attract more influence on political and cultural matters. It is therefore reasonable to consider the Nordic region as a single entity including the market perspective.

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To make the story short, an overview picture about logistics and distribution in Europe with basic tendencies resulting in the change from country-based to region-based strategy in the Nordic region has been given. Moreover, the Nordic region is seen, from the above analysis on historical, economic and social perspectives to be a single market. This chapter is therefore, very essential since it lays the basic pre-requisite for shaping the location for the future regional gateway/distribution center from the general geographical area level in Chapter 3.

CHAPTER 3

DIANOGSIS OF LOCATION FOR THE NORDIC REGIONAL GATEWAY/ DISTRIBUTION CENTER FROM THE GENERAL GEOGRAPHICAL AREA LEVEL

From the analysis in Chapter 2 of historical, economic and social perspectives, the changing strategy of considering the Nordic region as a single market in the logistics and distribution system of international logistics companies has been devised. The question is from regional perspective, where the Regional Distribution Center (RDC) should be placed in the Nordic region. In this chapter, this question will be worked out following a number of diagnosis, analysis and considerations. The chapter will open with a general diagnosis on the theoretical perspective on ***the principle of centre of gravity*** followed by analysis on population distribution, population growth and end with a specific recommendation about the general geographical area of the future regional distribution center.

3. 1. Principle of centre of gravity

In the following parts, some basic notions on *the principle of centre of gravity* will be introduced to place foundations for further analysis on general geographical location of the future regional gateway for the Nordic region.

3. 1. 1. Centre of gravity in physics

In physics, the *centre of gravity* (CoG) of a collection of masses is defined as an imaginary point where all the weights of the object can be considered to be

concentrated through that point, and hence, there is no momentum arm to make the object unbalanced[6]. The following figure represents the idea of this concept.

CENTRE OF GRAVITY MODEL

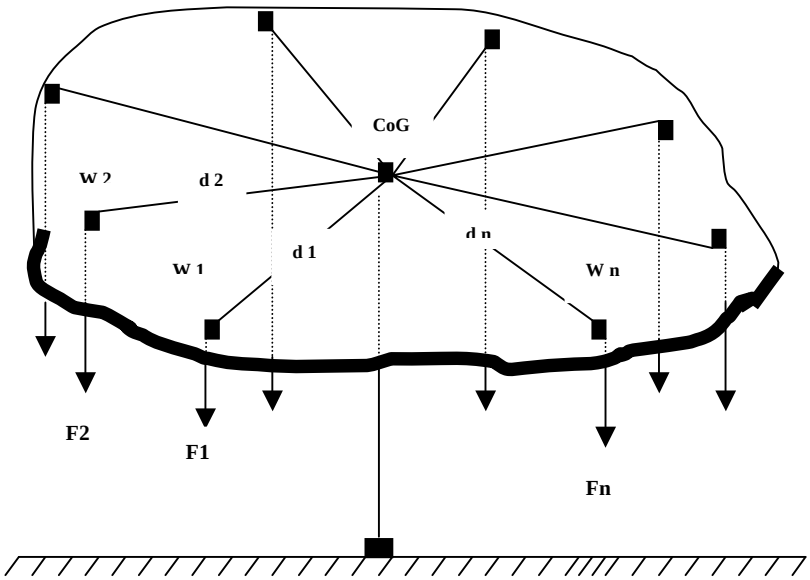

Figure 10

Supposing that an object carries a collection of weights W_1, W_2, … W_n and the relevant distances from these to an imaginary CoG are d_1, d_2 … d_n. The forces exerting to this object at various locations are calculated based on Newton's law of gravity as follows:

$$F_1 = W_1 \times d_1, \quad F_2 = W_2 \times d_2, \ldots \quad F_{n-1} = W_{n-1} \times d_{n-1}, \quad F_n = W_n \times d_n$$

In order to make the object balanced, the CoG should be placed where the following equation is satisfied:

$$F_1 + F_2 + \ldots + F_{n-1} + F_n = 0 \quad \text{or} \quad \sum_{i=1}^{n}(F_i \times d_i) = 0 \qquad (1)$$

The equation (1) indicates that all weights of the object have a mutual relationship, and any changes in one direction of a weight should be responded in the other direction of the other weight so that the balance status is maintained.

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[6] *This concept is discussed intensively in many scientific literatures; further references can be available from many sources, for example from http://theory.uwinnipeg.ca and http://www.astronomynotes.com/gravappl/gravappla.htm*

Furthermore, as the force exerting to a weight depends on weight and distance to CoG, an increase in weight will be reacted by the decrease in that distance so that the object is still kept balanced. *The CoG in this case will, therefore, shift to the new area which is near the heavier weights*. Further realization can be mentioned here, as a diagnosis from equation (1), is that in order to have the balance status quo the CoG will tend to locate in the area near major weights to offset other lighter ones in further distances.

3. 1. 2. Application of CoG in shaping the general geographical area of the gateway for the optimization of transport logistics

In fact, the philosophy of CoG concept in physics can be applied in transport logistics. In order to choose a location area for the gateway all elements of 'weights' and 'distances' have to be taken into consideration. From the general geographical level the population concentration points are analyzed as 'weights' because cargoes are transported over relevant distances from the gateway to these points and vice versa. In order to make the transport optimized and balanced, the *CoG principle* should be preserved. The gateway's location should, therefore, be near to areas where the 'weights', meaning population points, are heavier or more concentrated. Other factors like population growth should also be considered to ensure the same arrangement in future and the CoG is maintained without shifting.

3. 2. Choosing future regional gateway for the Nordic region from general geographical level by the application of CoG

In order to have a general overview of the Nordic region and a rough idea about the geographical area of the future distribution center, it is necessary to examine some important aspects, as mentioned in the previous part, affecting the choice of location from the level of general geographical area.

3. 2. 1. Population distribution

The first important parameter to be examined is the population distribution in the Nordic countries in general, and in major Nordic regions and cities in particular. These are very essential because they indicate where the major ''weights'' are distributed and give the initial picture about geographical location of the future distribution center. With some exceptions from the manufacturing sector, the general

principle is that the future regional distribution center should be located reasonably near the major weighting population areas with the optimization of distance and costs.

The term ‘’Nordic region’’ as defined before in this study is limited in four Nordic countries: Sweden, Denmark, Norway and Finland. The following statistics indicates the population of each country in the region.

Table 4: POPULATION OF NORDIC COUNTRIES IN 2000

COUNTRY	SWEDEN	DENMARK	FINLAND	NORWAY
POPULATION	8,866,800	5,392,700	5,194,200	4,463,200

Source: The Nordic Council of Ministers, http://www.nordern.org

The proportion of population from each country can be presented as follows:

POPULATION PROPOTION OF NORDIC COUNTRIES

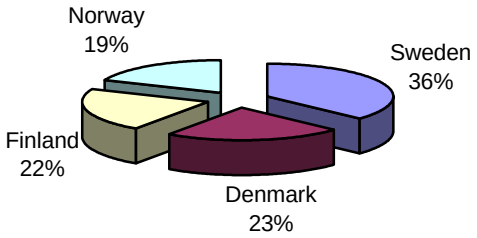

Figure 11
Source: Compiled from table 2

From the above Table 4 and Figure 11 a general conclusion can be drawn here namely that Sweden and Denmark are the two countries with the most crowded population in the Nordic region. Indeed, with the vast majority of Nordic population (59%) concentrated in these countries it seems reasonable that the future regional Distribution Center should be located somewhere in the Swedish or Danish areas to serve the Nordic market because with some exceptions population implies market. However, the location of a future distribution center also has to have good connection to other big markets in the region like Finland and Norway as well as other Baltic states, and this issue will be dealt in later part.

The absolute figures on a country’s population, however, are not enough to have a precise judgment on where the distribution center should be located. Further analysis on population distribution is presented in Table 5.

Table 5 : POPULATION OF MAJOR NORDIC REGIONS AND CITIES IN 2000 AND PROJECTION TO 2010

SQ	REGIONS AND CITIES	POPULATION		SQ	REGIONS AND CITIES	POPULATION	
		2000	2010			2000	2010
1	The Copenhagen region	1798639	1852757	8	The Turku region	284300	282050
	Copenhagen	495989	496013		Turku	170500	168000
2	The Aallborg region	485126	497818	9	The Oslo region	965014	1031097
	Aallborg	162061	169234		Oslo	509199	546091
3	The Aarhus region	639847	661746	10	The Bergen region	332447	351261
	Aarhus	285183	285183		Bergen	230667	243733
4	The Odense region	473856	479870	11	The Stavanger region	251516	274084
	Odense	185193	187934		Stavanger	109315	117850
5	The Helsinki region	1196755	1300701	12	The Stockholm region	1646595	1646595
	Helsinki	554584	577061		Stockholm	743714	743714
6	The Tampere region	294356	307722	13	The Göteborg region	778520	778520
	Tampere	195000	202300		Göteborg	465613	465613
7	The Oulu region	164603	184000	14	The Malmö region	525100	525100
	Oulu	118500	129000		Malmö	260700	295300

Source: compiled from NORDSTAT (2000)

In order to have a clearer picture the detailed population distribution in the Nordic region is analyzed. Table 5 gives statistical figures on population of the major most crowded Nordic regions and cities. Based on that, the following figures are devised to work out the distribution of the Nordic population in 2000 and 2010.

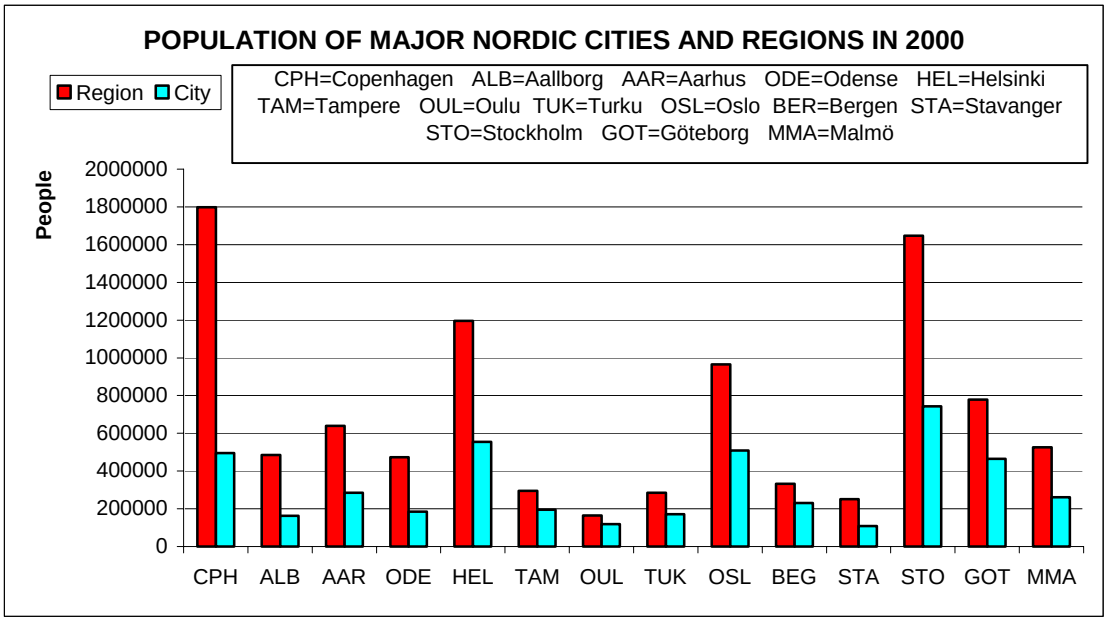

Figure 12

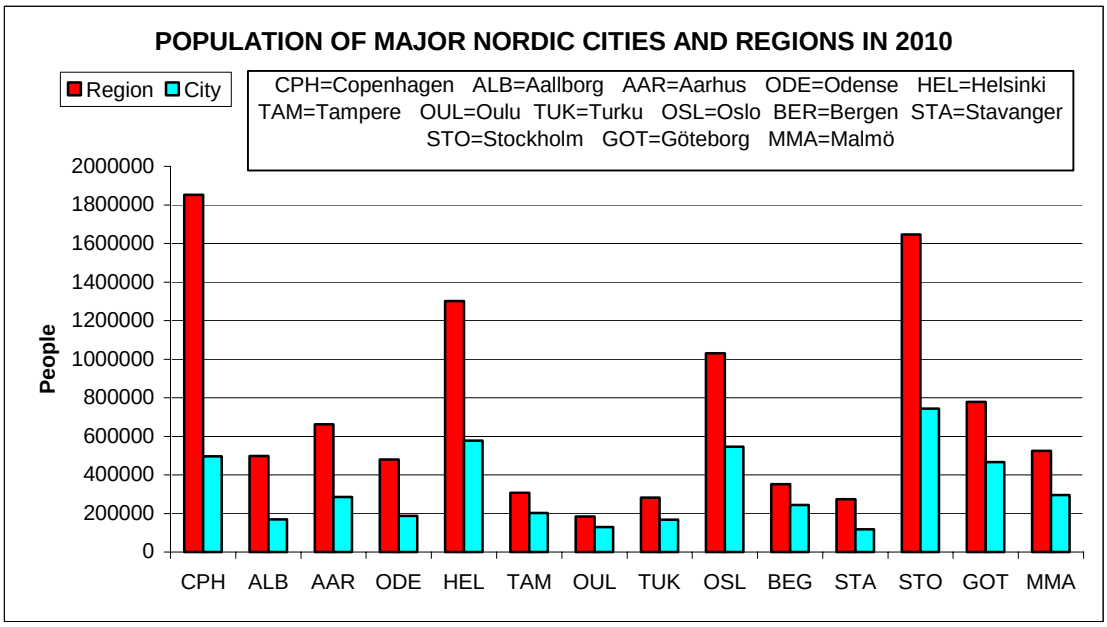

Figure 13

In terms of index the above figures can also be expressed as follows:

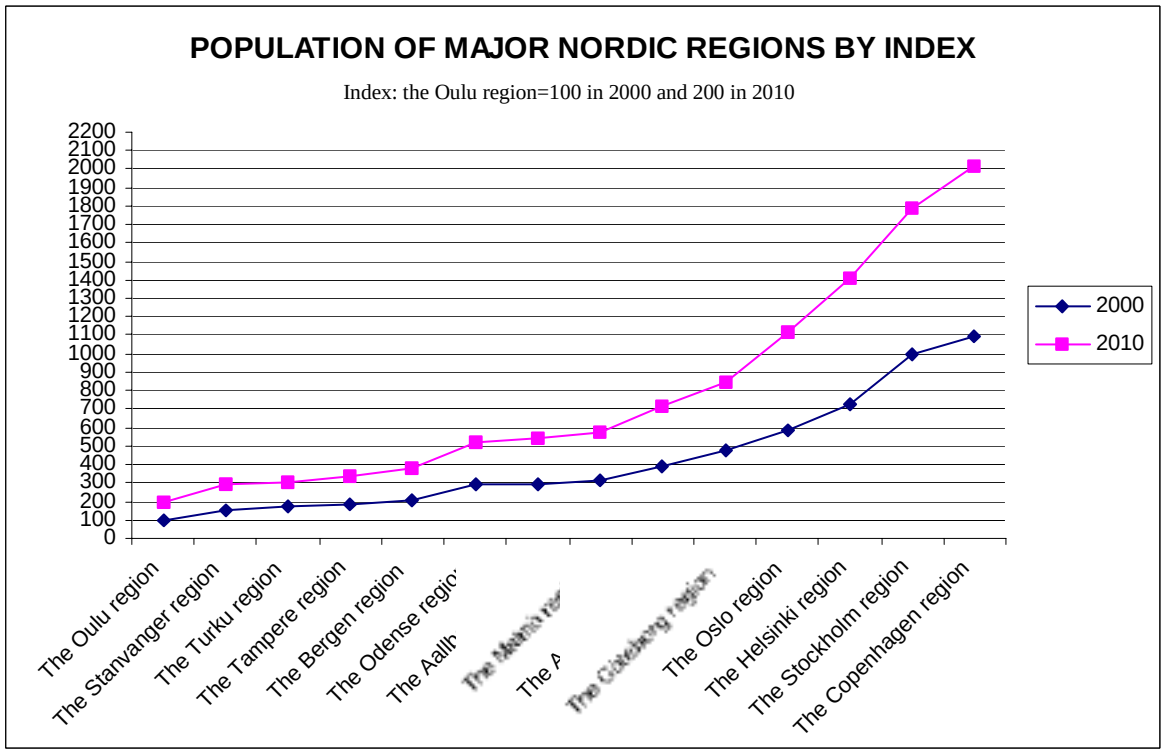

Figure 14

Source: Compiled from table 3

Figures 12, 13 and 14 clearly show the most densely populated areas in the Nordic region are the Copenhagen, the Stockholm, the Helsinki, the Oslo, the Göteborg, the Aarhus and the Malmö regions. In the future, by 2010, the development of the population in these regions is very similar in pattern to those in 2000. It is very interesting to recognize that among the seven most populated regions there are three belonging to Sweden and two to Denmark. Moreover, most of them are located in the Southern part of Sweden and adjacent to the Copenhagen region as can be seen from the following map.

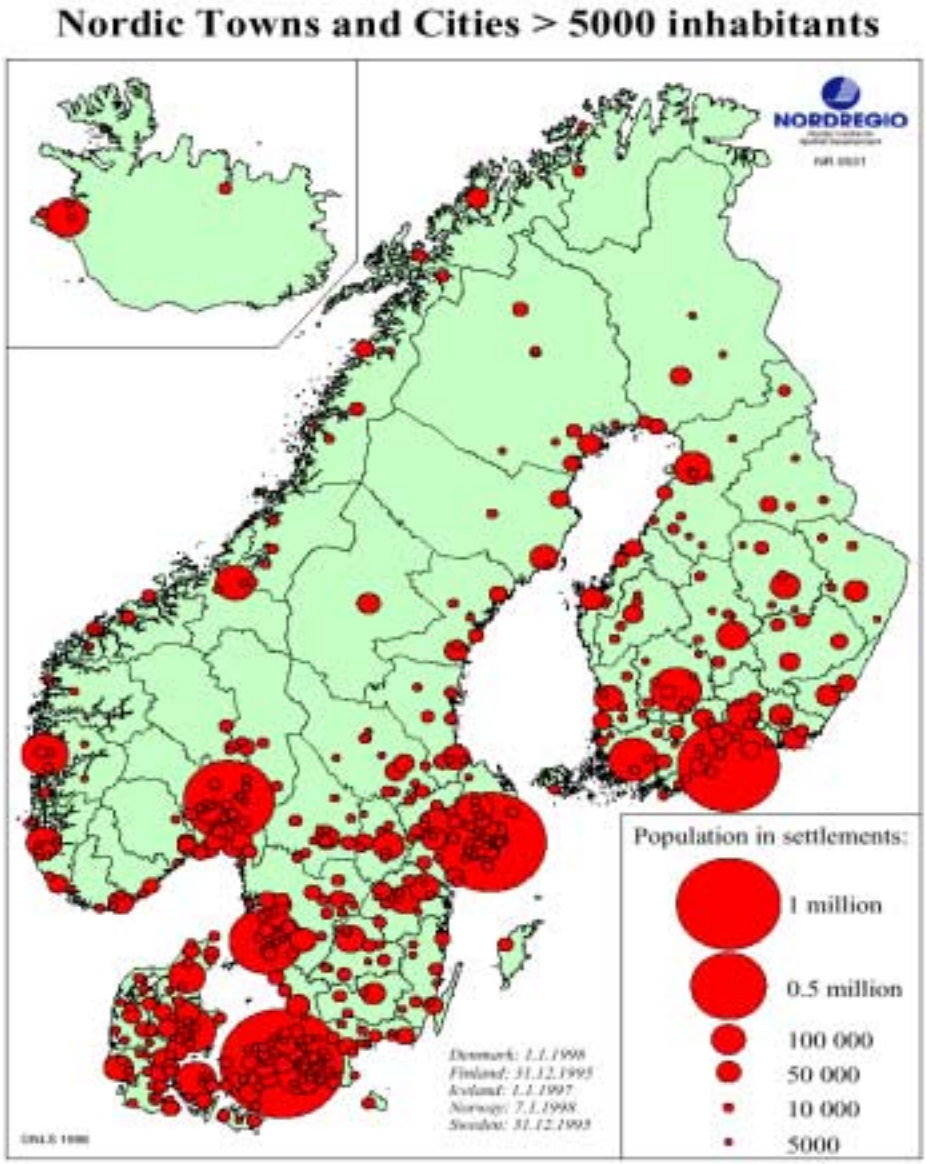

Figure 15

If applying the ***principle of centre of gravity*** in this case, it is obvious that the Southern part of Sweden and Copenhagen region are considered to have more ‘’weights’’ than other regions as the Helsinki and the Oslo regions in terms of population distribution, and hence the future distribution center should be located within this geographical area. If the distribution center is placed in the Helsinki or the Oslo regions, it is only advantageous to serve these regions alone but not balanced to serve the others in the Nordic region because shipments need to cover a great amount of distances to reach the major markets in the Southern part of Sweden and the Copenhagen region. Again, the ***Centre*** of gravity, here that is the future distribution center, should be placed near the major weighting areas (in this case the densely populated areas). In short, it can be said that the Southern Sweden and the Copenhagen region is the most suitable geographical area for the future regional distribution center. The following analyzed indicator will also strengthen this diagnosis and appraisal.

3. 2. 2. Population growth

In addition to the population distribution, the population growth is another important indicator to show the weighting areas because it does affect the choice of location taking into consideration the future perspective. For instance, if the growth factor of a crowded region slows down substantially, and it may go up quickly in another region having average size of population before or vice versa, it means that there may be a shifting of *centre of gravity* in the whole arrangement and hence the location of regional distribution center has also to be moved accordingly. Let us look at the following figure devising the demographic development of major Nordic regions and cities.

DEMOGRAPHIC DEVELOPMENT IN NORDIC REGIONS 1980-1992 INCLUDING POPULATION OF 1992

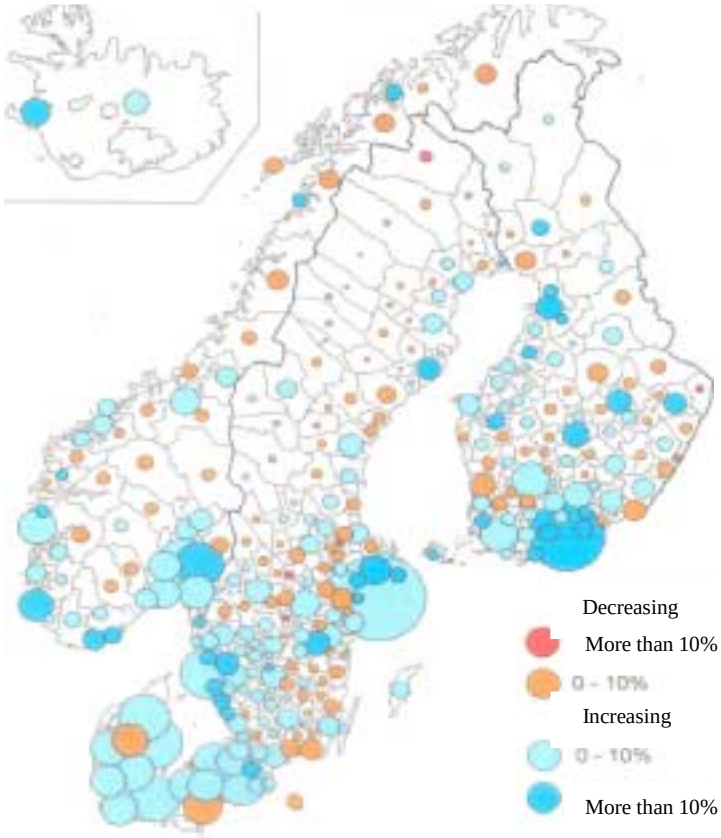

Figure 16

Source : Philip Moding and the Nordic Council of Ministers

The above figure clearly shows that in general the population in Southern Sweden and the Copenhagen region has been increasing relatively and continuously since 1980. Referring to the part of population distribution recently in 2000 and the projection for 2010 it is also easy to see that the Southern Sweden and the Copenhagen region are very dynamic in terms of population growth with increasing population. This fact is very important because it ensures the same pattern of population development in future, and it affects the choice of location for the distribution center herein. Clearly, together with population distribution in the Nordic region the population growth is another essential parameter to diagnose the general geographical area for the regional distribution center. It now clearly comes to the picture that the Southern Sweden-Copenhagen region is reasonable area for the choice of location.

In the EU scenario and with recent developments in infrastructure as well as in other sectors, the newly emerged Öresund region as the combination from the Skåne region in Southern Sweden and the Greater Copenhagen region can be considered as a good place for Nordic regional distribution center to take advantage from the crowded population from these two regions and from other factors.

3. 3. The Öresund region as the place for Nordic regional distribution center

In fact, the choice of the Öresund region comes from a number of considerations from many angles. They are gradually analyzed in the following parts to devise the best view of the new region.

3. 3. 1. Geographical location

The Öresund region consists of the Skåne region in the Southern part of Sweden, and on the Danish side of the Danish islands of Zealand, Lolland, Falster and Bornholm, which is called the Greater Copenhagen region. This is the first transnational region in Europe.

THE ÖRESUND REGION

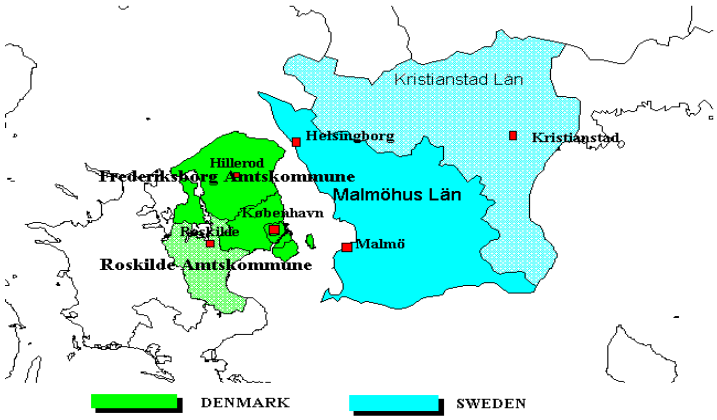

Figure 17

Centrally located in Northern Europe, the Öresund region has advantage from its strategic geographical location as the gateway to this vast Nordic region including Norway and Finland. Its location is also very important as the corridor to other Baltic states such as Poland, Estonia, Latvia and Lithuania. For international logistics companies, this geographical location is very essential because it can facilitate the whole logistics and distribution chain in terms of distance and transit time.

3. 3. 2. Population and labor force

The population in the Öresund region counts for about 3.2 million inhabitants; two-thirds of the population is situated in Greater Copenhagen and one-third in Skåne. Besides, statistics showed that one-third of the Danish population live in the Greater Copenhagen region and about 9.2% of the Danish population is living in Copenhagen city (Danmarks Statistik: www2.dst.dk/internet/startuk.htm). On the Swedish side, the Skåne region gathers the second biggest number of inhabitants in the country after Stockholm (Chamber of Commerce and Industry of southern Sweden, http://www.handelskammaren.com). Furthermore, the Öresund region is one of the most densely populated areas in the Nordic region with an average of 209 inhabitants per km^2 of which 5948 inhabitants per km^2 in Copenhagen city and 1568 inhabitants per km^2 in Malmö city (Greater Copenhagen Statistical office, www.hsk.dk and City of Malmö, www.malmo.se, 1998). This region is also growing quickly in terms of population growth as shown in Figure 16 from the previous part. From the figure it can be seen that the Öresund region has a high population growth and that it is very meaningful as a potential big market.

As far as the labor force is concerned, the Öresund region has a powerful workforce with more than 1.6 million employees of which 48% are women (1996 figure). In another aspect, the participation rates in the labor market by age and sex are very high in the region, both on the Swedish and Danish sides (average 81.7% between 20 and 59 as the main working period), and this means the labor force is stable and potential.

Table 6: PARTICIPATION RATES IN THE LABOR MARKET (%)

	Greater Copenhagen		Skåne		The Öresund region
Age	Male	Female	Male	Female	Average
20-24	80.8	76.4	60.7	55.2	71.3
25-29	87.6	81.4	74.9	63.2	79.3
30-34	89.7	84.9	86.7	72.6	84.7
35-39	89.4	86.5	84.1	75.8	85.1
40-44	89.2	86.7	84.4	78.4	85.5
45-49	89.5	86.5	84.5	83.3	86.4
50-54	85.5	78.1	86.4	86.2	83.5
55-59	80.3	67.7	83.2	78.5	76.6
20-59	**86.8**	**81.4**	**80.6**	**74.1**	**81.7**

Source: Adapted from www.oresund.com

The educational level of the labor force is also an advantage of the Öresund region. It can be seen that the region has a high educational level of employees and therefore facilitating the business of international companies here.

Table 7: EMPLOYEES BY EDUCATIONAL LEVEL, 1999 IN % OF LABOR FORCE

	Greater Copenhagen	Skåne	The Öresund region
No vocational train./educa.	37	29	34
Vocational training	39	44	41
Short higher education	7	14	9
Medium or long higher education	17	13	16

Source: Adapted from www.oresund.com

As the population and, workforce and its educational level represent the potential market users and employees, the Öresund region is definitely advantageous for international logistics companies to place their regional distribution center(s) in this region.

3. 3. 3. Economic indicators

With the GDP of USD 100 billion, the Öresund region is one of the richest regions in the world. It was ranked the 1st in Nordic region and 8th in Europe. Compared to other OECD economies, both Swedish and Danish economies are good and controlled in a sustainable economic growth. From 1996 to 1997, for example, the real GDP increased by 3.3% in Denmark and 1.8% in Sweden taking into consideration the inflation rate (2.1% in Denmark and 1.6% in Sweden in 1997). As far as trade is concerned, 70% of the Swedish national exports pass through the Skåne region whereas 37% of GDP belongs to the Greater Copenhagen region in Denmark (http://www.oresund.com, 1994 figure).

Another economic indicator giving a good example of the advantages of choosing the Öresund region to place regional distribution center(s) is the Purchasing Power Parity (PPP) per capita. In 1996, for instance, the figure for this indicator was USD21,753 which is higher than the average of the EU. This indicator gives a clearer view of the economic strength of the region beyond GDP. It indicates the real purchasing capability of consumers in the region.

Table 8: PPP-CORRECTED GDP PER CAPITA IN THE ÖRESUND, 1996

Area	PPP (USD)
Greater Copenhagen	24,400
Skåne	17,600
The Öresund region	21,800
Sweden	19,200
Denmark	22,500
EU average	20,400

Source: Adapted from www.oresund.com

3. 3. 4. Infrastructure

Transportation infrastructure is one of critical points for considering locating a regional distribution center in the Öresund region. Overall from the previous part, the Nordic region in general has an excellent transportation infrastructure to facilitate the movement of goods in the distribution system of international logistics companies. As the most important part in the Nordic region, the Öresund region possesses lots of advantages from its transport infrastructure system represented by concrete facts and figures.

✸ Road and rail transport infrastructure

The Öresund region is linked to the trans-European rail and road networks with a major part of the international Scandinavian rail and road traffic passing through the Öresund corridor (see Figure 9). With the current two major fixed links (the Store Belt Bridge and the Öresund fixed link) and the future link at Fehmarn Belt connecting Denmark to Germany, the road and rail transport infrastructure becomes more sophisticated and enhances the road and rail traffic between the European mainland and the whole Nordic region. On the Swedish side, major motorways were built to facilitate transport (for example, the E6 connecting the Öresund region with Göteborg and the E4 with Stockholm). The Danish road infrastructure, on the other hand is also advantageous for transportation with fast transit time. For instance, Figure 18 shows the delivery time in Sweden and Norway from a distribution center in Copenhagen, Denmark.

DELIVERY TIME IN SWEDEN AND NORWAY FROM A DISTRIBUTION CENTER IN COPENHAGEN

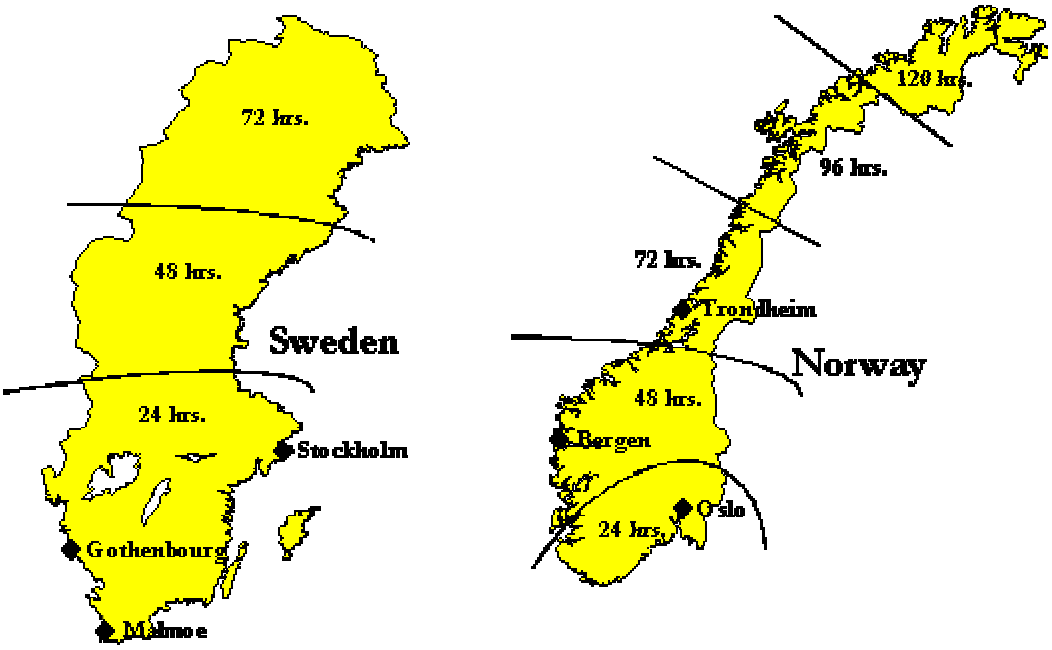

Figure 18

Source: Invest in Denmark, http://www.investindk.com

The figure shows that most of the major markets can be reached within 24 hours and the minor ones can be served within 48 hours.

✸ Air transport infrastructure

In the Öresund region, there are three major airports: Copenhagen in Denmark and Änglholm and Sturup in the Skåne region. Copenhagen Airport, which is the largest one in the Nordic region, is directly linked to the European land transport network by direct highway and rail connections to/from Continental Europe and the rest of the Nordic region through the highway and rail system passing the Öresund strait. Copenhagen is said to be the most efficient airport in Europe with the lowest distribution and transportation costs, and direct flights to most of the world business centers. The airport can deliver cargo shipments to handling companies one hour before take-off. Two hours after landing the cargo is available and it can operate within a three-hour transit time as shown in Table 9.

Table 9: TRANSIT TIME IN MAJOR EUROPEAN AIRPORTS, 1998

City airport	Hours
COPENHAGEN	3
STOCKHOLM	4
BERLIN	5
AMSTERDAM	8
BRUSSELS	10

Source: Copenhagen airport, http://www.cph.dk

With more than 39 IATA freight agents using Copenhagen airport and many of them using it as their Baltic hub, Copenhagen airport provides international logistics companies the best air transport infrastructure to apply their strategy of serving the Nordic region from regional distribution center.

✸ Sea transport infrastructure

With regards to the sea transport infrastructure, the Öresund region is well-served by a sophisticated ports system. The three major ports in the region are the port of Copenhagen, the port of Malmö and the port of Helsinborg. The port of Copenhagen and the port of Malmö recently formed the venture of Copenhagen Malmö Port, first in the history of one port and two nations, aiming at enhancing the competitiveness, facilitating trade and serving customers with wide ranges of services. As far as the rail and road traffic to Germany from Scandinavian is concerned, the port of Trelleborg plays a very important role. In 2000, the Port handled 10.5m tons of goods, an increase of 200,000 tons or 9% over 1999, and traffic comprising 119,000 rail wagons, 410,000 trucks, 47,000 ITU's (Intermodal Transport Units) and 375,000 cars. The volume of goods handled through the port represents 15% of Sweden's foreign trade in value terms (Port of Trelleborg, http://www.trelleborgshamn.se).

The port' efficiency due to its state-of-the-art handling equipment, IT system, motivated staffs, good management system etc together with the best connections to the road and railway system of the region offers their customers easy, fast and cost-saving services, contributing to the good transportation infrastructure in the region to be an ideal location for regional distribution center.

For the period 1990-2005, the Danish and Swedish governments are investing DKK100 billion in the transportation infrastructure in the Öresund region (Source:

http://www.oresund.com). This will obviously strengthen the current position of the region as the leading in transport infrastructure in the Nordic region, and enhance and facilitate the multi-modal transport and logistics and distribution system.

3. 3. 5. Education, research and development (R&D)

With regards to education and R&D, the Öresund region has the highest educational level in Europe, providing the labor market with a wide range of specialists and high skill workforce. As far as R&D is concerned, the Öresund region is viewed as the most productive region in Europe, ranked 4th in Europe after London, Paris and Moscow in terms of number of published scientific research publications (Chamber of Commerce and Industry of Southern Sweden, http://www.handelskammaren.com). In the region, the University of Öresund with its 120,000 students and researchers is one of the largest university collaborations in Europe. The university which consists of 11 different universities on both the Swedish and Danish sides (such as Lund University, Copenhagen Business School, Malmö University…) is a virtual university, i.e. the member universities in the collaboration broadly exchange knowledge via the internet. The existence of World Maritime University in Malmö, Sweden is another example of the concentration of knowledge and R&D in the region, as it is becoming the research center for the regional maritime activities. All these contribute to ***the critical mass of factors*** motivating and generating research work in the region, and in turn attracting business sectors to come.

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To conclude this chapter, it is clearly perceived that the Southern Sweden and Copenhagen region, especially the Öresund region, is likely the most suitable geographical area for the future regional distribution center as the gateway to the whole Nordic region. The chapter has gone through some necessary indicators such as population distribution, population growth and the applied ***principle of centre of gravity*** as well as some in-depth analysis about the sub-region's infrastructure and other indicators to pinpoint a suitable location. This is the initial, general but very essential suggestion of site selection within the chosen geographical area to be solved in later chapters.

CHAPTER 4

CURRENT OPERATING PRACTICES OF SCHENKER INTERNATIONAL IN THE NORDIC REGION AND ALTERNATIVE LOCATIONS FOR THE REGIONAL DISTRIBUTION CENTER

Chapter 2 described the basic idea of considering Nordic as a single market and the need to have a single gateway for this region; Chapter 3 gave the essence of shaping the location for this future gateway from a general geographical area level. The next closer approach of analyzing and finding the location for this gateway will be devised in chapter 4 when all the alternative locations within a defined geographical area stated in previous chapter are taken shape. As analyzed and synthesized from a specific company perspective, this chapter will open with a general introduction about Schenker International followed by analysis of its current operating practices in the Nordic region and wrapped up with alternative location identifications based on this analysis.

4. 1. Introduction to Schenker International and its parent company

Schenker International is the specialist in global freight forwarding by air and sea as well as related services. The range of its services includes customized logistics projects that meets special demands of exchanging goods on a global scale. It is the freight forwarding arm of Schenker AG which comprises European Land Transport,

Logistics and Freight Forwarding activities. Schenker AG is owned by a German group, Stinnes Logistics, in Essen, Germany.

4. 1. 1. History of the company

According to internal sources, Schenker AG was established by Gottfried Schenker in Vienna almost 130 years ago and it has witnessed many important events during its history. The concentration through mergers and acquisitions mentioned in Chapter 2 can also be seen clearly in the company's history. More details about the company's important milestones can also be found in **appendix A** of this study**.**

4. 1. 2. Key figures of Schenker AG

The following table shows some key figures till December 31st, 2000 of Schenker AG including ones of the air and sea freight handled by Schenker International as the targeted company in this study.

Table 10: KEY FIGURES OF SCHENKER AG, 2000

Division	Sales (Million Euro)	Employees	Locations/Offices
European Land Transport	3220	18200	640
Air and Sea Freight (**Schenker International**)	2380	7500	340
Logistics Systems	330	3300	20
TOTAL	**5930**	**29000**	**1000**

Source: Schenker AG, www.schenker.com

With the wide range coverage and sophisticated services, Schenker International is one of the leading freight forwarders and logistics service providers in the world. Schenker Land Transport is also the leader in European road transportation.

4. 1. 3. Schenker International in the Nordic region

In the Nordic region Schenker International has the head office based in Göteborg, Sweden, and presently has branch offices spread out over the Nordic countries.

✸ For Seafreight

Branch offices are located in Göteborg, Malmö, Stockholm-Arlanda (Sweden), Copenhagen, Äarhus (Denmark), Oslo (Norway) and Helsinki (Finland).

✸ For Airfreight

Branch offices are located in Stockholm-Arlanda, Landvetter, Malmö (Sweden), Copenhagen, Äarhus (Denmark), Oslo - Gardermoen (Norway) and Helsinki (Finland).

✸ Self-owned warehouses

The self-owned warehouses of Schenker International are located in Göteborg and Trollhattan (Sweden).

✸ Representative offices

Schenker International representative offices are based in Norrkoping (Sweden), Oulo, Vaasa and Tampere (Finland).

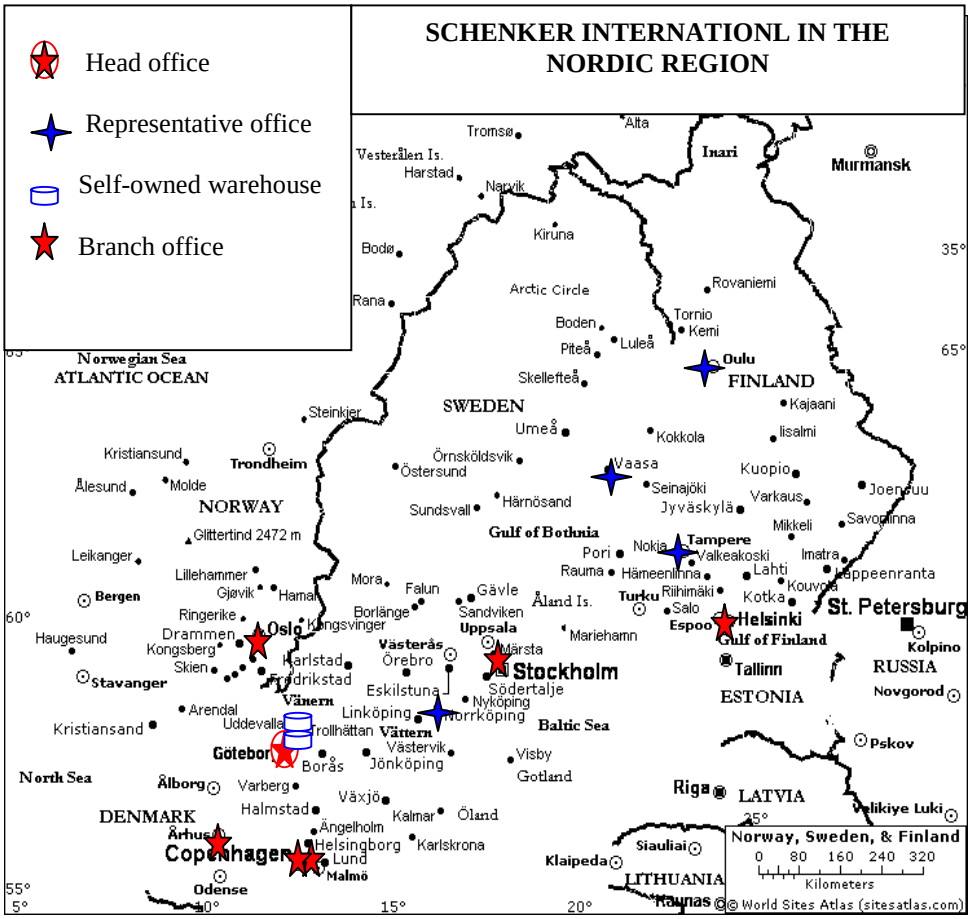


Figure 19

4. 2. Current distribution patterns being deployed

Generally speaking, Schenker International is currently handling the LCL (Less than container load) cargo on the country-based distribution patterns. Basically

it means that inbound/outbound cargo to/from a specific country in the region pass through the gateways in that country as shown in the following figures.

4. 2. 1. For Sweden

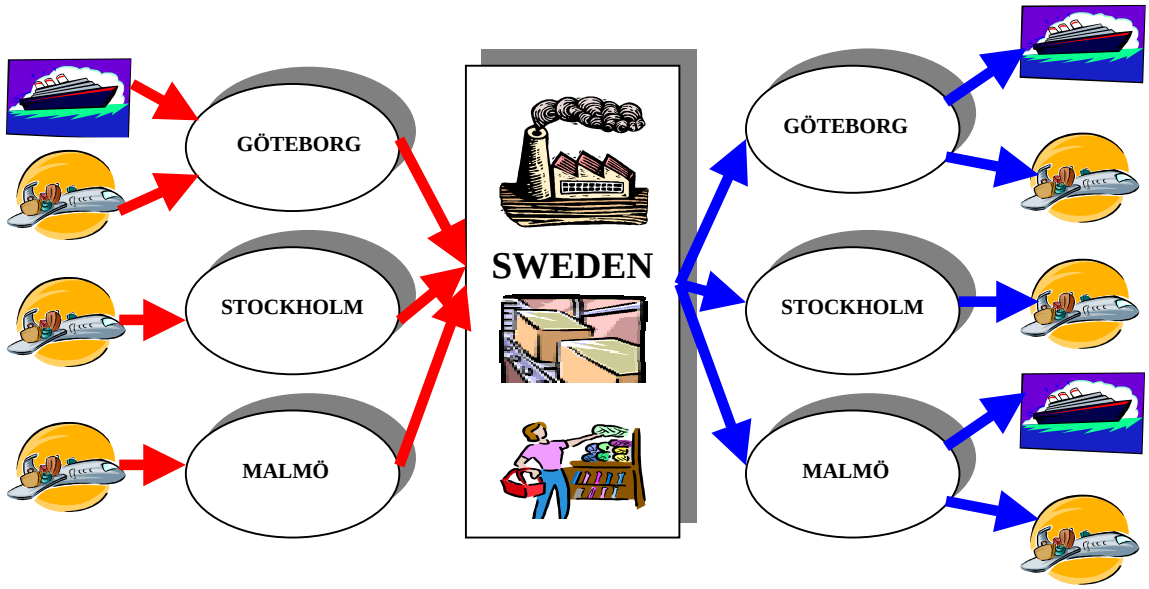


Figure 20

4. 2. 2. For Denmark

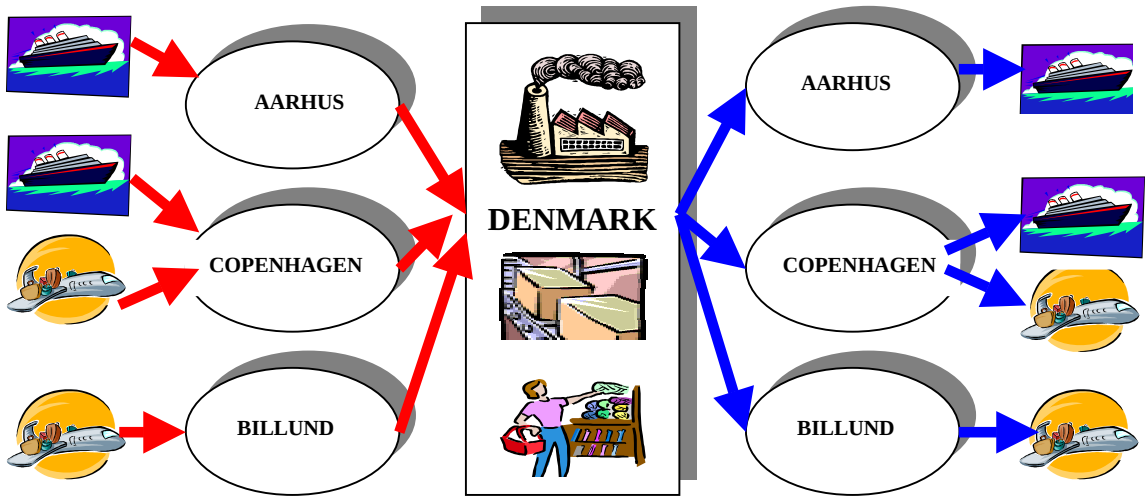


Figure 21

4. 2. 3. For Norway

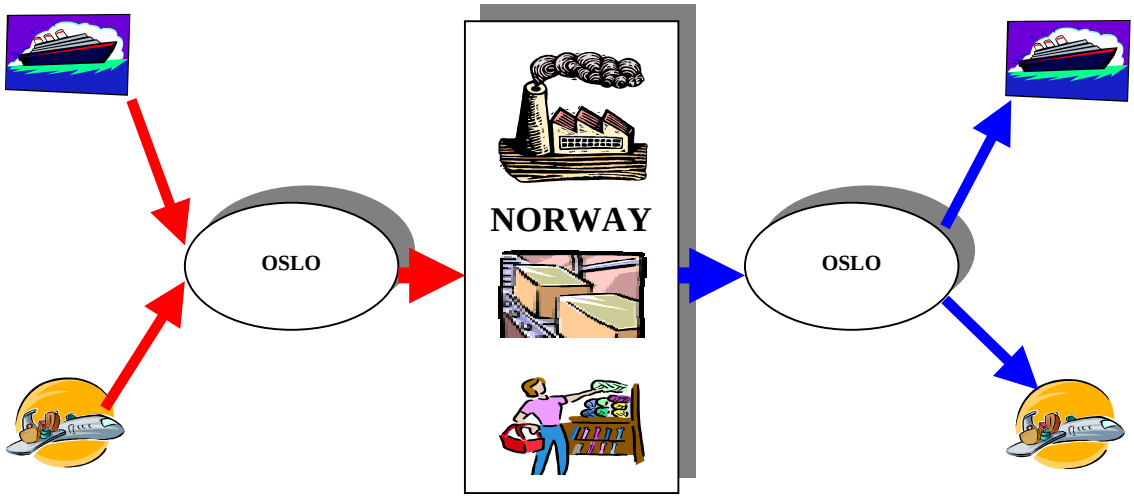


Figure 22

4. 2. 4. For Finland

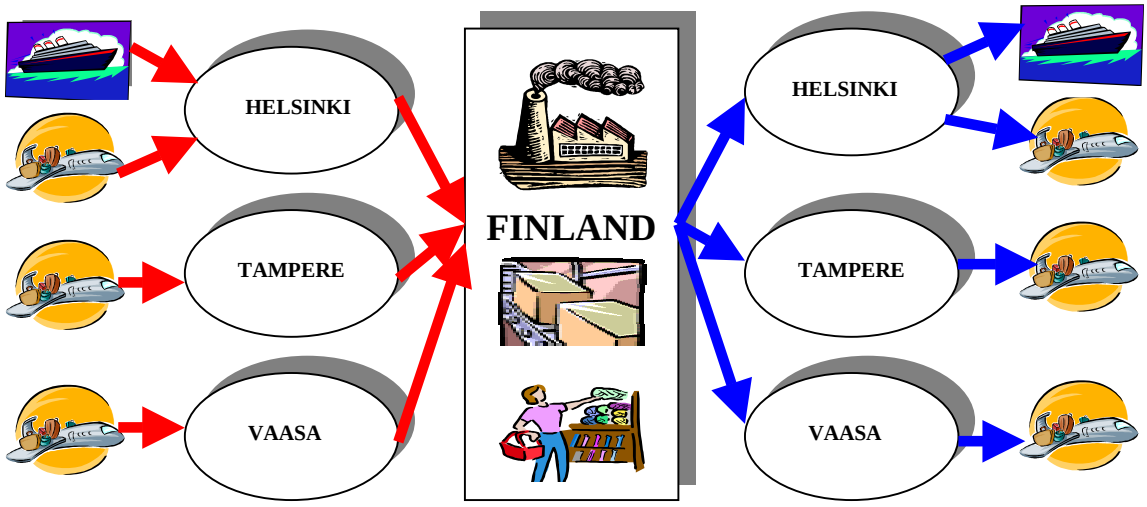


Figure 23

The current practice for airfreight cargoes is that outbound cargoes are forwarded directly to the airports instead of being consolidated before shipment. It is expected that in the near future when the new regional gateway/distribution center is established, the company is able to consolidate up to 80% of its outbound LCL cargoes, and this will contribute to the company's competitive advantages.

4. 3. Customer service levels

Traditionally sea-freight cargoes are not much time sensitive due to the characteristics of the sea transport. However, Schenker International has been using multiple services of major shipping lines serving main Nordic seaports such as P&O Nedlloyd, Hapag-Lloyd, APL, MaerskSealand etc with high frequency to ensure the best possible customer service level for its customers. The company's (Schenker's) corporate philosophy defines its customer service level for sea-freight cargoes as to achieve customers' satisfaction.

As far as airfreight is concerned, the transit time has a special importance because cargoes transported by air usually have high value. The company therefore has to strive to offer a high level of customer service for the sake of being competitive. The customer service level of the company is based on performance. Recently, Schenker International has developed its airfreight products, ''Schenker JET cargo FIRST, Schenker JET cargo BUSINESS and Schenker JET cargo ECONOMY'' to meet its customers' requirements. For the first time Schenker's customers will be provided with defined transit times without any restrictions on time or weights. Schenker JET cargo FIRST is an express service for urgent shipments which offers customers a defined transit time of up to 2 days from the Schenker branch office in origin to the destination. Schenker JET cargo BUSINESS offers transit time of up to 4 days from the origin to the destination at a good price level. Schenker JET cargo ECONOMY is the economical alternative for less urgent shipments of a maximum of 6 days. According to Schenker International's source, the FIRST class air cargoes (with transit time of maximum of 2 days) count for about 20% of the total volume of the company. The company's customer service levels is summarized in Table 11.

Table 11: CUSTOMER SERVICE LEVELS OF SCHENKER INTERNATIONAL

Activities	Strategies	Details
Sea-freight	Customers' satisfaction based	Using multiple strategic shipping lines (MaerskSealand, P&O - Nedlloyd, APL…)
Airfreight	Performance based	- FIRST class (2 days) - BUSINESS class (4 days) - ECONOMY class (6 days)

4. 4. Economic implications of current distribution patterns

In the previous part, current distribution patterns for both sea-freight and airfreight of Schenker International have been presented. In reality, such operating practices have profound economic implications for the company especially when the new regional gateway/distribution center is considered to replace the current ones. As analyzed from the above, the following factors are seen as implications of the current system.

☞ **First of all**, as Schenker International is operating on a country-based strategy in the Nordic region, the gateways/distribution centers are dispersed throughout the region in each country without taking advantage of the close proximity of customer concentration. In fact, as analyzed in Chapter 3, due to the good infrastructure in the region, many areas can be connected promptly with fast transit time (for example, from a single distribution center in Copenhagen the whole Southern Sweden area and the major markets in Norway can be served within 24 hours). The existence and operation of the many gateways are therefore not advantageous for the company to save costs and gain competitive edge.

☞ **The second economic implication** resulted from the current pattern is that the company is not able to take advantage of economies of scales. Indeed, with the dispersed gateways, the cargo volumes are also spread out and the transportation costs are therefore not economical when Schenker International may not hold the negotiating power with shipping lines and airlines. This can be seen clearly in the case of outbound LCL airfreight cargoes when they were not consolidated before shipment. Such operation can ensure the highest customer service level, but on the contrary it leads to high operation costs. It is therefore reasonable to have a compromise between the customer service level and the costs involved.

☞ **The third implication** is the direct effect of the second when the company may not be able to obtain the quantity purchase discount from the shipping lines and airlines because cargo volumes are not high enough as a consequence of using many dispersed gateways/distribution centers. In the freight forwarding service this factor is very important to ensure the profit margin for the company. The need to

consolidate cargoes within a more centralized distribution framework is more and more essential in the freight forwarding and logistics sectors today.

☞ **The last but not least implication** comes from the Schenker JET cargo FIRST service with a transit time of maximum 2 days. In Chapter 3 the conclusion was reached that the future regional gateway/distribution center should be located within the Southern Sweden/Copenhagen region. As Finland is separated from the rest of the Scandinavia by the Northern Baltic Sea, transportation to other main areas in Sweden, Norway and Denmark is mainly by sea, and thus affects the transit time of fast-transit cargo like Schenker JET cargo FIRST if the gateway is going to be placed in the very South of Sweden. It is therefore advisable that there should be flexibility in using the gateways for such kind of cargo in the Finnish market (which counts for about 20% of airfreight cargoes in Finland).

The following chart summarizes the above analyzed implications.

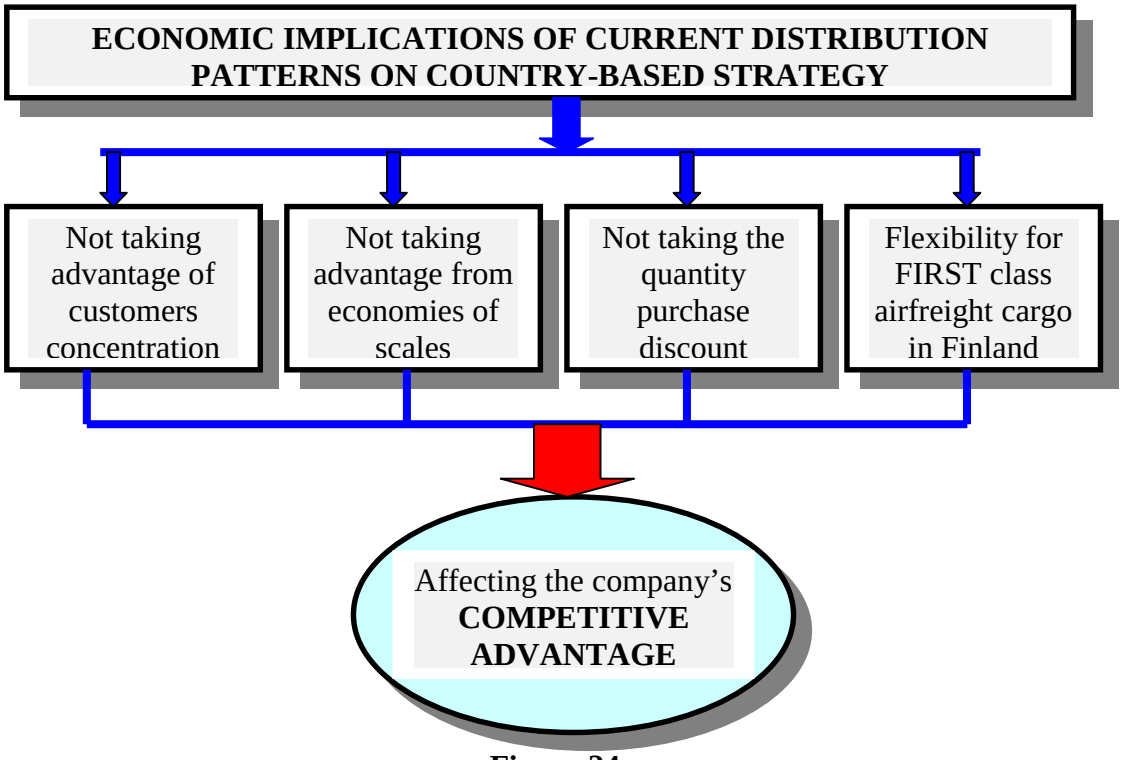


Figure 24

In short, through analysis of economic implications of the current distribution pattern in use the need for the establishment of a new gateway/distribution center is

visibly important and essential. In the following part possible alternative locations based on a number of relevant considerations will be discussed.

4. 5. Alternatives identification

In this part, alternative locations for a future regional gateway/distribution center as well as alternative seaports and airports used will be identified based on a number of considerations.

4. 5. 1. Customers proximity

The first issue to be looked at is the customers' proximity in the region based on data provided by Schenker International. According to the company's internal sources, basically the company's customers are using both sea and air services provided by the company, which means in general both airfreight and sea-freight flows come from and go to the same customers' locations.

In addition to that, other assumptions from Schenker International (P. Lingrend & C. Jorgensen, personal communication, June, 14, 2001) are:

☞ Growth factors for both sea-freight and airfreight are 40% for export and 25% for import flows.

☞ Airfreight cargo volume counts for about 5% of that of sea-freight.

☞ Cargo volumes through Malmö, Copenhagen and Åarhus are relatively small.

Taking all the assumptions into consideration and from the data provided by Schenker International based on existing customers' profiles, the following tables and figures are devised to see the cargo flows and therefore, customers' proximity. In combination with the previous part on current distribution patterns of Schenker International, the customers' proximity can also be shown on geographical maps in following pages in the form of cargo flows.

Table 12: IMPORT FLOWS FROM GÖTEBORG GATEWAY TO LOCATIONS

DESTINATION	ZIP CODE	VOLUME (CBM) 2000	VOLUME (CBM) 2001
JÖNKÖPING	550-	151.2	189
BORÅS	501-	3061.8	3827.25
ALVESTA	342-	1058.4	1323
ANDERSTORP	334-	1852.2	2315.25
MALMÖ	201-	2028.6	2535.75
NORRKÖPING	601-	214.2	267.75
HELSINGBORG	250-	226.8	283.5
STOCKHOLM	101-	1688.4	2110.5
KUNGÄLV	442-	5115.6	6394.5
TOTAL		**15397.2**	**19246.5**

Table 15: EXPORT FLOWS FROM VARIOUS LOCATIONS TO GÖTEBORG GATEWAY

DESTINATION	ZIP CODE	VOLUME (CBM) 2000	VOLUME (CBM) 2001
NÄSSJÖ	571-	1348.2	1887.48
MOTALA	591-	264.6	370.44
SKÖVDE	541-	289.8	405.72
KOLBÄCK	730 40	37.8	52.92
BILLINGSFORS	660 11	252	352.8
HALMSTAD	301-	252	352.8
BORÅS	501-	126	176.4
SVENLJUNGA	512-	2053.8	2875.32
TOTAL		**4624.2**	**6473.88**

Table 13: IMPORT FLOWS FROM OSLO GATEWAY TO LOCATIONS

DESTINATION	ZIP CODE	VOLUME (CBM) 2000	VOLUME (CBM) 2001
HEIMDAL	7080	293.08	366.35
STAVANGER	4014	41.20	51.50
NITTEDAL	1482	126.38	157.97
SKAARER	1472	133.31	166.64
STABEKK	1368	36.16	45.20
HOLMESTRAND	3080	17.01	21.26
FJELLSTRAND	1458	98.03	122.54
FARSUND	4551	137.97	172.46
FJELLSTRAND	1458	72.58	90.72
DROBAL	1441	127.51	159.39
TOTAL		**1083.2**	**1354.0**

Table 16: EXPORT FLOWS FROM VARIOUS LOCATIONS TO OSLO GATEWAY

DESTINATION	ZIP CODE	VOLUME (CBM) 2000	VOLUME (CBM) 2001
NOTODDEN	3671	72.20	101.08
OSLO	316	25.20	35.28
OSLO	1008	12.60	17.64
ORJE	1860	134.95	188.92
TOTAL		**244.9**	**342.9**

Table 14: IMPORT FLOWS FROM HELSINKI GATEWAY TO LOCATIONS

DESTINATION	ZIP CODE	VOLUME (CBM) 2000	VOLUME (CBM) 2001
JYVSKYL	40100	71.82	89.78
MNTYHARJU	52700	187.74	234.68
HELSINKI	00580	39.06	48.83
VANTAA	01380	162.54	203.18
HELSINKIMEDIA	00040	156.24	195.30
TAMMISAARI	10600	23.94	29.93
HELSINKI	00800	22.68	28.35
ESPOO	02180	56.70	70.88
ULVILA	28400	85.68	107.10
HELSINKI	00810	40.32	50.40
ESSPOO	02630	185.22	231.53
TOTAL		**1031.94**	**1289.925**

Table 17: EXPORT FLOWS FROM VARIOUS LOCATIONS TO HELSINKI GATEWAY

DESTINATION	ZIP CODE	VOLUME (CBM) 2000	VOLUME (CBM) 2001
ESPOO	02920	217.98	305.17
SAVONLINNA	57100	94.50	132.30
RAUMA	26100	20.16	28.22
VANTAA	01510	27.72	38.81
HELSINKI	00390	40.32	56.45
HELSINKI	00380	128.52	179.93
KEMPELE	90440	74.34	104.08
ULVILA	28400	79.38	111.13
HELSINKI	00210	26.46	37.04
HELSINKI	00810	28.98	40.57
TOTAL		**738.4**	**1033.7**

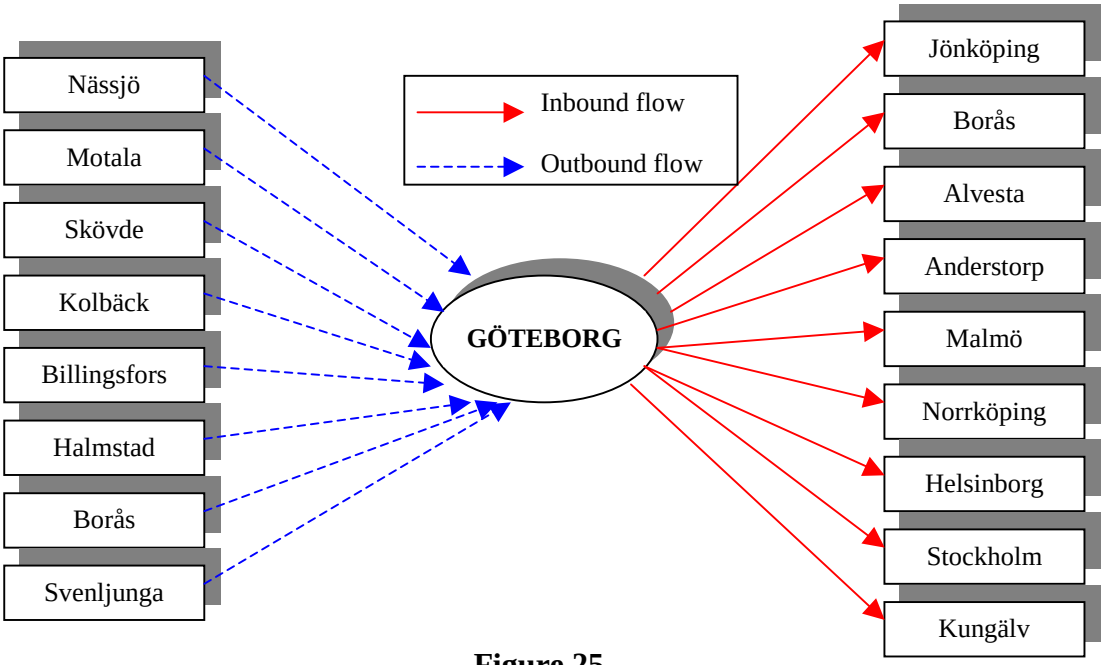


Figure 25

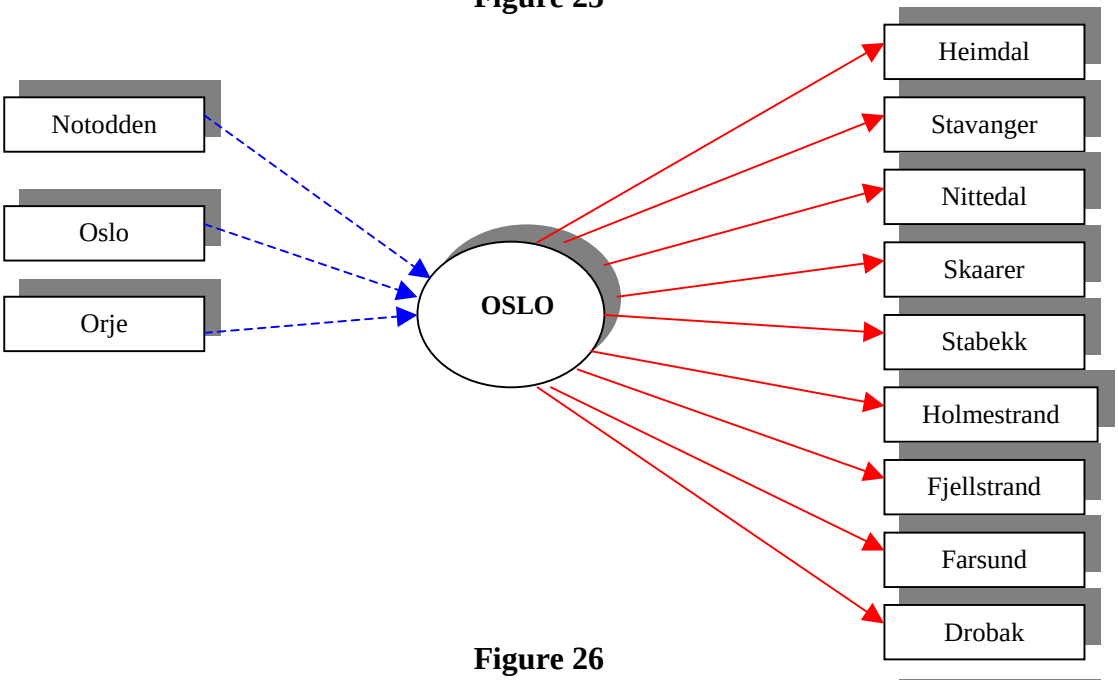


Figure 26

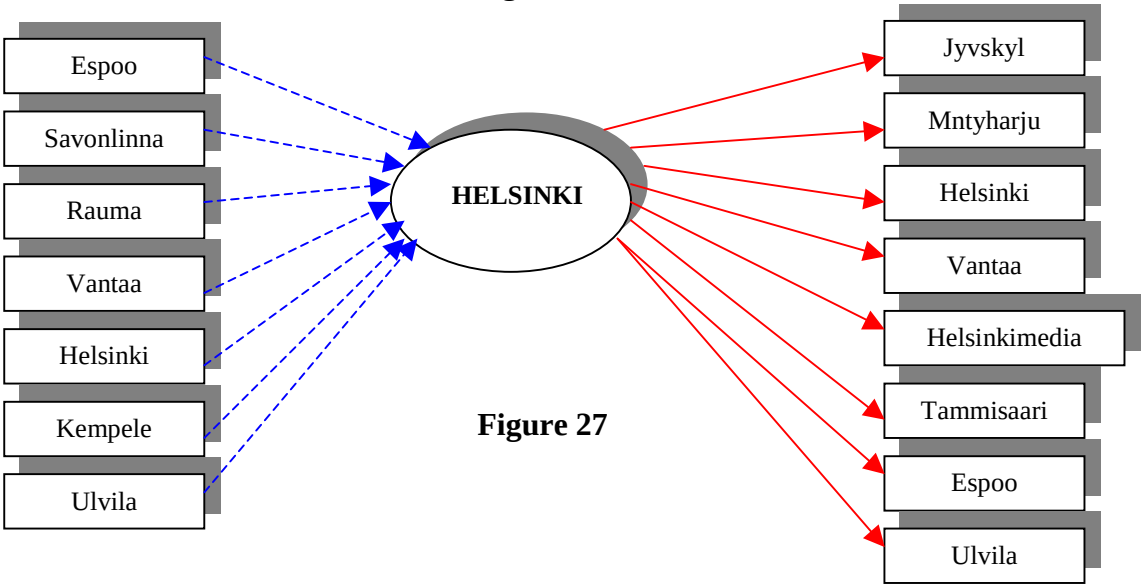
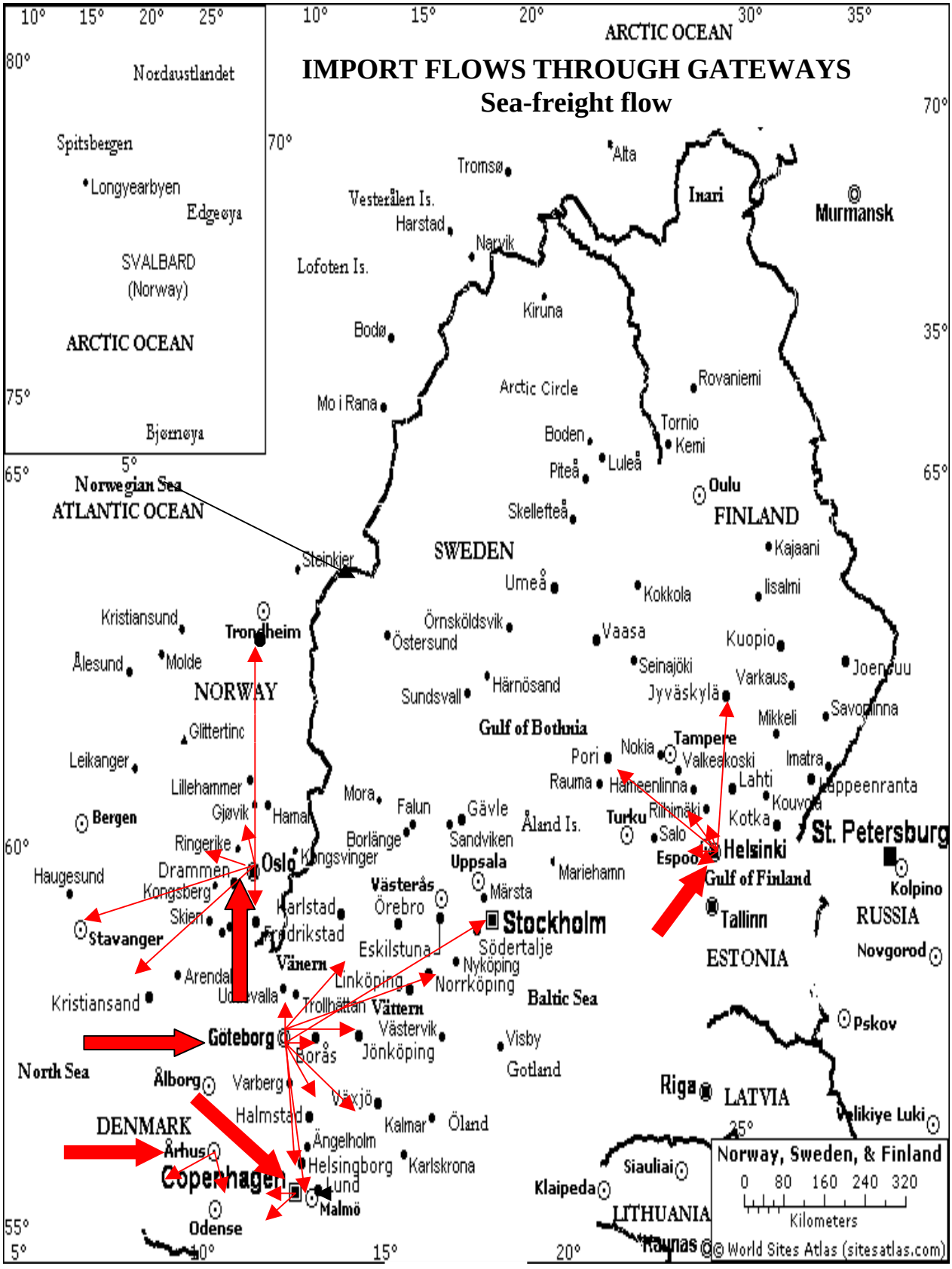


Figure 27


IMPORT FLOWS THROUGH GATEWAYS
Sea-freight flow
ARCTIC OCEAN
Nordaustlandet
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Longyearbyen
Edgeøya
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Bjørnøya
Norwegian Sea
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Siauliai
Copenhagen
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Norway, Sweden, & Finland
0 80 160 240 320
Kilometers
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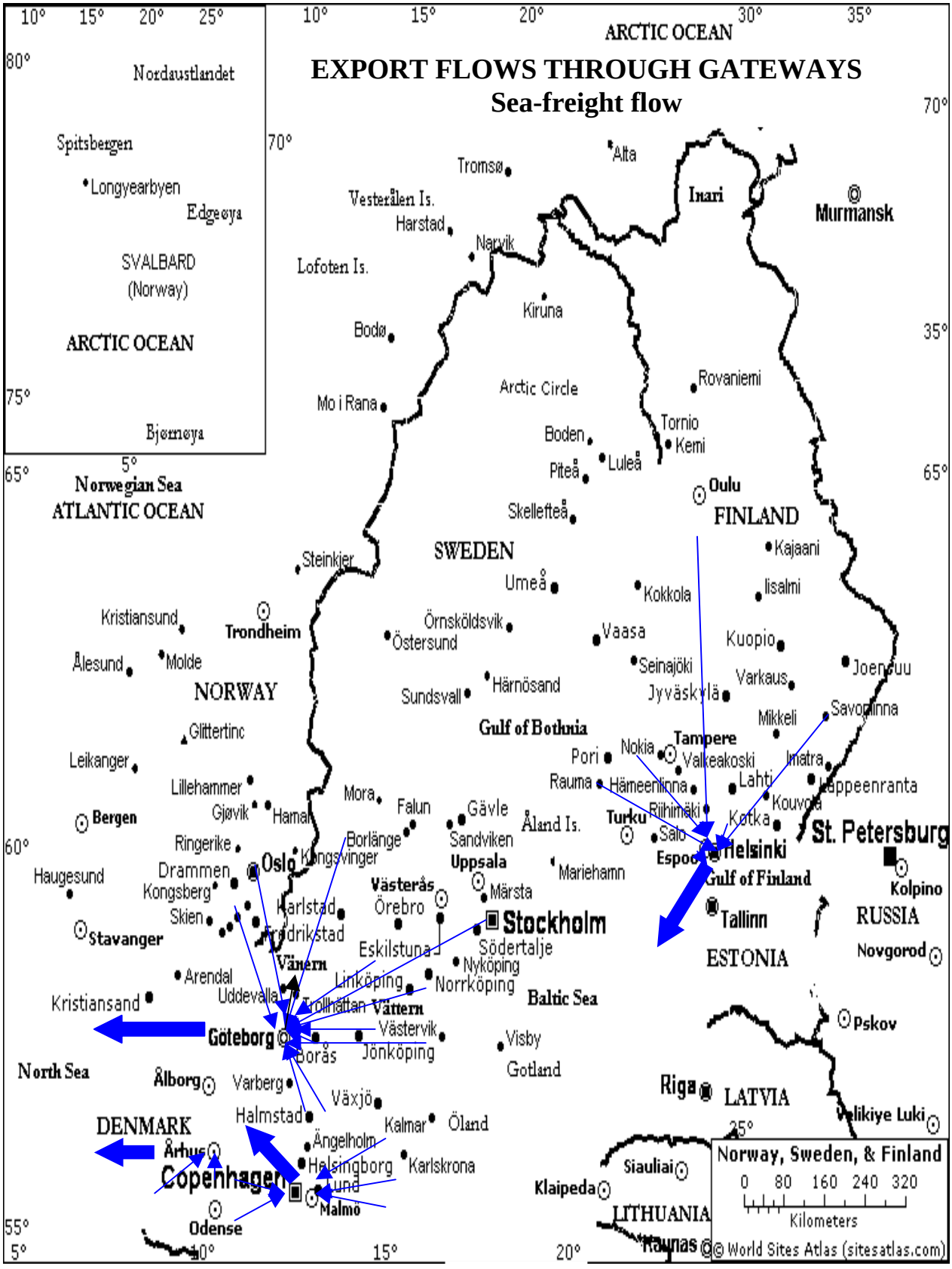
Figure 28


EXPORT FLOWS THROUGH GATEWAYS
Sea-freight flow
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Norway, Sweden, & Finland
0 80 160 240 320
Kilometers
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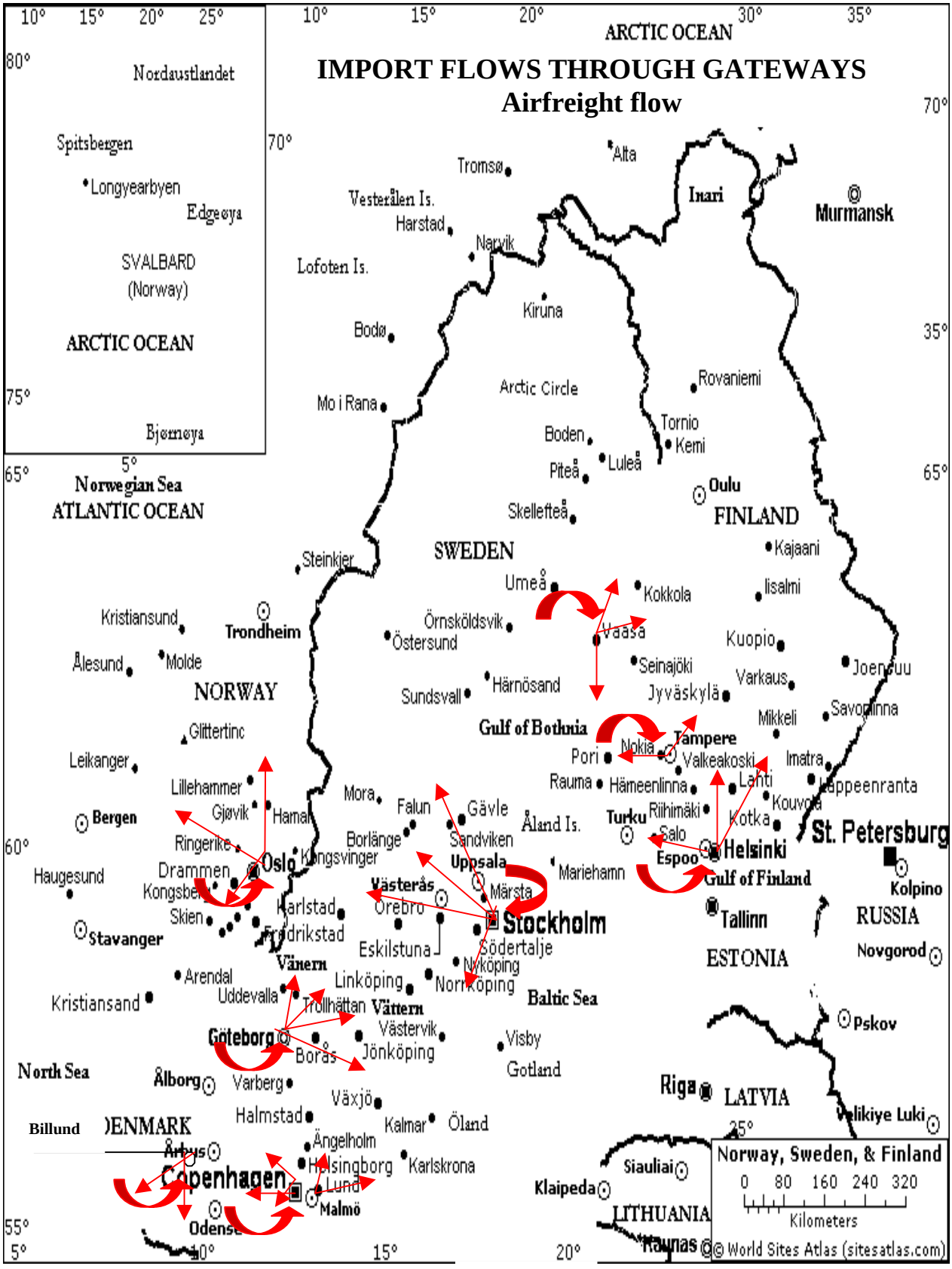
Figure 29


IMPORT FLOWS THROUGH GATEWAYS
Airfreight flow
ARCTIC OCEAN
Nordaustlandet
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Malmö
LITHUANIA
Odense
Kaunas
Norway, Sweden, & Finland
0 80 160 240 320
Kilometers
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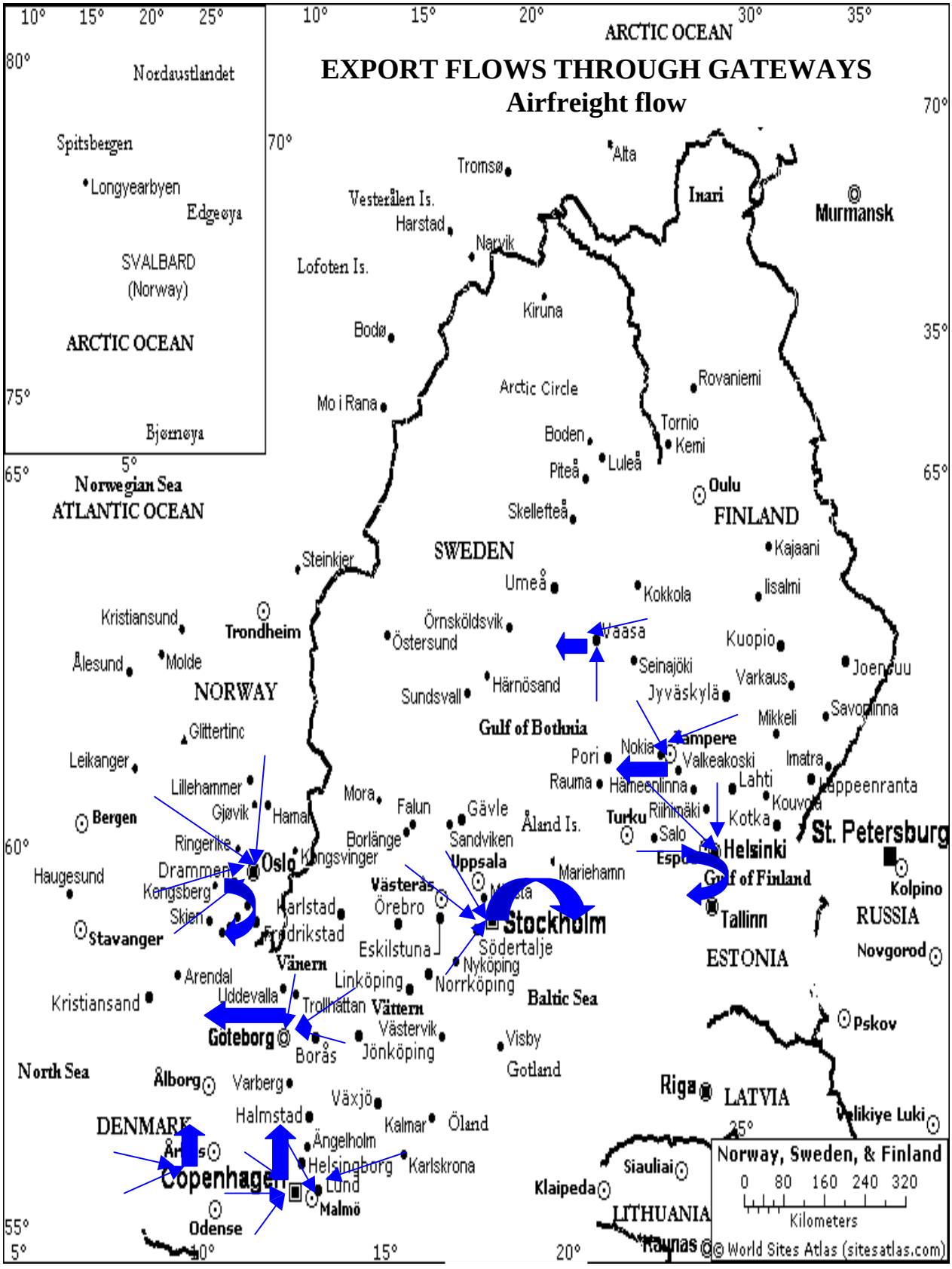
Figure 30


EXPORT FLOWS THROUGH GATEWAYS
Airfreight flow
ARCTIC OCEAN
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Lund
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Norway, Sweden, & Finland
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Kilometers
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Figure 31

Based on the illustrated maps, it now comes to the scene that the company's customers are located mainly in the Southern Sweden and Copenhagen region surrounding the Göteborg, the Stockholm and the Malmö-Copenhagen regions. In terms of volume, moreover, this region counts for about 90% (estimated from the above tables) of the total inbound/outbound of both sea-freight and airfreight cargoes of Schenker International in the whole Nordic region. Hence, the possibly selected locations of a regional gateway/distribution center, taking into account all factors analyzed in Chapter 3 and customers' proximity within the Southern Sweden and Copenhagen region, are shaped as Göteborg, Stockholm, Malmö, Copenhagen, Jönköping, Borås, Alvesta, Anderstorp, Norrköping, Helsingborg, Kungälv, Nässjö, Motala, Skövde, Kolbäck, Billingsfors, Halmstad, Svenljunga, Trelleborg, Trollhättan and Linköping.

In the following, detailed considerations of possible seaports and airports used for the future gateway/distribution center will be analyzed.

4. 5. 2. Seaport and airport services

4. 5. 2. 1. Airport services

As far as the airports are concerned, there are four main important ones in the Southern Sweden and Copenhagen region: Copenhagen, Stockholm, Göteborg and Malmö. In Chapter 3 the findings of the infrastructure analysis of transport logistics in the region already showed that Copenhagen and Stockholm are the biggest and second biggest cargo airports in the Nordic region with a variety of services of major cargo airlines. The Landvetter airport in Göteborg, moreover, is the second largest cargo airport in Sweden after Stockholm. On the other hand, the Malmö Sturup airport with its close proximity to Copenhagen Airport could play an important role in the Öresund region, offering flexibility in choosing the airport.

The Stockholm Airport, however, may not be considered as a good choice. In Chapter 3, it was analyzed that the construction and operation of the new Öresund fixed link has a tremendous positive effect to the transport logistics in the Nordic region. In the air cargo market, for example, it helps to expand the Copenhagen airport's market area due to the fast transit time over the strait between Sweden and

Denmark. This was summarized as follows by the Cargo Manager of the Copenhagen Airport:

> *'' The Öresund link will effectively move our catchments area about one to one and a half hours further North''.*
>
> *(CargoVision, May 1999)*

What is the implication of this movement? Companies operating in the South of Sweden will probably move further to the South to be near to the bridge to take advantage of Copenhagen Airport, because it is quite a long way to go to the country's air cargo gateway in Stockholm. This trend of relocation of manufacturing has strengthened the diagnosis that Stockholm is not the optimum airport for Schenker International in relation to the company's future gateway seen from the whole logistics chain.

Moreover, in terms of airlines' frequency and airports' transit time Malmö Sturup is not convenient as the airport of the region for Schenker International's cargo flows. There are only two major airfreight lines (SAS and KLM) with few international destinations; in 2000 the airport handled only 4,688 tons of cargo compared with annual 420,000 tons in Copenhagen (Malmö Sturup Airport: http://www.lfv.se/site/airports/malmo/eng/start.asp#airtraffic and Copenhagen Airport: http://www.cph.dk). This airport, however, is expanding its capacity in response to growing traffic in the region and with its close proximity to Copenhagen it can be considered as a flexibility.

It now comes to the scene that the two best choices of airports are Copenhagen and Göteborg-Landvetter. Yet compared with the former, the latter has constraints on the number of international nonstop and direct destinations as well as the number of cargo airlines serving the airport. In Copenhagen Airport almost all the world's biggest cargo airlines are presented here as DHL, TNT, Fedex, UPS whereas in Göteborg-Landvetter the size of cargo airlines are smaller e.g. SAS or Lufthansa. It can be summarized as follows:

Table 18: COPENHAGEN AIRPORT AND GÖTEBORG-LANDVETTER AIRPORT

Airport	No. of international nonstop & direct destinations	No. of cargo airlines
Copenhagen	140 (Worldwide)	9
Göteborg-Landvetter	23 (Europe & Middle East)	5

Source: Copenhagen airport, http://www.cph.dk and Göteborg-Landvetter airport: http://www.lfv.se/site/airports/landvetter/eng/index.asp

This comparison will be especially valid when we come to the analysis of alternatives for the simulation in chapter 5.

4. 5. 2. 2. Seaport services

As far as seaports in the Southern Sweden and Copenhagen region are concerned, the most important ones are Göteborg, Copenhagen-Malmö, Helsinborg, Stockholm and Trelleborg. As analyzed in Chapter 3, although being an important port in the Öresund region the main traffic of the port of Trelleborg is RO/RO (rail cargoes and passengers) to Germany and the Baltic states. The port of Helsinborg, with regards to container traffic by RO/RO vessels and freight ferries, offers basically the same direct sailings to destinations as the Copenhagen-Malmö Port but with less frequent sailings (for example, Unifeeder line offers 1 sailing/week from Helsinborg and 2 sailings/week from Copenhagen-Malmö Port to Rotterdam as the feeder service – Source: Copenhagen-Malmö port, http://www.cmport.com and port of Helsingborg, http://www.port.helsingborg.se/). For freight forwarding and logistics companies, like Schenker International, service frequency is important since it is related to capital tie-up of cargo that the company takes care of. In general, it can be said that the choice of seaports for the company can be limited within Göteborg, Copenhagen-Malmö and Stockholm.

As far as the services of these seaports are concerned, the port of Göteborg and Copenhagen-Malmö Port have great advantages over the port of Stockholm in terms of frequencies and coverage of services of shipping lines serving the ports. These ports will be examined by looking at the following tables indicating frequencies of cargo-ships (containerships and freight ferries as in relation to Schenker International's freight flows in the forms of LCL containers or LCL truck/lorries).

Table 19: DIRECT REGULAR SAILINGS FROM THE PORT OF GÖTEBORG

DESTINATION	SHIP TYPE	OPERATOR	FREQUENCY
North America	Container	ACL	1 sailings/week
United Kingdom	Container Container Container Ferry Ferry	ACL ''K'' Line Unifeeder DFDS Seaways DFDS Tor Line	2 sailings/day
Continental Europe	Ferry Container Container Container Container Container	DFDS Tor Line Hyundai ''K'' Line Maersk Sealand Team Line Unifeeder	6 sailings/day
Nordic area	Ferry Container Container Container	DFDS Seaways ''K'' Line Team Line Unifeeder	4 sailings/day
Far East	Container Container	Hyundai Maersk Sealand	2 sailings/week

Source: compiled from Port of Göteborg, http://www.portgot.se

Table 20: DIRECT REGULAR SAILINGS FROM COPENHAGEN-MALMÖ PORT

DESTINATION	SHIP TYPE	OPERATOR	FREQUENCY
United Kingdom	Container	Unifeeder	2 sailings/week
Continental Europe (*)	Ferry Ferry Container Container	ESCO Nord Unifeeder Baltic Cont. Line	15 sailings/weeks
Nordic area	Ferry Ferry Ferry Container	DFDS Seaways ESCO Finncarrier Unifeeder	19 sailings/week
Russia	Ferry Container	Esco Unifeeder	3 sailings/week

(*) Feeder services to Hamburg, Bremerhaven & Rotterdam for transshipment

Source: compiled from Copenhagen Malmö Port, http://www.cmport.com

Table 21: DIRECT REGULAR SAILINGS FROM PORT OF STOCKHOLM

DESTINATION	SHIP TYPE	OPERATOR	FREQUENCY
Finland	Ferry Ferry Ferry Ferry	Polferries Hansaliin Finnlink Viking Line	Several sailings/day
Continental Europe	Container	Team Line ESCO/Melship MSC	4 sailings/week

Source: compiled from Port of Stockholm, http://www.portsofstockholm.com

From the Tables 19, 20, 21 it is obvious that in terms of service frequency and service coverage the port of Stockholm is much less advantageous than the others because shipping lines using the port offer much less frequent sailings and with narrower coverage. These factors have a vital importance for freight forwarders and logistics providers such as Schenker International because they affect its flexibility and competitive advantage especially in the scenario when all future cargo flows are concentrated through a single gateway. In short, the port of Stockholm is not convenient to be the choice of seaport for Schenker International.

In comparison with the port of Göteborg, the only constraints of Copenhagen-Malmö Port as a feeder port are that there is no direct sailing to important shipping routes, i.e., North America and the Far East and less frequent services to continental Europe. In fact, from Copenhagen cargoes accepted to these destinations have to be transshipped at Bremerhaven, Hamburg or Rotterdam to connecting mother vessels at these ports. Such a practice does affect the transit time of cargo, and hence, the inventory cost for cargo-owners. The following tables are extracted from the schedule of MaerskSealand (Source: http://www.maersksealand.com) for a container from Copenhagen and from Göteborg to Hongkong will illustrate the case.

Table 22: SAILING SCHEDULE FROM GÖTEBORG TO HONGKONG

Locations	Departure	Arrival	Vessel's name	Transit time
Göteborg	11-08-2001		SINE MAERSK Voy. No.: 0107	29 days
Hongkong		09-09-2001		

Table 23: SAILING SCHEDULE FROM COPENHAGEN TO HONGKONG

Locations	Departure	Arrival	Vessel's name	Transit time
Copenhagen	11-08-2001		UNIFEEDER15 Voy. No. : 0166	36 days
Bremerhaven	20-08-2001		CARSTEN MAERSK Voy. No. : 0107	
Hongkong		16-09-2001		

Nevertheless, it is necessary to reaffirm that with the increasing traffic in the Öresund region, the relocation trend to the South of manufacturing as well as the port's development capability, Copenhagen-Malmö port plays an extremely important role in transport logistics and should also be considered as one of the choices of seaports for Schenker International since the port is currently striving for its expanded cargo hinterland to attract direct calls from shipping lines.

To conclude, in the case of Schenker International the port of Göteborg, Copenhagen-Malmö Port, Landvetter and Copenhagen airports should be chosen as the seaports and airports for cargo flows from and to the Nordic regions. More detailed analysis on these alternative seaports/airports in relation with alternative gateways in the simulation will be conducted in Chapter 5.

****

In short, this chapter gave a closer approach and more detailed analysis on the possible locations for the regional gateway/distribution center of Schenker International as well as the choice of seaports/airports. In this part of the study, a number of considerations from customers' proximity, ports and airports' services to the analysis of the current trend of relocation from manufacturers have been analyzed to come to a general identification of possible alternative gateways and seaports and airports used. In the following chapter, the author will continue to narrow this comparative analysis to a specific solution with the help from the computer simulation based on either the *minimized total distances transport with relevant volumes* or *least total distribution cost principle*.

CHAPTER 5

OPTIMIZATION OF LOCATION FOR THE REGIONAL GATEWAY/DISTRIBUTION CENTER OF SCHENKER INTERNATIONAL FROM SPECIFIC SITE SELECTION LEVEL

This chapter is the final step in the process of selecting the regional gateway/distribution center for Schenker International. In this chapter, the author will continue to narrow down the analysis and synthesis of optimization to the specific site selection level from the general geographical level with alternatives gateways and airports/seaports identified in the previous Chapters 3 and 4. This chapter will begin with some considerations to selecting regarding the business-related environment, followed by a theoretical model based on *the principle of minimized total distances transport and relevant volumes* in combination with *the centre of gravity principle* or *the least total distribution cost principle*, basic prerequisites for the simulation and the optimization calculation by an excel-based simulation.

5. 1. Business-related environment considerations

When all possible alternative locations for the future regional gateway/distribution center have already been taken shape as analyzed in Chapter 4, there are, in fact, many non-quantifiable considerations before coming to the concrete comparison among alternatives. The business-related environment considerations make part of the study for choosing the specific location for the distribution center, and they can be addressed as in the following figure.

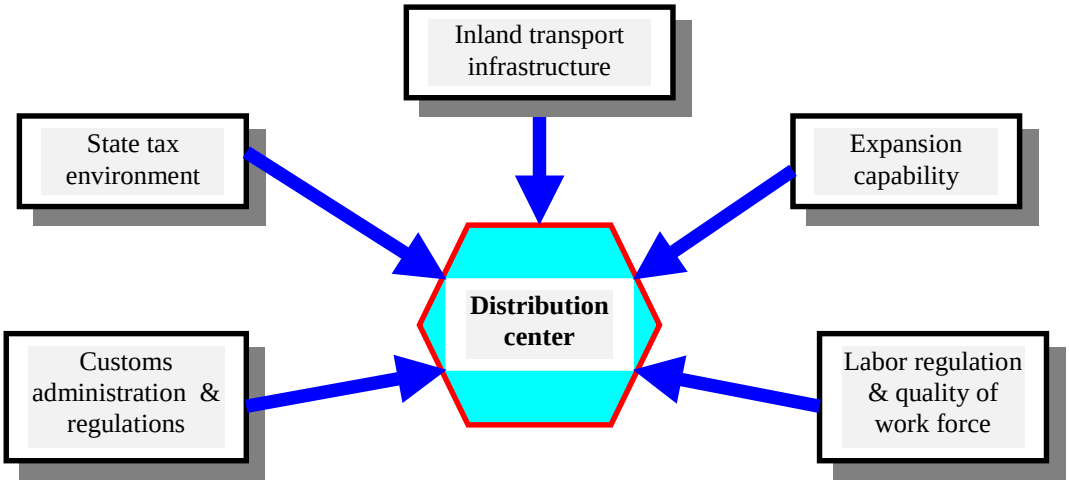

Figure 32

In order to assess and compare alternatives following the above considerations, theoretically speaking a weighted marking system will be applied. The weighted marks for each consideration of each alternative will be allocated based on expertise judgments from experts in the industry.

In the case of Schenker International, alternatives that should be compared following these considerations are located within the Southern Sweden and Copenhagen region. Through discussions with experts in the field, the outcomes were revealed that all these alternatives received more or less the same weighted marks for all considerations with only a few minor differences[7].

As a matter of this fact, we can now come to the direct comparison process to optimize the location by the minimized total distances transport and relevant volumes or the least total distribution cost. The following parts will make this clearer.

5. 2. Optimization of location from different alternatives

In this part of the study, the optimization of location from different alternatives will be made based on *the principle of minimized total distances transport and relevant volumes* in combination with *the centre of gravity principle* or *the least total distribution cost principle* supported by a number of analyses.

[7] *Interviews and discussions with Mr. Carsten Lykke Jorgensen, Schenker Air; Mr. Peter Lindgren, Schenker Sea and Mr. Erik Lenormand, Schenker Land Transport.*

5. 2. 1. Theoretical model for specific site selection within a chosen general geographical area

It is well known that one of the main objectives in transport logistics is to optimize the integration of distances and given volumes of cargoes to be transported. In the scope of this study, taking into account the above objective the gateway chosen should therefore be placed where the integration of volumes transported and distances involved is the minimum. Also, in Chapter 2 the *total distribution cost* concept was analyzed as one of the most important issues in logistics, and this should also be considered as the criteria in choosing location for the gateway. In other words, taking this principle into account, then the gateway should be placed where the total distribution cost is the least one.

Let $\sum C$ be the total distribution cost, W be the warehousing cost, I be the inventory cost, O be the depot operating cost and T be the transportation cost. The result is:

$$\sum C = W + I + O + T \qquad (2)$$

Through discussions with Schenker International specialists and persons-in-charge[8], it came to the scene that the company will outsource the operation of the future gateway to a third party. The land transport will be taken care of by Schenker Land Transport Division. This means that the elements of warehousing, inventory and depot operating costs in this study, specifically, can be considered not to have an impact on the choice. The equation (2) for the case of Schenker International can now be seen as follows:

$$\sum C = T \qquad (2')$$

Since the transport tariff is normally constructed on distance and weight/volume band, it is also easy to see that the transport tariff is positively correlative with distance and negatively correlative with weight/volume band. Hence, the task of this study now is to optimize either the integration of distances with given volumes of cargoes to be transported or the total distribution cost. Figure 33 indicating the scenario is as follows:

[8] *Interviews and discussions with Mr. Carsten Lykke Jorgensen, Schenker Air; Mr. Peter Lindgren, Schenker Sea.*

CUSTOMERS' LOCATIONS AND ALTERNATIVE GATEWAYS IN THE THEORETICAL MODEL

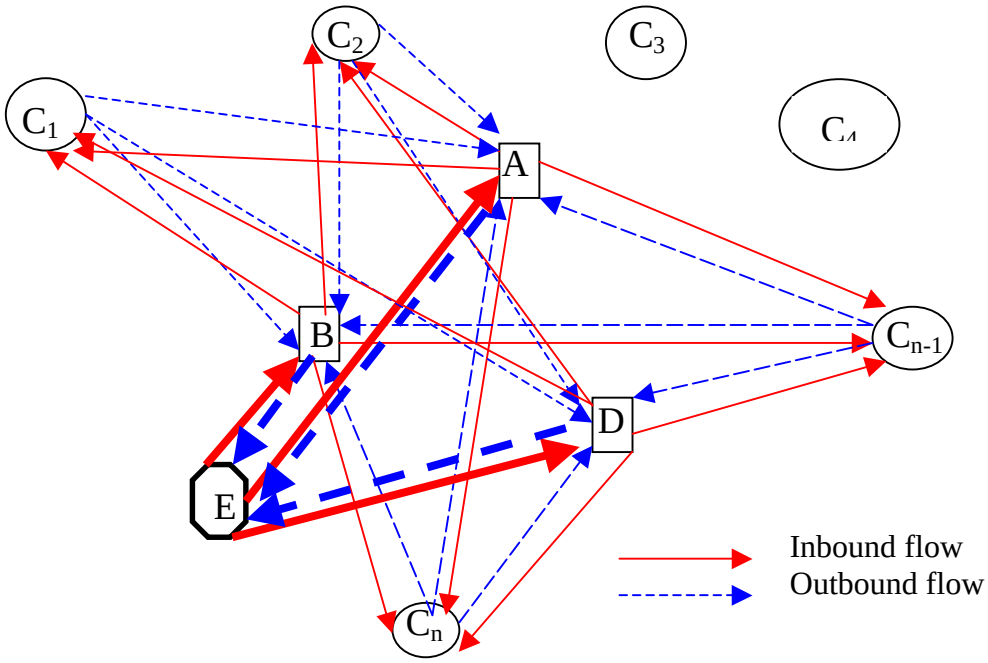

Figure 33

Let C_1, C_2, C_3, ... C_{n-1}, C_n be customers' locations 1, 2, 3, …(n-1) and n respectively; A, B, and D are alternative gateways; E is the airport/seaport used. The some basic assumptions are as follows:

* Distances

D_{EA}, D_{EB}, D_{ED} are trunking distances from airport/seaport E to alternative gateways A, B and D.

D_{AC1}, D_{AC2}, D_{AC3}, ... D_{ACn-1}, D_{ACn} are local delivery distances from gateway A to customers' locations C_1, C_2, C_3, ... C_{n-1}, C_n respectively.

Similar inferences can be drawn with D_{BC1}, D_{BC2}, D_{BC3}, ... D_{BCn-1}, D_{BCn} with gateway B and D_{DC1}, D_{DC2}, D_{DC3}, ... D_{DCn-1}, D_{DCn} with gateway D.

* Volume

V_{IAC1}, V_{IAC2}, V_{IAC3}, ... V_{IACn-1}, V_{IACn} are volumes of inbound cargo from gateway A to customers' locations C_1, C_2, C_3, ... C_{n-1}, C_n respectively.

Similar inferences can be drawn with V_{IBC1}, V_{IBC2}, V_{IBC3}, ... V_{IBCn-1}, V_{IBCn} and V_{IDC1}, V_{IDC2}, V_{IDC3}, ... V_{IDCn-1}, V_{IDCn}

V_{OAC1}, V_{OAC2}, $V_{OAC3, \ldots}$ $V_{OACn-1,}$ V_{OACn} are volumes of outbound cargo from customers' locations $C_1, C_2, C_3, \ldots C_{n-1,} C_n$ respectively to gateway A.

Similar inferences can be drawn with V_{OBC1}, V_{OBC2}, $V_{OBC3, \ldots}$ $V_{OBCn-1,}$ V_{OBCn} and V_{ODC1}, V_{ODC2}, $V_{ODC3, \ldots}$ $V_{ODCn-1,}$ $V_{ODCn.}$

* Transport tariff

P_{IAC1}, P_{IAC2}, $P_{IAC3, \ldots}$ $P_{IACn-1,}$ P_{IACn} are transport tariff for inbound cargo from seaport/airport E through gateway A to customers' locations $C_1, C_2, C_3, \ldots C_{n-1,} C_n$

Similar inferences can be drawn with P_{IBC1}, P_{IBC2}, $P_{IBC3, \ldots}$ $P_{IBCn-1,}$ P_{IBCn} and P_{IDC1}, P_{IDC2}, $P_{IDC3, \ldots}$ $P_{IDCn-1,}$ P_{IDCn}.

P_{OAC1}, P_{OAC2}, $P_{OAC3, \ldots}$ $P_{OACn-1,}$ P_{OACn} are transport tariff for outbound cargo from customers' locations $C_1, C_2, C_3, \ldots C_{n-1,} C_n$ respectively through gateway A to seaport/airport E.

Similar inferences can be drawn with P_{OBC1}, P_{OBC2}, $P_{OBC3, \ldots}$ $P_{OBCn-1,}$ P_{OBCn} and P_{ODC1}, P_{ODC2}, $P_{ODC3, \ldots}$ $P_{ODCn-1,}$ $P_{ODCn.}$

* Integration of total distances transport with given relevant volumes

$\sum VD_A$ is the integration of total distances transport with given relevant volumes from/to seaport/airport E through gateway A.

Similar inferences can be drawn with $\sum VD_B$ and $\sum VD_{D.}$

* Total transport cost over relevant distance with given volume

$\sum C_A$ is the total transport cost for inbound and outbound cargo volume transported over relevant distances from/to seaport/airport E through gateway A.

Similar inferences can be drawn with $\sum C_B$ and $\sum C_D$

In combination with the centre of gravity theory the result is:

(3)
$$\sum VD_A = D_{EA} \times \sum^{n}_{i=1}(V_{IACi} + V_{OACi}) + \sum^{n}_{i=1}\{(V_{IACi} + V_{OACi}) \times D_{ACi}\}$$
$$\sum VD_B = D_{EB} \times \sum^{n}_{i=1}(V_{IBCi} + V_{OBCi}) + \sum^{n}_{i=1}\{(V_{IBCi} + V_{OBCi}) \times D_{BCi}\}$$
$$\sum VD_D = D_{ED} \times \sum^{n}_{i=1}(V_{IDCi} + V_{ODCi}) + \sum^{n}_{i=1}\{(V_{IDCi} + V_{ODCi}) \times D_{DCi}\}$$

(4)
$$\sum C_A = \sum^{n}_{i=1}(V_{IACi} \times P_{IACi}) + \sum^{n}_{i=1}(V_{OACi} \times P_{OACi})$$
$$\sum C_B = \sum^{n}_{i=1}(V_{IBCi} \times P_{IBCi}) + \sum^{n}_{i=1}(V_{OBCi} \times P_{OBCi})$$
$$\sum C_D = \sum^{n}_{i=1}(V_{IDCi} \times P_{IDCi}) + \sum^{n}_{i=1}(V_{ODCi} \times P_{ODCi})$$

The gateway to be chosen (A, B or D) following the principle of minimizing the integration of total distances transport with relevant volumes will satisfy the following:

$$\begin{pmatrix} \sum VD_A \\ \sum VD_B \\ \sum VD_D \end{pmatrix} \longrightarrow \mathbf{MIN} \qquad (5)$$

Or

$$\begin{pmatrix} \sum C_A \\ \sum C_B \\ \sum C_D \end{pmatrix} \longrightarrow \mathbf{MIN} \qquad (6)$$

5. 2. 2. Basic prerequisites for the simulation

In order to build the simulation for the specific case of Schenker International, some basic prerequisites are established as expressed in the following parts.

✍ **The choice of principle applied in the simulation**

In the previous part it is clear that the gateway location will be worked out when either the expression (5) or (6) is satisfied. By the time this part of the study was written, the author had tried to have a meeting with the person-in-charge of Schenker-BTL (Mr. Jan Gagner, Network Production, Schenker-BTL AB Göteborg), the division taking care of the land transport for shipments of Schenker International. The outcomes of this meeting were that the transport tariffs were not available for the time being.

It is, therefore, consequential for the author to choose the expression (5) as the principle applied for this study because the constraint of time, and it should forward the same result as (6) for the reason explained in the previous part.

✍ **The distances used in the simulation**

The excel-based simulation was built up with distances combined from the support of the following tools:

🕮 Distances table in Sweden, Norway, Finland (Avståndstabell).

🕮 Distances table (sea) of Fairplay's world shipping encyclopedia from the World Maritime University's library.

🕮 The simulation tool of 4ROOMS, Schenker-BTL: this is constructed from three components: maps, roads and railways and postal database. By positioning two locations on the map (using their postal codes and longitude and latitude coordinates), the distance between the two is shown with high precision level because this simulation tool indicates the real roads taken by the trucks in practice.

Moreover, other assumptions from Schenker International are that Seaports, Schenker-BTL's facilities and customers are located within the cities, so distances from seaports to these facilities and distances from these facilities to these customers are relatively small.

✍ **Routes taken by Schenker-BTL vehicle fleet**

The following are routes normally taken by Schenker-BTL vehicle fleet[9] which is used for land transport of Schenker International's shipments in this simulation:

🕮 Shipments to and from Norway are via Oslo.

🕮 Shipments to and from Finland are via Stockholm and Turku.

🕮 Shipments to and from the gateway in Copenhagen are via Malmö.

🕮 Exceptionally shipments to Helsinborg from the gateway in Copenhagen and vice versa are via Helsingor in Denmark.

5. 2. 3. Optimization by excel-based simulation

5. 2. 3. 1. Solutions for seaports/airports used

In the previous Chapter 4 the author already analyzed and came to conclusion that there are two possible seaports (Göteborg and Copenhagen-Malmö port) and airports (Göteborg-Landvetter and Copenhagen) which can be used by Schenker

[9] *As provided by Mr. Jan Nordh and Mr. Erik Lenormand*

International for the company's cargo flows in relation with the new regional gateway/distribution center for the whole Nordic region. The choice of a single seaport and airport used, however, is identified only through simulation of different possible solutions and further empirical analysis in the company's operating practices.

Based on this background and in order to compare from a broad perspective, there are four solutions of using the seaport and airport as follows:

- Solution 1:Both sea-freight and airfreight flows going through Göteborg.
- Solution 2:Both sea-freight and airfreight flows going through Copenhagen.
- Solution 3:Sea-freight flows going through Göteborg and airfreight flows going through Copenhagen.
- Solution 4:Sea-freight flows going through Copenhagen and airfreight flows going through Göteborg.

The simulation of comparing the integration of total distances transport with relevant given volumes of cargo among alternative gateways will be done based on these four solutions used. In the end, a summary table of the best three alternative gateways in each solution will also be devised and analyzed further.

5. 2. 3. 2. How is the integration of total distances transport with given relevant volumes calculated?

This is the main part in the simulation. The formula applied for calculation is the equation (3) expressed in part (**5. 2. 1)**. This formula is the generalized one in the general situation with the use of seaports and airports. The simulation is presented in details with four solutions of seaport/airport used in **Appendix B**. The following extraction is to illustrate this calculation.

Supposing that the future regional gateway is placed in Malmö, and the choice of seaport used is through Göteborg and the airport used is through Copenhagen (solution 3). Now the integration of total distances transport with relevant volumes (both sea-freight and airfreight) and in both directions of inbound and outbound from the seaport and airport through the gateway in Malmö and then to customer's location in Borås and vice versa should be calculated.

The following data is available and used for the calculation:

- Distance from Copenhagen airport to the gateway in Malmö is about 20 Km.
- Distance from the port of Göteborg to the gateway in Malmö is about 279 Km.
- Inbound airfreight volume to Borås is 182.25 CBM.
- Inbound sea-freight volume to Borås is 3645 CBM.
- Outbound airfreight volume from Borås is 8.4 CBM.
- Outbound sea-freight volume from Borås is 168 CBM.
- Distance from the gateway in Malmö to customer's location in Borås is about 288 Km.

The integration is calculated as follows:

$VD_{Malmö} = \{(20 \times 182.25) + (279 \times 3645) + (182.25 + 3645) \times 288\} +$

$+ \{(8.4 + 168) \times 288 + (8.4 \times 20) + (168 \times 279)\} \approx 2{,}220{,}691$ (CBM.Km)

Taking into consideration all customers' locations of both sea-freight and airfreight, inbound and outbound flows then we have the integration for the regional gateway placed in Malmö with solution 3 of seaport/airport used is:

$$\mathbf{\sum VD_{Malmö} \approx 19{,}026{,}702\ CBM.Km}$$

The same principle is applied for calculating the integration of other alternative gateways and in four solutions of seaport/airport used. Details of these calculations are presented in **Appendix B**.

5. 2. 3. 3. Findings of the simulations

Upon completion of calculating the integration of total distances transport with relevant volumes for both sea-freight and airfreight and in both inbound and outbound directions in all four solutions of airport/seaport used for all the alternative gateways, the findings are presented in **Appendix C**. The principle of minimum integration (expression (**5**) in (**5. 2. 1**)) is applied here to identify the possible best gateway locations. The ranking table of the best three alternative locations in each solution of seaport/airport used is as follows:

Table 24: RANKING TABLE OF THE BEST THREE ALTERNATIVE GATEWAYS IN RELATION WITH DIFFERENT SEAPORTS/AIRPORTS SOLUTIONS

SOLUTIONS			ALTERNATIVE GATEWAYS		
No.	**Seaport**	**Airport**	**1**	**2**	**3**
1	GÖTEBORG	GÖTEBORG	GÖTEBORG	KUNGÄLV	BORÅS
2	COPENHAGEN	COPENHAGEN	HELSINGBORG	MALMÖ	COPENHAGEN
3	GÖTEBORG	COPENHAGEN	GÖTEBORG	KUNGÄLV	BORÅS
4	COPENHAGEN	GÖTEBORG	HELSINGBORG	MALMÖ	COPENHAGEN

Source: compiled from appendix C

From Table 24 it is clear that if either solution 1 or 3 is taken then Göteborg is the best place for the regional gateway/distribution center for Schenker International; if either solution 2 or 4 is taken then the best location is Helsingborg.

In order to have a clearer view of the difference among these best alternative locations, the quantified indicator is needed. In terms of value of the integration of total distances transport with relevant volumes (CBM.Km) derived from **Appendix C,** the above findings can be presented as in the following figure:

DISTRIBUTION OF BEST ALTERNATIVE GATEWAYS UNDER DIFFERENT SOLUTIONS OF AIRPORT/SEAPORT

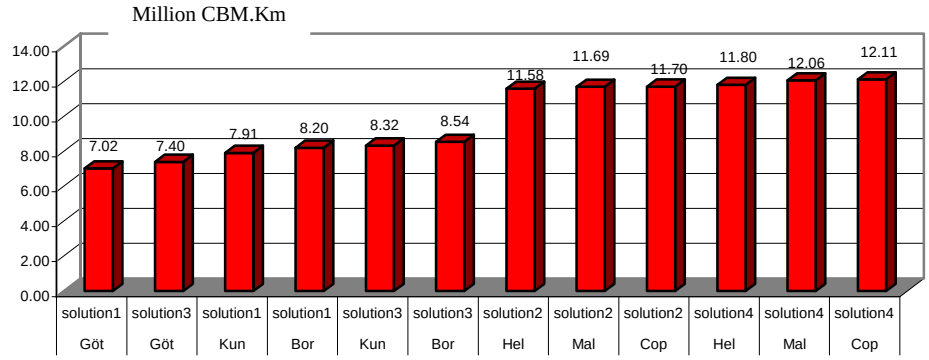

Figure 34

Source: compiled from appendix C

Figure 34 shows that Göteborg and its surrounding cities (Kungälv and Borås) are the best places for the regional gateway/distribution centers in that sea-freight flows go through the port of Göteborg and airfreight flows go through either Copenhagen or Göteborg-Landvetter airports. Helsingborg, Malmö and Copenhagen will be the best places when both the port and airport of Copenhagen are used, yet this solution returns higher CBM.Km than the previous solutions.

The choice of best location in practice, however, depends on not only the minimum CBM.Km but also many operating practices as analyzed in the part below.

5. 3 The choice of the best location

In practice, the choice of the best location for Schenker International besides the above findings will need to be further analyzed associated with other factors.

✍ First of all, the author perceived that the best location in terms of CBM.Km is Göteborg when all inbound and outbound flows of sea-freight and airfreight go through the port of Göteborg and Göteborg-Landvetter airport (solution 1). Here it is necessary to notice that Landvetter Airport, as analyzed in Chapter 4, has some basic constraints on frequency and service's coverage (number of direct/nonstop flights to major cities in the world). For the time being this airport is used together with other airports in Sweden, Norway, Finland and Denmark i.e. cargo flows are dispersed. If solution 1 is executed fully then there will be a large volume of airfreight cargo in the whole Nordic region concentrated here, and with its current facilities and services this airport is not likely to be completely advantageous for the company to divert all airfreight flows here because cargo may have to wait and inventory cost will increase. It is, therefore, essential that the company give less weight to solution 1 and 4, in which Landvetter airport is used taking into consideration the above analysis.

✍ In solution 2 and 3, to choose Göteborg as the best location for the future gateway in solution 3 returns lower CBM.Km than Helsingborg in solution 2 when both Copenhagen-Malmö Port and Copenhagen Airport are used. Again, it is noted that although there are some constraints such as no direct sailing to the Far East and North America, Copenhagen-Malmö Port as analyzed in Chapter 3 and 4 is emerging as one of the leading ports in Northern Europe. With the close proximity to the Öresund fixed link and its coverage over Sweden and Denmark, the port offers many advantages from its strategic position as well as its development capacity for distribution centers. For example, DaimlerChrysler has moved its Danish-Swedish head office to here; other well-known companies and organizations like Sony Nordic

or UNICEF have their distribution center placed in this port and distribute to the whole Nordic region and Baltic states (Hummelmose[10], 2001).

✍ Moreover, as Schenker's new market concept considering the Nordic region to include not only traditional four countries as stated in this study but also the Baltic states (Erik Lenormand, 2001), a vision for the future is very important for the company in locating the regional distribution center; and hence, a location within the newly established and enhanced Öresund region with the operation of the Öresund fix link may be reasonable to expand the distribution network to the Baltic states.

✍ Last but not least, the trend of relocation in manufacturing to the South as devised in Chapter 4 is extremely important for the company in its considerations to locate the new regional distribution center. Such a move in manufacturing will probably change the current customers' locations structure of the company, and again, *the principle of centre of gravity* here explains that the gateway/distribution center, or the centre of gravity should be moved near to major cargo flows centers.

In short, with the above analysis and concrete findings from the simulation, it is now time for Schenker International to look thoroughly into the above solutions and alternatives so that the choice of the best solution can be devised accordingly.

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To conclude this chapter, all the necessary steps for optimization the location for the regional gateway in the Nordic region of Schenker International have been analyzed and completed. The theoretical model was introduced at the beginning as the ground for other considerations as the basis, and the simulation was built with firm prerequisites. This chapter is the last step in the process of optimization the gateway location, going through from general geographical area to specific site selection. The best alternative locations, as identified and analyzed, will help Schenker International to optimize its cargo routing, saving cost and gain competitive advantages.

[10] *Managing Director, Port of Copenhagen.*

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

Chapter 5 has finished the optimization of the location process by pinpointing the best alternative places in relation with airport/seaport used for Schenker International to place its regional gateway/distribution center for inbound and outbound sea-freight and airfreight in the Nordic region. It is now necessary to summarize all issues that have been mentioned, diagnosed and analyzed in this project as well as suggesting some possible recommendations so that the project can be feasible.

6. 1. Conclusion

The issues of rationalization of depots (warehouses and distribution centers) and locations of depots play a very important role and have a vital essence for freight forwarding and logistics companies. Schenker International, as one of the biggest company in this field, realized these as an essential part in its strategies to enhance business processes for the sake of gaining competitive advantages. This study is an effort to help the company decide the optimum location for placing the company's regional gateway for the Nordic region of inbound and outbound sea-freight and airfreight flows. The study has covered all the necessary issues to come out with the final solution for the problem raised at the beginning.

The optimization of the location process began with the overview picture about current tendencies of European logistics and distribution, namely growing concentration through mergers and acquisitions, outsourcing of logistics and

distribution from manufacturers and consolidation trend through a rationalized number of depots and their location. Those are motivators for Schenker International to think about and to implement the changing trend of strategies in this field, from traditional country-based to regional-based, pan-European and global strategies, especially in the current scenario when Europe is considered as a single market since the establishment of the European Union in 1993.

As an indispensable part of Europe, the Northern European region, namely the Nordic region, consisting of Sweden, Norway, Denmark and Finland, in this study was considered as a single market. This philosophy is backed by concrete explanations and analysis from historical, economic and social perspectives. Hence, to place a single gateway/distribution center of inbound and outbound sea-freight and airfreight flows for this region is reasonable for Schenker International.

The issue coming next after this philosophy is to optimize the location for the future gateway/distribution center. There are two levels of optimization: from general geographical area and from specific site selection levels. As far as the first level is concerned, *the principle of centre of gravity* was applied for diagnosing and analyzing. As population was considered as ‘’weight’’ in the theoretical model, analysis of population distributions and population growths of major Nordic regions and cities was made to shape the centre of gravity in the Nordic region, and the outcome of this analysis is the Southern Sweden and Copenhagen region. Within this region, the Öresund region was also assessed as the newly emerging area for future gateway/distribution center for freight forwarding and logistics companies seen from many angles namely geographical location, population and labor force, economic indicators and infrastructure etc.

In order to optimize the location in the second level, current operating practices and customer service levels of Schenker International were analyzed and assessed. From this analysis, some economic implications were drawn, showing that the company is not taking advantages of customers’ proximity, economies of scales and quantity purchase discount as well as the flexibility of the gateway for the air cargo market in Finland. Based on that, a single gateway/distribution center for the

Nordic region, and alternative locations for distribution centers and seaports/airports to be used were proposed after analyzing the customers' proximity through the company's cargo flows, services of ports and airports in the Southern Sweden and Copenhagen region and the current trend of manufacturers in this region.

The second level of optimization of location was then followed by the excel-based simulation to work out the best solution of location for the project. In this level, *the principle of minimized the integration of total distances transport with relevant volumes* in combination with *the centre of gravity principle* and *the least total distribution cost principle* were introduced. The simulation was prepared based on the first principle with some concrete prerequisites such as the choice of principle and cargo routing. It worked out Göteborg as the best location for the regional gateway for Schenker International in terms of minimum CBM.Km. The centre of gravity model expressed in Chapter 3 can now be realized in the case of Schenker International with Göteborg as the centre of gravity as the following:

GRAVITY MODEL APPLIED FOR SCHENKER INTERNATIONAL WITH SOME REPRESENTATIVE CUSTOMERS' LOCATIONS

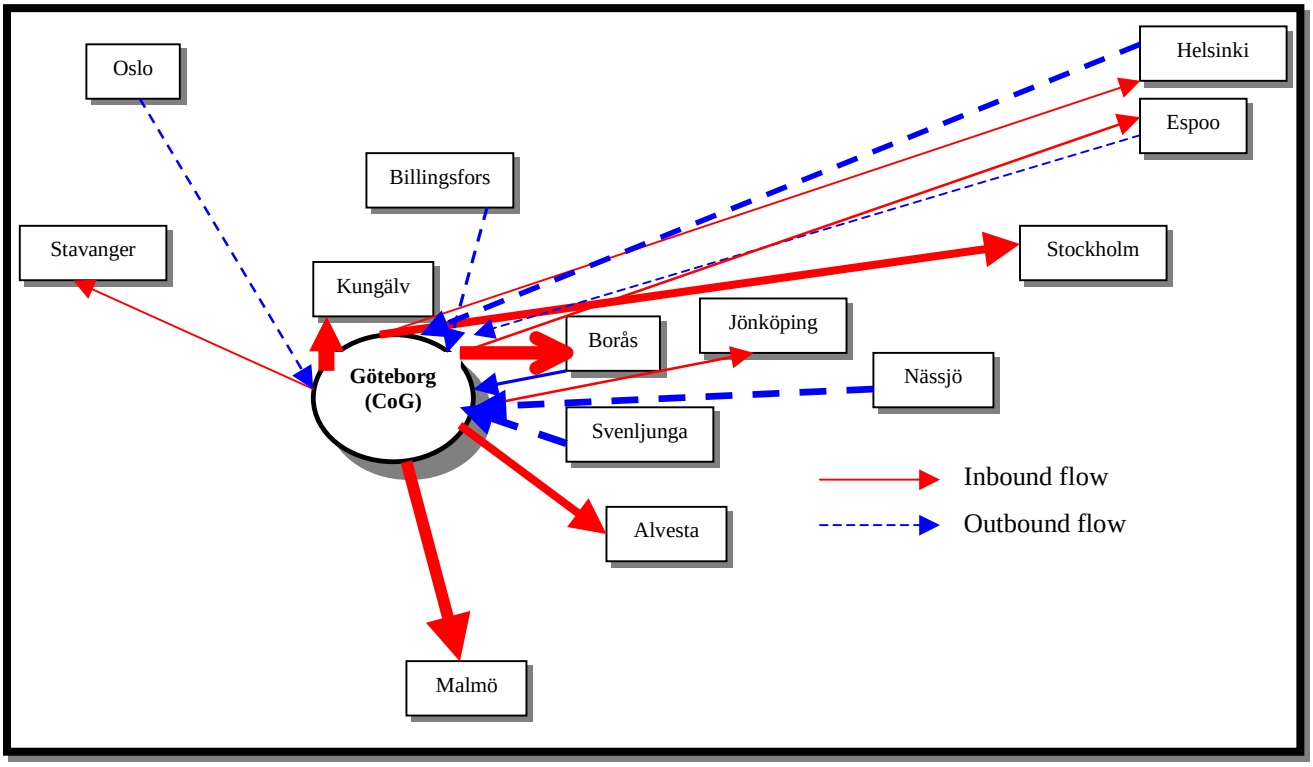

Figure 35

Since the simulation was built based on four possible solutions of airports and seaports used, Helsingborg was also identified as the second best choice of location for the regional gateway/distribution center when Copenhagen-Malmö Port is used. Such a finding, in the author's opinion, is extremely important for Schenker International especially in the scenario when this one port – two nations came into operation on January 1, 2001, offering many advantages to distribution as analyzed in previous chapters.

In addition to the findings of the simulation, deep analysis on the choice of the best location for the gateway seen from not only the CBM.Km but also other factors in the operating practices such as current facilities of airports, the trend of relocation from manufacturing to the South of Sweden were also taken into consideration. Based on these analyses, recommendations are made to the company to consider not only the outcome of the raw calculation in the simulation but also these factors, especially taking into account the movement in the port industry (Copenhagen-Malmö Port) and the emergence of the Öresund region since it may affect the company's customer proximity structure.

In short, the problem raised in this project has been solved. This project, however, can be done more attractively if the simulation based on total distribution cost can be performed; yet this depended totally on the response of Schenker-BTL in providing the necessary data on transport tariffs. The problems of time constraints and boundary of a Master's thesis have also limited the scope of this study. Nevertheless, the findings of this study are academically sound and reliable to be applied in practical operation of Schenker International.

6. 2. Recommendations

From the diagnosis, analysis and comparison to the findings of this study, some recommendations can be drawn as follows:

📖 Although the cargo volumes from and to Denmark market are small, it will be more complete for the simulation to have them in the picture. Moreover, the excel-based simulation file can be developed with increasing number of customers' locations as well as transport tariffs as soon as they are available.

📖 The growth rate used in the simulation is the same for all customers' locations. In practice, however, the growth rate of cargo flows in each customer's location may be different from one region to another depending on many factors such as the nature of cargo and its seasonal characteristics and marketing activities of the company in each region. If the study is wished to develop further, a more detailed growth rate of each customer's location should be devised so that a sensitivity testing can be added to the study as an effective way to check the reliability and stability of the findings.

📖 It is very essential to repeat and emphasize that the final decision on choosing the location for the regional gateway for Schenker International should be made based not only on the findings of the simulation but also on the analysis of other indicators such as the movement in the port industry, the relocation trend of manufacturing sector, the emergence of the Öresund region together with the operation of the Öresund fixed link, and even the new business concept of the company as well. It is believed from the author's view that such a combination between the comparative analysis in this study and the company's philosophy on logistics and distribution will lead to the efficient output for the company.

📖 The research methodology approach as well as the simulation of this study can be applied within Schenker International internal network/connectivity for other working regions of the company. The basic principles of application are valid for all regions, only specific data on customers' locations, cargo volumes and transport distances are changing according to specific working practices of the company in those regions.

With these in mind, this dissertation is the author's ambition to contribute a part in helping Schenker International decide the best place for the regional gateway/distribution center of inbound and outbound sea-freight and airfreight flows in the Nordic region, as well as applying the essential ideas of this study in other regions where the company is having the same problems, for the sake of saving costs, rationalizing businesses and gaining competitive advantages.

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APPENDIX A

MILESTONES IN HISTORY OF SCHENKER A. G

1872	Gottfried Schenker founds Schenker & Co. in Vienna, Austria.
1873	First consolidated rail consignment from Paris, France, to Vienna, Austria.
1874	Branch offices established in Budapest, Hungary, Bucharest, Romania, Prague, Czech Republic and London, England.
1880	Acquired a stake in the steam navigation company Adria Dampfschiffahrts-Gesellschaft.
1895	Founded Austro-Americana Shipping Company.
1918	After WW I, Schenker focuses on express delivery services, regional freight forwarding, removals and trade-fair services.
1922	First air freight shipments in Germany.
1924	The German export industry goes on an international exhibition tour organized by Schenker.
1928	Following the acquisition of BEHALA, Schenker headquarters are transferred to Berlin.
1931	Schenker is acquired by the German Railways. First sea freight container shipments.
1945	Rebuilding process begins following disappropriation and the loss of numerous bases in WW II.
1947	Subsidiary established in the U.S. Internationalization and airfreight are pursued on a large scale.
1966	Dedicated company founded in Hong Kong to oversee Asian market.
1972	Schenker becomes the official freight for warder for Munich Olympics. Coinage of JETcargo, SEAcargo and Eurocargo as trade marks for bulk transportation by air, sea, rail and road.

1989 Company decides to introduce SWORD (Schenker's Worldwide Online Real time Data Network) and EDIFACT standards.

1991 Stinnes AG acquires a majority stake in Schenker from the German railroad company Deutsche Bundesbahn and divides the business into Schenker International (air and sea freight) and Schenker Eurocargo (European land transport).

1996 Stinnes air and sea freight, land transport, handling/logistics and seaport activities are grouped under the umbrella of Schenker-Rhenus AG.

1997 Schenker looks back on 125 years of history. Schenker AG repositions itself by divesting the bulk cargo business and forming three new business areas: Schenker Logistics, Schenker International and Schenker Eurocargo. The shareholding in the Swedish company BTL-AB, Gothenburg, gives birth to Europe's leading transportation and logistics provider.

1998 Co-ordination of land transport operations in Europe at Schenker and BTL under the Schenker-BTL name.

1999 Takeover of BTL AB. Schenker Australia appointed Official Freight Forwarder of the Sydney 2000 Olympic Games. Strategic alliance between Schenker and Seino.

2000 Opening of the Integrated Logistics Center Rotterdam. Schenker, Inc. named for the Salt Lake City 2002 Olympic Winter Games. Schenker and Deutsche Bahn establish Railog joint venture for rail related logistics services.

2001 Merger of Schenker-BTL (Deutschland) AG and Schenker International Deutschland GmbH to form Schenker Deutschland AG.

APPENDIX B 1
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 1: both seafreight and airfreight going through Göteborg **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			KOLBÄCK		BILLINGSFORS		HALMSTAD		SVENLJUNGA		TRELLEBORG		TROLLHÄTTAN		LINKÖPING	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	281	120582.0	235	75222.0	162	58023.0	86	35154.0	324	120204.0	148	41958.0	131	77490.0
BORÅS	182.25	3645.00	334	2644629.8	194	1366328.3	154	1144347.8	47	562605.8	321	2422649.3	97	654459.8	214	1886834.3
ALVESTA	63.00	1260.00	396	996219.0	354	683991.0	116	345303.0	132	306936.0	224	709128.0	267	451143.0	246	694575.0
ANDERSTORP	110.25	2205.00	358	1655403.8	267	995557.5	97	560290.5	50	347287.5	264	1333584.0	170	564921.0	208	1127526.8
MALMÖ	120.75	2415.00	569	2348104.5	436	1518914.3	136	712545.8	239	859619.3	33	874833.8	347	1067550.8	419	1769953.5
NORRKÖPING	12.75	255.00	132	130929.8	329	131733.0	349	132268.5	257	95586.8	490	214735.5	317	104690.3	43	86215.5
HELSINGBORG	13.50	270.00	513	246645.0	381	154224.0	81	64071.0	184	80514.0	96	115668.0	291	103477.5	363	182007.0
STOCKHOLM	100.50	2010.00	131	1029924.0	410	1209316.5	508	1378156.5	416	1089018.0	650	2030301.0	413	1027813.5	202	1015150.5
KUNGÄLV	304.50	6090.00	353	4540095.0	141	1943928.0	161	1956717.0	116	1381212.0	328	4092480.0	61	863257.5	295	3670443.0
HEIMDAL	17.45	348.90	1184	564537.6	1053	445475.5	1259	514348.4	1178	468188.9	1370	616192.3	1059	415068.9	1185	536329.1
STAVANGER	2.45	49.05	807	59948.9	676	43210.6	882	52893.1	801	46403.8	993	67210.8	682	38935.9	808	55983.2
NITTEDAL	7.52	150.45	371	115004.0	240	63662.9	446	93361.7	365	73457.2	557	137278.1	246	50551.2	372	102840.1
SKAARER	7.94	158.70	353	118310.9	222	64154.5	428	95481.9	347	74485.8	539	141806.4	228	50323.8	354	105480.0
STABEKK	2.15	43.05	403	34353.9	272	19663.1	478	28161.2	397	22465.6	589	40727.5	278	15911.3	404	30873.3
HOLMESTRAND	1.01	20.25	384	15755.5	253	8845.2	459	12842.6	378	10163.5	570	18753.5	259	7080.4	385	14118.3
FJELLSTRAND	5.84	116.70	393	91901.3	262	52077.4	468	75114.0	387	59674.5	579	109178.7	268	41907.0	394	82466.1
FARSUND	8.21	164.25	708	183672.6	577	127622.3	783	160045.2	702	138314.9	894	207989.8	583	113307.9	709	170393.0
FJELLSTRAND	4.32	86.40	393	68040.0	262	38556.0	468	55611.4	387	44180.6	579	80831.5	268	31026.2	394	61054.6
DROBAL	7.59	151.80	337	110616.7	206	58814.9	412	88780.2	331	68697.1	523	133090.7	212	45585.5	338	98343.6
JYVSKYL	4.28	85.50	695	94443.3	974	102074.2	1072	109256.2	980	96957.0	1214	136996.7	977	94353.5	766	93814.9
MNTYHARJU	11.18	223.50	538	210034.1	817	229981.5	915	248755.5	823	216605.0	1057	321270.1	820	209799.5	609	208391.4
HELSINKI	2.33	46.50	565	45016.7	844	49166.8	942	53072.8	850	46383.8	1084	68159.7	847	44967.8	636	44674.9
VANTAA	9.68	193.50	617	197892.5	896	215162.3	994	231416.3	902	203581.4	1136	294197.4	899	197689.3	688	196470.2
HELSINKIMEDIA	9.30	186.00	403	148428.0	682	165028.5	780	180652.5	688	153896.4	922	241000.2	685	148232.7	474	147060.9
TAMMISAARI	1.43	28.50	516	26124.5	795	28668.2	893	31062.2	801	26962.4	1035	40309.0	798	26094.6	587	25915.1
HELSINKI	1.35	27.00	565	26138.7	844	28548.5	942	30816.5	850	26932.5	1084	39576.6	847	26110.4	636	25940.3
ESPOO	3.38	67.50	528	62724.4	807	68748.8	905	74418.8	813	64708.9	1047	96319.1	810	62653.5	599	62228.3
ULVILA	5.10	102.00	536	95640.3	815	104743.8	913	113311.8	821	98639.1	1055	146405.7	818	95533.2	607	94890.6
HELSINKI	2.40	48.00	565	46468.8	844	50752.8	942	54784.8	850	47880.0	1084	70358.4	847	46418.4	636	46116.0
ESPOO	11.03	220.50	528	204899.6	807	224579.3	905	243101.3	813	211382.3	1047	314642.5	810	204668.1	599	203279.0
TOTAL	#####	########	####	**16232484.9**	####	**10268751.3**	####	**8899011.0**	####	**6957894.0**	####	**15235877.9**	####	**6845490.2**	####	**12916858.0**

APPENDIX B 1
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 1: both seafreight and airfreight going through Göteborg **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			KOLBÄCK		BILLINGSFORS		HALMSTAD		SVENLJUNGA		TRELLEBORG		TROLLHÄTTAN		LINKÖPING	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	295	1230637.0	277	830491.2	210	670055.4	119	413358.1	351	1251399.2	190	498294.7	126	764429.4
MOTALA	17.64	352.80	170	195221.9	277	162993.6	290	161141.4	198	110391.1	432	275607.4	234	114095.5	45	120022.6
SKÖVDE	19.32	386.40	219	233694.7	190	143219.2	225	150116.4	131	93721.3	409	292524.1	103	71812.4	174	183791.2
KOLBÄCK	2.52	50.40	0	18892.4	289	23919.8	432	30534.8	352	23919.8	602	48368.9	292	19368.7	172	23866.9
BILLINGSFORS	16.80	336.00	289	227908.8	0	57506.4	303	158054.4	257	125949.6	469	275536.8	101	61740.0	320	211327.2
HALMSTAD	16.80	336.00	432	278359.2	303	164404.8	0	51156.0	106	72676.8	169	169696.8	214	101606.4	310	207799.2
BORÅS	8.40	168.00	334	121892.4	194	62974.8	154	52743.6	47	25930.8	321	111661.2	97	30164.4	214	86965.2
SVENLJUNGA	136.92	2738.40	352	2038601.9	257	1207634.4	106	721705.3	0	287532.0	272	1679186.9	144	626819.8	218	1429034.0
NOTODDEN	4.81	96.26	419	78435.9	288	45585.8	494	64588.3	413	51852.6	605	92687.8	294	37196.4	420	70653.0
OSLO	1.68	33.60	313	23637.6	182	12171.6	388	18804.2	307	14359.0	499	28612.1	188	9243.4	314	20921.0
OSLO	0.84	16.80	313	11818.8	182	6085.8	388	9402.1	307	7179.5	499	14306.0	188	4621.7	314	10460.5
ORJE	9.00	179.93	409	144716.1	278	83315.7	484	118833.4	403	95029.0	595	171354.4	284	67634.9	410	130168.9
ESPOO	14.53	290.64	528	270077.2	807	296016.8	905	320430.6	813	278622.0	1047	414728.7	810	269772.0	599	267941.0
SAVONLINNA	6.30	126.00	888	164713.5	1167	175959.0	1265	186543.0	1173	168417.9	1407	227423.7	1170	164581.2	959	163787.4
RAUMA	1.34	26.88	473	23425.9	752	25825.0	850	28082.9	758	24216.2	992	36804.1	755	23397.7	544	23228.4
VANTAA	1.85	36.96	617	37799.0	896	41097.7	994	44202.3	902	38885.6	1136	56194.0	899	37760.2	688	37527.3
HELSINKI	2.69	53.76	565	52045.1	844	56843.1	942	61359.0	850	53625.6	1084	78801.4	847	51988.6	636	51649.9
HELSINKI	8.57	171.36	565	165893.6	844	181187.5	942	195581.7	850	170931.6	1084	251179.5	847	165713.7	636	164634.1
KEMPELE	4.96	99.12	1031	144457.5	1310	153303.9	1408	161630.0	1316	147371.6	1550	193789.5	1313	144353.4	1102	143729.0
ULVILA	5.29	105.84	536	99240.9	815	108687.1	913	117577.7	821	102352.6	1055	151917.4	818	99129.7	607	98463.0
HELSINKI	1.76	35.28	565	34154.6	844	37303.3	942	40266.8	850	35191.8	1084	51713.4	847	34117.5	636	33895.3
HELSINKI	1.93	38.64	565	37407.4	844	40856.0	942	44101.8	850	38543.4	1084	56638.5	847	37366.8	636	37123.4
TOTAL	**373.83**	**7476.67**	**9878**	**5633031.3**	**####**	**3917382.5**	**####**	**3406911.3**	**####**	**2380057.9**	**####**	**5930131.9**	**####**	**2670779.3**	**####**	**4281417.8**

	KOLBÄCK	BILLINGSFORS	HALMSTAD	SVENLJUNGA	TRELLEBORG	TROLLHÄTTAN	LINKÖPING
INBOUND	16232484.9	10268751.3	8899011.0	6957894.0	15235877.9	6845490.2	12916858.0
OUTBOUND	5633031.3	3917382.5	3406911.3	2380057.9	5930131.9	2670779.3	4281417.8
GRAND TOTAL	**21865516.2**	**14186133.8**	**12305922.3**	**9337952.0**	**21166009.9**	**9516269.5**	**17198275.8**

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COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 1: both seafreight and airfreight going through Göteborg **2001**

CUSTOMERS LOCATIONS	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			GÖTEBORG		MALMÖ		COPENHAGEN		JÖNKÖPING		BORÅS		ALVESTA		ANDERSTORP	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	147	28053.0	291	107730.0	311	115290.0	0	27783.0	82	27972.0	118	63693.0	81	41391.0
BORÅS	182.25	3645.00	66	258066.0	288	2170050.8	308	2323140.8	82	876440.3	0	252598.5	154	1427564.3	73	807549.8
ALVESTA	63.00	1260.00	219	291627.0	191	621810.0	211	674730.0	118	350595.0	154	291060.0	0	289737.0	84	293706.0
ANDERSTORP	110.25	2205.00	138	322812.0	231	1180777.5	251	1273387.5	81	527877.0	73	321819.8	84	701520.8	0	319504.5
MALMÖ	120.75	2415.00	279	711096.8	0	707474.3	20	808904.3	291	1110658.5	288	897655.5	191	1039657.5	231	935691.8
NORRKÖPING	12.75	255.00	318	85527.0	458	197331.8	478	208041.8	170	84876.8	253	85412.3	285	134946.0	247	103083.8
HELSINGBORG	13.50	270.00	223	63625.5	63	96957.0	65	103194.0	236	108580.5	232	84483.0	169	109998.0	175	88735.5
STOCKHOLM	100.50	2010.00	477	1009723.5	617	1891008.0	637	1975428.0	329	1004598.0	412	1008819.0	444	1399261.5	406	1148112.0
KUNGÄLV	304.50	6090.00	22	149814.0	295	3670443.0	315	3926223.0	163	1982295.0	82	946386.0	236	2909497.5	154	1867194.0
HEIMDAL	17.45	348.90	1161	425849.9	1440	629747.1	1460	644400.9	1179	485773.5	1144	443277.5	1274	546953.1	1246	507021.5
STAVANGER	2.45	49.05	784	40451.5	1063	69116.4	1083	71176.5	802	48875.9	767	42901.6	897	57476.8	869	51863.0
NITTEDAL	7.52	150.45	348	55200.1	627	143123.1	647	149442.0	366	81039.9	331	62715.1	461	107421.3	433	90202.3
SKAARER	7.94	158.70	330	55227.6	609	147971.9	629	154637.3	348	82484.3	313	63154.7	443	110312.4	415	92149.2
STABEKK	2.15	43.05	380	17241.5	659	42399.9	679	44208.0	398	24635.4	363	19391.9	493	32184.2	465	27257.1
HOLMESTRAND	1.01	20.25	361	7706.1	640	19540.2	660	20390.7	379	11184.1	344	8717.6	474	14734.9	446	12417.3
FJELLSTRAND	5.84	116.70	370	45513.0	649	113712.5	669	118613.9	388	65556.2	353	51342.2	483	86019.6	455	72663.3
FARSUND	8.21	164.25	685	118383.2	964	214370.9	984	221269.4	703	146593.1	668	126587.5	798	175394.4	770	156596.0
FJELLSTRAND	4.32	86.40	370	33696.0	649	84188.2	669	87817.0	388	48535.2	353	38011.7	483	63685.4	455	53797.0
DROBAL	7.59	151.80	314	50276.2	593	138988.1	613	145363.7	332	76347.8	297	57858.6	427	102965.9	399	85592.4
JYVSKYL	4.28	85.50	1041	93584.0	1181	131071.5	1201	134662.5	893	93366.0	976	93545.6	1008	110153.9	970	99470.7
MNTYHARJU	11.18	223.50	884	207788.0	1024	305781.5	1044	315168.5	736	207218.0	819	207687.4	851	251102.3	813	223175.9
HELSINKI	2.33	46.50	911	44549.3	1051	64937.3	1071	66890.3	763	44430.8	846	44528.4	878	53561.0	840	47750.9
VANTAA	9.68	193.50	963	195947.8	1103	280787.9	1123	288914.9	815	195454.4	898	195860.7	930	233448.1	892	209270.3
HELSINKIMEDIA	9.30	186.00	749	146558.7	889	228110.4	909	235922.4	601	146084.4	684	146475.0	716	182605.5	678	159364.8
TAMMISAARI	1.43	28.50	862	25838.1	1002	38333.9	1022	39530.9	714	25765.4	797	25825.3	829	31361.4	791	27800.3
HELSINKI	1.35	27.00	911	25867.4	1051	37705.5	1071	38839.5	763	25798.5	846	25855.2	878	31100.0	840	27726.3
ESPOO	3.38	67.50	874	62046.0	1014	91641.4	1034	94476.4	726	61873.9	809	62015.6	841	75127.5	803	66693.4
ULVILA	5.10	102.00	882	94615.2	1022	139337.1	1042	143621.1	734	94355.1	817	94569.3	849	114382.8	811	101637.9
HELSINKI	2.40	48.00	911	45986.4	1051	67032.0	1071	69048.0	763	45864.0	846	45964.8	878	55288.8	840	49291.2
ESPOO	11.03	220.50	874	202683.6	1014	299361.8	1034	308622.8	726	202121.3	809	202584.4	841	245416.5	803	217865.0
TOTAL	**1042.40**	######	####	**4915354.3**	####	**13930840.7**	####	**14801355.8**	####	**8287061.1**	####	**5975075.8**	####	**10756571.2**	####	**7984573.9**

APPENDIX B 1
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 1: both seafreight and airfreight going through Göteborg **2001**

CUSTOMERS LOCATIONS	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			GÖTEBORG		MALMÖ		COPENHAGEN		JÖNKÖPING		BORÅS		ALVESTA		ANDERSTORP	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	191	363205.1	318	1126825.6	338	1202324.8	43	358621.2	126	362396.2	111	622868.4	108	464320.1
MOTALA	17.64	352.80	260	96843.6	399	251158.3	419	265975.9	111	95573.5	195	96684.8	226	164845.8	189	121133.9
SKÖVDE	19.32	386.40	155	63466.2	376	265746.6	396	281975.4	84	93721.3	109	71001.0	203	171213.8	139	112384.4
KOLBÄCK	2.52	50.40	357	18968.0	569	44876.2	589	46993.0	281	22649.8	334	21168.0	396	32545.8	358	26248.3
BILLINGSFORS	16.80	336.00	163	58010.4	436	252252.0	456	266364.0	235	134769.6	194	91728.0	354	202154.4	267	142884.0
HALMSTAD	16.80	336.00	145	51660.0	136	146412.0	156	160524.0	162	109015.2	154	77616.0	116	118188.0	97	82908.0
BORÅS	8.40	168.00	66	11894.4	288	100018.8	308	107074.8	82	40395.6	0	11642.4	154	65797.2	73	37220.4
SVENLJUNGA	136.92	2738.40	100	291639.6	239	1489415.8	259	1604428.6	86	669949.6	47	324911.2	132	1009237.3	50	540560.2
NOTODDEN	4.81	96.26	396	40171.0	675	96427.6	695	100470.7	414	56704.3	379	44979.4	509	73584.2	481	62566.8
OSLO	1.68	33.60	290	10281.6	859	40148.6	879	41559.8	308	16052.4	273	11959.9	403	21944.2	375	18098.6
OSLO	0.84	16.80	290	5140.8	859	20074.3	879	20779.9	308	8026.2	273	5980.0	403	10972.1	375	9049.3
ORJE	9.00	179.93	386	73194.7	665	178344.6	685	185901.6	404	104097.3	369	82182.1	499	135647.7	471	115055.0
ESPOO	14.53	290.64	874	267156.3	1014	394587.4	1034	406794.3	726	266415.2	809	267025.5	841	323482.3	803	287166.9
SAVONLINNA	6.30	126.00	1234	163447.2	1374	218691.9	1394	223983.9	1086	163125.9	1169	163390.5	1201	187866.0	1163	172122.3
RAUMA	1.34	26.88	819	23155.8	959	34941.3	979	36070.3	671	23087.2	754	23143.7	786	28365.1	748	25006.5
VANTAA	1.85	36.96	963	37427.5	1103	53632.7	1123	55185.0	815	37333.3	898	37410.9	930	44590.4	892	39972.2
HELSINKI	2.69	53.76	911	51504.8	1051	75075.8	1071	77333.8	763	51367.7	846	51480.6	878	61923.5	840	55206.1
HELSINKI	8.57	171.36	911	164171.4	1051	239304.2	1071	246501.4	763	163734.5	846	164094.3	878	197381.0	840	175969.6
KEMPELE	4.96	99.12	1377	143461.3	1517	186920.5	1537	191083.5	1229	143208.6	1312	143416.7	1344	162670.8	1306	150285.7
ULVILA	5.29	105.84	882	98177.2	1022	144582.7	1042	149028.0	734	97907.3	817	98129.6	849	118689.0	811	105464.3
HELSINKI	1.76	35.28	911	33800.0	1051	49268.5	1071	50750.3	763	33710.0	846	33784.1	878	40637.3	840	36229.0
HELSINKI	1.93	38.64	911	37019.1	1051	53960.8	1071	55583.6	763	36920.5	846	37001.7	878	44507.5	840	39679.4
TOTAL	**373.83**	**7476.67**	**####**	**2103796.0**	**####**	**5462666.3**	**####**	**5776686.5**	**####**	**2726386.2**	**####**	**2221126.5**	**####**	**3839111.7**	**####**	**2819531.0**

	GÖTEBORG	MALMÖ	COPENHAGEN	JÖNKÖPING	BORÅS	ALVESTA	ANDERSTORP
INBOUND	4915354.3	13930840.7	14801355.8	8287061.1	5975075.8	10756571.2	7984573.9
OUTBOUND	2103796.0	5462666.3	5776686.5	2726386.2	2221126.5	3839111.7	2819531.0
GRAND TOTAL	**7019150.3**	**19393507.0**	**20578042.3**	**11013447.3**	**8196202.3**	**14595682.9**	########

APPENDIX B 1
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 1: both seafreight and airfreight going through Göteborg **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			NORRKÖPING		HELSINBORG		STOCKHOLM		KUNGÄLV		NÄSSJÖ		MOTALA		SKÖVDE	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	170	92232.0	236	86751.0	329	152334.0	163	34965.0	43	44226.0	111	70119.0	84	45171.0
BORÅS	182.25	3645.00	253	2185359.8	232	1741398.8	412	3402425.3	82	398034.0	126	1213238.3	195	1741398.8	109	1010394.0
ALVESTA	63.00	1260.00	285	797769.0	169	518616.0	444	1218483.0	236	341334.0	111	399546.0	226	642978.0	203	473634.0
ANDERSTORP	110.25	2205.00	247	1308116.3	175	921469.5	406	2044365.8	154	407484.0	108	692259.8	189	1039547.3	139	680683.5
MALMÖ	120.75	2415.00	1207	3867018.8	63	725224.5	617	2774110.5	295	803832.8	318	1290696.8	399	1671059.3	376	1346483.3
NORRKÖPING	12.75	255.00	0	85144.5	402	167343.8	162	171092.3	334	95319.0	165	95319.0	84	92106.0	213	98532.0
HELSINGBORG	13.50	270.00	402	204120.0	0	63220.5	561	294273.0	239	73993.5	263	128709.0	343	170950.5	321	134946.0
STOCKHOLM	100.50	2010.00	162	1013040.0	561	1654632.0	0	1006708.5	494	1089018.0	324	1086907.5	243	1061581.5	341	1046808.0
KUNGÄLV	304.50	6090.00	334	4169214.0	239	2954259.0	494	6209059.5	0	140679.0	207	2545011.0	276	3427452.0	171	2084607.0
HEIMDAL	17.45	348.90	1212	560507.9	1313	562705.9	1287	646232.6	1121	418732.3	1146	489803.3	1151	516912.8	1111	463792.8
STAVANGER	2.45	49.05	835	59382.4	936	59691.4	910	71434.0	744	39450.9	769	49442.4	774	53253.6	734	45785.7
NITTEDAL	7.52	150.45	399	113266.3	500	114214.1	474	150231.8	308	52130.9	333	82777.6	338	94467.6	298	71561.5
SKAARER	7.94	158.70	381	116477.9	482	117477.7	456	155470.5	290	51990.1	315	84317.3	320	96648.3	280	72486.2
STABEKK	2.15	43.05	431	33856.7	532	34127.9	506	44434.1	340	16363.3	365	25132.6	370	28477.6	330	21923.2
HOLMESTRAND	1.01	20.25	412	15521.6	513	15649.2	487	20497.1	321	7293.0	346	11418.0	351	12991.4	311	9908.3
FJELLSTRAND	5.84	116.70	421	90553.4	522	91288.6	496	119226.6	330	43132.3	355	66904.1	360	75971.7	320	58204.1
FARSUND	8.21	164.25	736	181775.5	837	182810.3	811	222131.7	645	115032.5	670	148490.2	675	161252.4	635	136245.4
FJELLSTRAND	4.32	86.40	421	67042.1	522	67586.4	496	88270.6	330	31933.4	355	49533.1	360	56246.4	320	43092.0
DROBAL	7.59	151.80	365	108863.4	466	109819.7	440	146160.6	274	47179.4	299	78101.1	304	89896.0	264	66784.4
JYVSKYL	4.28	85.50	726	93725.1	1125	121016.7	564	93455.8	1058	96957.0	888	96867.2	807	95789.9	905	95161.5
MNTYHARJU	11.18	223.50	569	208156.7	968	279497.9	407	207452.7	901	216605.0	731	216370.4	650	213554.3	748	211911.5
HELSINKI	2.33	46.50	596	44626.1	995	59468.9	434	44479.6	928	46383.8	758	46334.9	677	45749.0	775	45407.3
VANTAA	9.68	193.50	648	196267.1	1047	258032.3	486	195657.5	980	203581.4	810	203378.2	729	200940.1	827	199517.9
HELSINKIMEDIA	9.30	186.00	434	146865.6	833	206236.8	272	146279.7	766	153896.4	596	153701.1	515	151357.5	613	149990.4
TAMMISAARI	1.43	28.50	547	25885.1	946	34982.3	385	25795.4	879	26962.4	709	26932.5	628	26573.4	726	26363.9
HELSINKI	1.35	27.00	596	25911.9	995	34530.3	434	25826.9	928	26932.5	758	26904.2	677	26564.0	775	26365.5
ESPOO	3.38	67.50	559	62157.4	958	83703.4	397	61944.8	891	64708.9	721	64638.0	640	63787.5	738	63291.4
ULVILA	5.10	102.00	567	94783.5	966	127341.9	405	94462.2	899	98639.1	729	98532.0	648	97246.8	746	96497.1
HELSINKI	2.40	48.00	596	46065.6	995	61387.2	434	45914.4	928	47880.0	758	47829.6	677	47224.8	775	46872.0
ESPOO	11.03	220.50	559	203047.4	958	273431.0	397	202352.9	891	211382.3	721	211150.8	640	208372.5	738	206751.8
TOTAL	**1042.40**	######	####	**16216752.7**	####	**11727914.8**	####	**20080562.8**	####	**5401826.3**	####	**9774471.7**	####	**12280469.7**	**14926**	**9079172.7**

APPENDIX B 1
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 1: both seafreight and airfreight going through Göteborg **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			NORRKÖPING		HELSINBORG		STOCKHOLM		KUNGÄLV		NÄSSJÖ		MOTALA		SKÖVDE	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	165	911652.8	263	917315.3	324	1511871.5	207	432232.9	0	360508.7	117	711580.0	126	530381.9
MOTALA	17.64	352.80	84	148916.9	343	209669.0	243	266716.8	276	110391.1	117	114095.5	0	96314.4	131	105945.8
SKÖVDE	19.32	386.40	213	215437.3	321	220711.7	341	331879.0	171	78304.0	126	128613.2	131	158636.5	0	62886.6
KOLBÄCK	2.52	50.40	132	23814.0	513	38949.1	131	32175.4	353	19845.0	295	25719.1	170	22755.6	219	19792.1
BILLINGSFORS	16.80	336.00	329	228261.6	381	213091.2	410	312933.6	272	103723.2	277	165110.4	277	189453.6	190	121716.0
HALMSTAD	16.80	336.00	349	235317.6	81	107251.2	508	347508.0	451	166874.4	210	141472.8	290	194040.0	225	134064.0
BORÅS	8.40	168.00	253	100724.4	232	80262.0	412	156819.6	82	18345.6	126	55918.8	195	80262.0	109	46569.6
SVENLJUNGA	136.92	2738.40	257	1653309.0	184	1170255.2	416	2567660.8	116	396794.2	119	891349.2	198	1316896.6	131	822341.5
NOTODDEN	4.81	96.26	447	77324.1	548	77930.5	522	100976.1	356	38207.2	381	57816.2	386	65295.9	346	50639.7
OSLO	1.68	33.60	341	23249.5	442	23461.2	416	31505.0	250	9596.2	275	16440.5	280	19051.2	240	13935.6
OSLO	0.84	16.80	341	11624.8	442	11730.6	416	15752.5	250	4798.1	275	8220.2	280	9525.6	240	6967.8
ORJE	9.00	179.93	437	142637.9	538	143771.5	512	186846.2	346	69524.2	371	106175.5	376	120155.9	336	92761.9
ESPOO	14.53	290.64	559	267635.8	958	360408.1	397	266720.3	891	278622.0	721	278316.9	640	274654.8	738	272518.6
SAVONLINNA	6.30	126.00	919	163655.1	1318	203874.3	757	163258.2	1251	168417.9	1081	168285.6	1000	166698.0	1098	165771.9
RAUMA	1.34	26.88	504	23200.1	903	31780.2	342	23115.5	836	24216.2	666	24188.0	585	23849.3	683	23651.7
VANTAA	1.85	36.96	648	37488.5	1047	49286.2	486	37372.1	980	38885.6	810	38846.8	729	38381.1	827	38109.5
HELSINKI	2.69	53.76	596	51593.5	995	68753.7	434	51424.1	928	53625.6	758	53569.2	677	52891.8	775	52496.6
HELSINKI	8.57	171.36	596	164454.2	995	219152.3	434	163914.4	928	170931.6	758	170751.7	677	168592.5	775	167333.0
KEMPELE	4.96	99.12	1062	143624.9	1461	175264.0	900	143312.7	1394	147371.6	1224	147267.5	1143	146018.6	1241	145290.1
ULVILA	5.29	105.84	567	98351.8	966	132135.9	405	98018.4	899	102352.6	729	102241.4	648	100907.9	746	100129.9
HELSINKI	1.76	35.28	596	33858.2	995	45119.6	434	33747.1	928	35191.8	758	35154.8	677	34710.2	775	34450.9
HELSINKI	1.93	38.64	596	37082.8	995	49416.7	434	36961.1	928	38543.4	758	38502.8	677	38016.0	775	37732.0
TOTAL	**373.83**	**7476.67**	**9991**	**4793214.9**	**####**	**4549589.6**	**9674**	**6880488.4**	**####**	**2506794.3**	**####**	**3128564.8**	**####**	**4028687.4**	**10726**	**3045486.7**

	NORRKÖPING	HELSINBORG	STOCKHOLM	KUNGÄLV	NÄSSJÖ	MOTALA	SKÖVDE
INBOUND	16216752.7	11727914.8	20080562.8	5401826.3	9774471.7	12280469.7	9079172.7
OUTBOUND	4793214.9	4549589.6	6880488.4	2506794.3	3128564.8	4028687.4	3045486.7
GRAND TOTAL	**21009967.6**	**16277504.3**	**26961051.2**	**7908620.6**	#########	**16309157.1**	**12124659.4**

APPENDIX B 2
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 2: both seafreight and airfreight going through Copenhagen **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			KOLBÄCK		BILLINGSFORS		HALMSTAD		SVENLJUNGA		TRELLEBORG		TROLLHÄTTAN		LINKÖPING	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	281	164430.0	235	130599.0	162	60102.0	86	65205.0	324	71253.0	148	97335.0	131	107730.0
BORÅS	182.25	3645.00	334	3532551.8	194	2487712.5	154	1186447.5	47	1171138.5	321	1431391.5	97	1775844.0	214	2499194.3
ALVESTA	63.00	1260.00	396	1303155.0	354	1071630.0	116	359856.0	132	517293.0	224	366471.0	267	838782.0	246	906255.0
ANDERSTORP	110.25	2205.00	358	2192541.8	267	1673925.8	97	585758.3	50	715412.3	264	733934.3	170	1243289.3	208	1497966.8
MALMÖ	120.75	2415.00	569	2936398.5	436	2261889.0	136	740439.0	239	1262803.5	33	218074.5	347	1810525.5	419	2175673.5
NORRKÖPING	12.75	255.00	132	193047.8	329	210183.8	349	135213.8	257	138159.0	490	145388.3	317	183141.0	43	129055.5
HELSINGBORG	13.50	270.00	513	312417.0	381	237289.5	81	67189.5	184	125590.5	96	42241.5	291	186543.0	363	227367.0
STOCKHOLM	100.50	2010.00	131	1519560.0	410	1827693.0	508	1401372.0	416	1424587.5	650	1483681.5	413	1646190.0	202	1352830.5
KUNGÄLV	304.50	6090.00	353	6023619.0	141	3817516.5	161	2027056.5	116	2397937.5	328	2436304.5	61	2736846.0	295	4693563.0
HEIMDAL	17.45	348.90	1184	649529.7	1053	552814.6	1259	518378.2	1178	526437.8	1370	521308.9	1059	522408.0	1185	594944.3
STAVANGER	2.45	49.05	807	71897.5	676	58300.8	882	53459.6	801	54592.7	993	53871.6	682	54026.1	808	64223.6
NITTEDAL	7.52	150.45	371	151653.6	240	109948.9	446	95099.4	365	98574.8	557	96363.2	246	96837.1	372	128115.7
SKAARER	7.94	158.70	353	156970.2	222	112978.5	428	97314.8	347	100980.8	539	98647.9	228	99147.8	354	132141.6
STABEKK	2.15	43.05	403	44840.9	272	32907.4	478	28658.4	397	29652.8	589	29020.0	278	29155.6	404	38105.7
HOLMESTRAND	1.01	20.25	384	20688.4	253	15075.1	459	13076.4	378	13544.2	570	13246.5	259	13310.3	385	17520.3
FJELLSTRAND	5.84	116.70	393	120329.4	262	87980.1	468	76461.8	387	79157.6	579	77442.1	268	77809.7	394	102071.7
FARSUND	8.21	164.25	708	223683.9	577	178153.8	783	161942.3	702	165736.5	894	163322.0	583	163839.4	709	197987.0
FJELLSTRAND	4.32	86.40	393	89087.0	262	65137.0	468	56609.3	387	58605.1	579	57335.0	268	57607.2	394	75569.8
DROBAL	7.59	151.80	337	147595.1	206	105516.2	412	90533.5	331	94040.1	523	91808.6	212	92286.8	338	123846.0
JYVSKYL	4.28	85.50	695	115271.1	974	128378.3	1072	110243.7	980	111231.2	1214	113744.9	977	120657.6	766	108178.9
MNTYHARJU	11.18	223.50	538	264478.7	817	298741.3	915	251336.9	823	253918.4	1057	260489.3	820	278559.2	609	245939.4
HELSINKI	2.33	46.50	565	56344.1	844	63472.5	942	53609.9	850	54146.9	1084	55514.0	847	59273.6	636	52486.9
VANTAA	9.68	193.50	617	245029.1	896	274692.6	994	233651.3	902	235886.2	1136	241575.1	899	257219.6	688	228978.2
HELSINKIMEDIA	9.30	186.00	403	193737.6	682	222251.4	780	182800.8	688	184949.1	922	190417.5	685	205455.6	474	178308.9
TAMMISAARI	1.43	28.50	516	33067.1	795	37436.2	893	31391.3	801	31720.5	1035	32558.4	798	34862.6	587	30703.1
HELSINKI	1.35	27.00	565	32715.9	844	36855.0	942	31128.3	850	31440.2	1084	32234.0	847	34416.9	636	30476.3
ESPOO	3.38	67.50	528	79167.4	807	89515.1	905	75198.4	813	75978.0	1047	77962.5	810	83419.9	599	73568.3
ULVILA	5.10	102.00	536	120487.5	815	136124.1	913	114489.9	821	115668.0	1055	118666.8	818	126913.5	607	112026.6
HELSINKI	2.40	48.00	565	58161.6	844	65520.0	942	55339.2	850	55893.6	1084	57304.8	847	61185.6	636	54180.0
ESPOO	11.03	220.50	528	258613.4	807	292416.1	905	245648.0	813	248194.8	1047	254677.5	810	272504.9	599	240323.0
TOTAL	#####	**20848.05**	####	**21311069.9**	####	**16682653.9**	####	**9139806.0**	####	**10438476.0**	####	**9566250.8**	####	**13259392.8**	**14301**	##########

APPENDIX B 2
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 2: both seafreight and airfreight going through Copenhagen **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			KOLBÄCK		BILLINGSFORS		HALMSTAD		SVENLJUNGA		TRELLEBORG		TROLLHÄTTAN		LINKÖPING	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	295	1668532.3	277	1383522.8	210	690817.7	119	713467.4	351	762541.9	190	1051326.4	126	1066426.2
MOTALA	17.64	352.80	170	281164.0	277	271532.5	290	165216.2	198	169291.1	432	179663.4	234	222634.4	45	179293.0
SKÖVDE	19.32	386.40	219	327821.8	190	262095.1	225	154579.3	131	158230.8	409	187442.6	103	190688.4	174	248706.4
KOLBÄCK	2.52	50.40	0	31169.9	289	39425.4	432	31117.0	352	32334.1	602	34662.6	292	34874.3	172	32334.1
BILLINGSFORS	16.80	336.00	289	309758.4	0	160876.8	303	161935.2	257	182044.8	469	184161.6	101	165110.4	320	267775.2
HALMSTAD	16.80	336.00	432	360208.8	303	267775.2	0	55036.8	106	128772.0	169	78321.6	214	204976.8	310	264247.2
BORÅS	8.40	168.00	334	162817.2	194	114660.0	154	54684.0	47	53978.4	321	65973.6	97	81849.6	214	115189.2
SVENLJUNGA	136.92	2738.40	352	2705676.1	257	2050103.2	106	753333.8	0	744707.9	272	934479.0	144	1469288.5	218	1889085.2
NOTODDEN	4.81	96.26	419	101885.8	288	75201.4	494	65700.2	413	67923.9	605	66508.8	294	66812.0	420	86825.3
OSLO	1.68	33.60	313	31822.6	182	22508.6	388	19192.3	307	19968.5	499	19474.6	188	19580.4	314	26565.8
OSLO	0.84	16.80	313	15911.3	182	11254.3	388	9596.2	307	9984.2	499	9737.3	188	9790.2	314	13282.9
ORJE	9.00	179.93	409	188546.6	278	138670.5	484	120911.6	403	125068.0	595	122423.0	284	122989.8	410	160396.8
ESPOO	14.53	290.64	528	340877.1	807	385432.2	905	323787.5	813	327144.4	1047	335689.2	810	359187.4	599	316768.5
SAVONLINNA	6.30	126.00	888	195407.1	1167	214722.9	1265	187998.3	1173	189453.6	1407	193158.0	1170	203345.1	959	184955.4
RAUMA	1.34	26.88	473	29973.9	752	34094.6	850	28393.3	758	28703.8	992	29494.1	755	31667.3	544	27744.2
VANTAA	1.85	36.96	617	46802.4	896	52468.4	994	44629.2	902	45056.1	1136	46142.7	899	49130.9	688	43736.6
HELSINKI	2.69	53.76	565	65141.0	844	73382.4	942	61979.9	850	62600.8	1084	64181.4	847	68527.9	636	60681.6
HELSINKI	8.57	171.36	565	207636.9	844	233906.4	942	197560.9	850	199540.2	1084	204578.1	847	218432.6	636	193422.6
KEMPELE	4.96	99.12	1031	168603.1	1310	183798.2	1408	162774.9	1316	163919.7	1550	166833.8	1313	174847.7	1102	160381.1
ULVILA	5.29	105.84	536	125023.5	815	141248.8	913	118800.1	821	120022.6	1055	123134.3	818	131691.4	607	116244.1
HELSINKI	1.76	35.28	565	42748.8	844	48157.2	942	40674.3	850	41081.8	1084	42119.0	847	44971.4	636	39822.3
HELSINKI	1.93	38.64	565	46820.1	844	52743.6	942	44548.1	850	44994.3	1084	46130.4	847	49254.4	636	43614.9
TOTAL	**373.83**	**7476.67**	**9878**	**7454348.6**	**####**	**6217580.7**	**####**	**3493266.8**	**####**	**3628288.3**	**####**	**3896851.0**	**####**	**4970977.4**	**10080**	**5537498.7**

	KOLBÄCK	BILLINGSFORS	HALMSTAD	SVENLJUNGA	TRELLEBORG	TROLLHÄTTAN	LINKÖPING
INBOUND	21311069.9	16682653.9	9139806.0	10438476.0	9566250.8	13259392.8	#########
OUTBOUND	7454348.6	6217580.7	3493266.8	3628288.3	3896851.0	4970977.4	5537498.7
GRAND TOTAL	**28765418.4**	**22900234.6**	**12633072.8**	**14066764.3**	**13463101.7**	**18230370.2**	#########

APPENDIX B 2
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 2: both seafreight and airfreight going through Copenhagen **2001**

CUSTOMERS LOCATIONS	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			GÖTEBORG		MALMÖ		COPENHAGEN		JÖNKÖPING		BORÅS		ALVESTA		ANDERSTORP	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	147	84294.0	291	58779.0	311	58887.0	0	58779.0	82	73710.0	118	62181.0	81	62748.0
BORÅS	182.25	3645.00	66	1396946.3	288	1178793.0	308	1180980.0	82	1504109.3	0	1178793.0	154	1396946.3	73	1240029.0
ALVESTA	63.00	1260.00	219	685314.0	191	279153.0	211	279909.0	118	567567.0	154	611226.0	0	279153.0	84	443205.0
ANDERSTORP	110.25	2205.00	138	1011764.3	231	581127.8	251	582450.8	81	907578.0	73	882110.3	84	682998.8	0	581127.8
MALMÖ	120.75	2415.00	279	1465663.5	0	50715.0	20	52164.0	291	1526521.5	288	1511307.0	191	1019371.5	231	1222231.5
NORRKÖPING	12.75	255.00	318	165201.8	458	127984.5	478	128137.5	170	128787.8	253	150207.8	285	132804.0	247	133339.5
HELSINGBORG	13.50	270.00	223	147987.0	63	23530.5	65	18589.5	236	155074.5	232	153090.0	169	107730.0	175	120771.0
STOCKHOLM	100.50	2010.00	477	1637748.0	617	1344388.5	637	1345594.5	329	1350720.0	412	1519560.0	444	1382377.5	406	1386598.5
KUNGÄLV	304.50	6090.00	22	2052634.5	295	2014267.5	315	2017921.5	163	3030993.0	82	2493855.0	236	2858341.5	154	2589772.5
HEIMDAL	17.45	348.90	1161	534863.7	1440	534863.7	1460	535073.0	1179	545854.1	1144	531932.9	1274	544022.3	1246	548418.5
STAVANGER	2.45	49.05	784	55777.2	1063	55777.2	1083	55806.6	802	57322.3	767	55365.2	897	57064.8	869	57682.8
NITTEDAL	7.52	150.45	348	102208.2	627	102208.2	647	102298.5	366	106947.4	331	100944.4	461	106157.5	433	108053.2
SKAARER	7.94	158.70	330	104813.4	609	104813.4	629	104908.6	348	109812.5	313	103480.3	443	108979.3	415	110978.9
STABEKK	2.15	43.05	380	30692.5	659	30692.5	679	30718.3	398	32048.6	363	30330.9	493	31822.6	465	32365.0
HOLMESTRAND	1.01	20.25	361	14033.3	640	14033.3	660	14045.4	379	14671.1	344	13863.2	474	14564.8	446	14820.0
FJELLSTRAND	5.84	116.70	370	81975.9	649	81975.9	669	82045.9	388	85652.0	353	80995.6	483	85039.3	455	86509.7
FARSUND	8.21	164.25	685	169703.1	964	169703.1	984	169801.7	703	174877.0	668	168323.4	798	174014.7	770	176084.2
FJELLSTRAND	4.32	86.40	370	60691.7	649	60691.7	669	60743.5	388	63413.3	353	59965.9	483	62959.7	455	64048.3
DROBAL	7.59	151.80	314	97706.1	593	97706.1	613	97797.2	332	102487.8	297	96431.0	427	101690.8	399	103603.5
JYVSKYL	4.28	85.50	1041	120298.5	1181	107819.8	1201	107871.1	893	108089.1	976	115271.1	1008	109435.7	970	109615.3
MNTYHARJU	11.18	223.50	884	277620.5	1024	245000.7	1044	245134.8	736	245704.7	819	264478.7	851	249224.9	813	249694.2
HELSINKI	2.33	46.50	911	59078.3	1051	52291.6	1071	52319.5	763	52438.1	846	56344.1	878	53170.4	840	53268.1
VANTAA	9.68	193.50	963	256406.9	1103	228165.5	1123	228281.6	815	228775.1	898	245029.1	930	231822.7	892	232229.0
HELSINKIMEDIA	9.30	186.00	749	204674.4	889	177527.7	909	177639.3	601	178113.6	684	193737.6	716	181043.1	678	181433.7
TAMMISAARI	1.43	28.50	862	34742.9	1002	30583.4	1022	30600.5	714	30673.1	797	33067.1	829	31122.0	791	31181.9
HELSINKI	1.35	27.00	911	34303.5	1051	30362.9	1071	30379.1	763	30447.9	846	32715.9	878	30873.2	840	30929.9
ESPOO	3.38	67.50	874	83136.4	1014	73284.8	1034	73325.3	726	73497.4	809	79167.4	841	74560.5	803	74702.3
ULVILA	5.10	102.00	882	126485.1	1022	111598.2	1042	111659.4	734	111919.5	817	120487.5	849	113526.0	811	113740.2
HELSINKI	2.40	48.00	911	60984.0	1051	53978.4	1071	54007.2	763	54129.6	846	58161.6	878	54885.6	840	54986.4
ESPOO	11.03	220.50	874	271578.8	1014	239396.9	1034	239529.2	726	240091.4	809	258613.4	841	243564.3	803	244027.4
TOTAL	**1042.40**	#######	####	**11429327.5**	####	**8261213.5**	####	**8268619.3**	####	**11877095.3**	####	**11272565.3**	####	#########	####	#########

APPENDIX B 2
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 2: both seafreight and airfreight going through Copenhagen **2001**

CUSTOMERS LOCATIONS	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			GÖTEBORG		MALMÖ		COPENHAGEN		JÖNKÖPING		BORÅS		ALVESTA		ANDERSTORP	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	191	924865.2	318	637968.2	338	639046.8	43	668167.9	126	819166.3	111	607768.6	108	677605.3
MOTALA	17.64	352.80	260	207076.0	399	155214.4	419	155426.0	111	156325.7	195	186331.3	226	161882.3	189	162993.6
SKÖVDE	19.32	386.40	155	184196.9	376	160665.1	396	160897.0	84	160259.4	109	169185.2	203	167968.1	139	158230.8
KOLBÄCK	2.52	50.40	357	34715.5	569	31169.9	589	31200.1	281	31328.6	334	33974.6	396	32122.4	358	32228.3
BILLINGSFORS	16.80	336.00	163	162993.6	436	160876.8	456	161078.4	235	192628.8	194	177105.6	354	199332.0	267	182750.4
HALMSTAD	16.80	336.00	145	156643.2	136	55036.8	156	55238.4	162	166874.4	154	162993.6	116	115365.6	97	122774.4
BORÅS	8.40	168.00	66	64386.0	288	54331.2	308	54432.0	82	69325.2	0	54331.2	154	64386.0	73	57153.6
SVENLJUNGA	136.92	2738.40	100	1147252.7	239	744707.9	259	746350.9	86	1141502.0	47	1020738.6	132	986234.8	50	865471.3
NOTODDEN	4.81	96.26	396	70248.7	675	70248.7	695	70306.4	414	73281.0	379	69440.0	509	72775.6	481	73988.5
OSLO	1.68	33.60	290	20779.9	859	31011.1	879	31031.3	308	21838.3	273	20497.7	403	21661.9	375	22085.3
OSLO	0.84	16.80	290	10390.0	859	15505.6	879	15515.6	308	10919.2	273	10248.8	403	10831.0	375	11042.6
ORJE	9.00	179.93	386	129413.2	665	129413.2	685	129521.2	404	135080.9	369	127901.8	499	134136.3	471	136403.4
ESPOO	14.53	290.64	874	357966.8	1014	315547.8	1034	315722.2	726	316463.4	809	340877.1	841	321040.9	803	321651.3
SAVONLINNA	6.30	126.00	1234	202815.9	1374	184426.2	1394	184501.8	1086	184823.1	1169	195407.1	1201	186807.6	1163	187072.2
RAUMA	1.34	26.88	819	31554.4	959	27631.3	979	27647.4	671	27716.0	754	29973.9	786	28139.3	748	28195.8
VANTAA	1.85	36.96	963	48975.7	1103	43581.4	1123	43603.6	815	43697.8	898	46802.4	930	44279.9	892	44357.5
HELSINKI	2.69	53.76	911	68302.1	1051	60455.8	1071	60488.1	763	60625.2	846	65141.0	878	61471.9	840	61584.8
HELSINKI	8.57	171.36	911	217712.9	1051	192702.9	1071	192805.7	763	193242.7	846	207636.9	878	195941.6	840	196301.4
KEMPELE	4.96	99.12	1377	174431.4	1517	159964.8	1537	160024.3	1229	160277.0	1312	168603.1	1344	161838.2	1306	162046.3
ULVILA	5.29	105.84	882	131246.9	1022	115799.5	1042	115863.0	734	116132.9	817	125023.5	849	117799.9	811	118022.2
HELSINKI	1.76	35.28	911	44823.2	1051	39674.1	1071	39695.3	763	39785.3	846	42748.8	878	40340.9	840	40415.0
HELSINKI	1.93	38.64	911	49092.1	1051	43452.6	1071	43475.8	763	43574.3	846	46820.1	878	44182.9	840	44264.1
TOTAL	**373.83**	**7476.67**	**####**	**4439882.2**	**####**	**3429385.3**	**####**	**3433871.3**	**####**	**4013869.1**	**####**	**4120948.8**	**####**	**3776307.7**	**####**	**3706638.2**

	GÖTEBORG	MALMÖ	COPENHAGEN	JÖNKÖPING	BORÅS	ALVESTA	ANDERSTORP
INBOUND	11429327.5	8261213.5	8268619.3	11877095.3	11272565.3	#########	#########
OUTBOUND	4439882.2	3429385.3	3433871.3	4013869.1	4120948.8	3776307.7	3706638.2
GRAND TOTAL	**15869209.7**	**11690598.8**	**11702490.6**	**15890964.4**	**15393514.1**	#########	#########

APPENDIX B 2
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 2: both seafreight and airfreight going through Copenhagen **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			NORRKÖPING		HELSINBORG		STOCKHOLM		KUNGÄLV		NÄSSJÖ		MOTALA		SKÖVDE	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	170	122472.0	236	56889.0	329	182574.0	163	90342.0	43	72009.0	111	100170.0	84	90720.0
BORÅS	182.25	3645.00	253	2797719.8	232	1136693.3	412	4014785.3	82	1519418.3	126	1775844.0	195	2349931.5	109	1932761.3
ALVESTA	63.00	1260.00	285	1009449.0	169	309582.0	444	1430163.0	236	728973.0	111	594027.0	226	853335.0	203	792477.0
ANDERSTORP	110.25	2205.00	247	1678556.3	175	555660.0	406	2414805.8	154	1085852.3	108	1032601.5	189	1407672.0	139	1238658.8
MALMÖ	120.75	2415.00	1207	4272738.8	63	324576.0	617	3179830.5	295	1546807.5	318	1663452.0	399	2074243.5	376	1957599.0
NORRKÖPING	12.75	255.00	0	127984.5	402	125039.3	162	213932.3	334	173769.8	165	134678.3	84	134678.3	213	163059.8
HELSINGBORG	13.50	270.00	402	249480.0	0	18427.5	561	339633.0	239	157059.0	263	170383.5	343	216027.0	321	203269.5
STOCKHOLM	100.50	2010.00	162	1350720.0	561	1321173.0	0	1344388.5	494	1707394.5	324	1397151.0	243	1397151.0	341	1555438.5
KUNGÄLV	304.50	6090.00	334	5192334.0	239	1943928.0	494	7232179.5	0	2014267.5	207	3485002.5	276	4444177.5	171	3625681.5
HEIMDAL	17.45	348.90	1212	619123.1	1313	504823.4	1287	704847.8	1121	526071.4	1146	543656.0	1151	575161.7	1111	552081.9
STAVANGER	2.45	49.05	835	67622.8	936	51554.0	910	79674.4	744	54541.1	769	57013.3	774	61442.5	734	58197.8
NITTEDAL	7.52	150.45	399	138541.9	500	89254.5	474	175507.4	308	98416.9	333	105999.5	338	119585.2	298	109632.9
SKAARER	7.94	158.70	381	143139.5	482	91149.3	456	182132.1	290	100814.2	315	108812.7	320	123143.3	280	112645.3
STABEKK	2.15	43.05	431	41089.1	532	26985.9	506	51666.5	340	29607.6	365	31777.4	370	35664.8	330	32817.0
HOLMESTRAND	1.01	20.25	412	18923.6	513	12289.7	487	23899.1	321	13523.0	346	14543.6	351	16372.1	311	15032.6
FJELLSTRAND	5.84	116.70	421	110159.0	522	71928.0	496	138832.2	330	79035.1	355	84916.8	360	95454.8	320	87735.1
FARSUND	8.21	164.25	736	209369.5	837	155561.2	811	249725.7	645	165564.0	670	173842.2	675	188674.0	635	177808.8
FJELLSTRAND	4.32	86.40	421	81557.3	522	53252.6	496	102785.8	330	58514.4	355	62869.0	360	70670.9	320	64955.5
DROBAL	7.59	151.80	365	134365.8	466	84636.1	440	171663.0	274	93880.7	299	101531.4	304	115239.0	264	105197.4
JYVSKYL	4.28	85.50	726	108089.1	1125	106832.3	564	107819.8	1058	123261.1	888	110064.2	807	110064.2	905	116797.3
MNTYHARJU	11.18	223.50	569	245704.7	968	242419.3	407	245000.7	901	285364.8	731	250867.6	650	250867.6	748	268468.2
HELSINKI	2.33	46.50	596	52438.1	995	51754.5	434	52291.6	928	60689.5	758	53512.2	677	53512.2	775	57174.1
VANTAA	9.68	193.50	648	228775.1	1047	225930.6	486	228165.5	980	263111.6	810	233244.9	729	233244.9	827	248483.0
HELSINKIMEDIA	9.30	186.00	434	178113.6	833	175379.4	272	177527.7	766	211119.3	596	182410.2	515	182410.2	613	197057.7
TAMMISAARI	1.43	28.50	547	30673.1	946	30254.2	385	30583.4	879	35730.5	709	31331.5	628	31331.5	726	33575.9
HELSINKI	1.35	27.00	596	30447.9	995	30051.0	434	30362.9	928	35239.1	758	31071.6	677	31071.6	775	33197.9
ESPOO	3.38	67.50	559	73497.4	958	72505.1	397	73284.8	891	85475.3	721	75056.6	640	75056.6	738	80372.3
ULVILA	5.10	102.00	567	111919.5	966	110420.1	405	111598.2	899	130019.4	729	114275.7	648	114275.7	746	122308.2
HELSINKI	2.40	48.00	596	54129.6	995	53424.0	434	53978.4	928	62647.2	758	55238.4	677	55238.4	775	59018.4
ESPOO	11.03	220.50	559	240091.4	958	236850.1	397	239396.9	891	279219.2	721	245185.0	640	245185.0	738	262549.4
TOTAL	#####	########	####	**19719225.1**	####	**8269223.3**	####	**23583035.2**	####	#########	####	**12992368.3**	####	**15761051.6**	####	#########

APPENDIX B 2
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 2: both seafreight and airfreight going through Copenhagen **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			NORRKÖPING		HELSINBORG		STOCKHOLM		KUNGÄLV		NÄSSJÖ		MOTALA		SKÖVDE	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	165	1213649.6	263	619093.4	324	1813868.3	207	985264.6	0	637968.2	117	1011689.3	126	985264.6
MOTALA	17.64	352.80	84	208187.3	343	151139.5	243	325987.2	276	218930.0	117	168550.2	0	155214.4	131	195221.9
SKÖVDE	19.32	386.40	213	280352.5	321	156607.9	341	396794.2	171	197179.9	126	188254.1	131	223146.0	0	160665.1
KOLBÄCK	2.52	50.40	132	32281.2	513	30587.8	131	40642.6	353	35350.6	295	33498.4	170	31169.9	219	32545.8
BILLINGSFORS	16.80	336.00	329	284709.6	381	157348.8	410	369381.6	272	207093.6	277	216972.0	277	245548.8	190	206740.8
HALMSTAD	16.80	336.00	349	291765.6	81	51508.8	508	403956.0	451	270244.8	210	193334.4	290	250135.2	225	219088.8
BORÅS	8.40	168.00	253	128948.4	232	52390.8	412	185043.6	82	70030.8	126	81849.6	195	108309.6	109	89082.0
SVENLJUNGA	136.92	2738.40	257	2113360.2	184	715954.7	416	3027712.0	116	1239262.9	119	1314021.2	198	1774072.4	131	1515293.6
NOTODDEN	4.81	96.26	447	93496.4	548	61960.3	522	117148.5	356	67822.8	381	72674.5	386	81367.1	346	74999.3
OSLO	1.68	33.60	341	28894.3	442	17887.0	416	37149.8	250	19933.2	275	21626.6	280	24660.7	240	22438.1
OSLO	0.84	16.80	341	14447.2	442	8943.5	416	18574.9	250	9966.6	275	10813.3	280	12330.4	240	11219.0
ORJE	9.00	179.93	437	172865.8	538	113921.4	512	217074.1	346	124879.0	371	133947.4	376	150194.9	336	138292.7
ESPOO	14.53	290.64	559	316463.4	958	312191.0	397	315547.8	891	368037.4	721	323177.1	640	323177.1	738	346065.0
SAVONLINNA	6.30	126.00	919	184823.1	1318	182970.9	757	184426.2	1251	207181.8	1081	187733.7	1000	187733.7	1098	197656.2
RAUMA	1.34	26.88	504	27716.0	903	27320.8	342	27631.3	836	32485.8	666	28336.9	585	28336.9	683	30453.7
VANTAA	1.85	36.96	648	43697.8	1047	43154.5	486	43581.4	980	50256.4	810	44551.6	729	44551.6	827	47462.2
HELSINKI	2.69	53.76	596	60625.2	995	59834.9	434	60455.8	928	70164.9	758	61867.0	677	61867.0	775	66100.6
HELSINKI	8.57	171.36	596	193242.7	995	190723.7	434	192702.9	928	223650.5	758	197201.1	677	197201.1	775	210695.7
KEMPELE	4.96	99.12	1062	160277.0	1461	158820.0	900	159964.8	1394	177865.9	1224	162566.7	1143	162566.7	1241	170372.4
ULVILA	5.29	105.84	567	116132.9	966	114577.1	405	115799.5	899	134914.2	729	118577.8	648	118577.8	746	126912.7
HELSINKI	1.76	35.28	596	39785.3	995	39266.6	434	39674.1	928	46045.7	758	40600.2	677	40600.2	775	43378.5
HELSINKI	1.93	38.64	596	43574.3	995	43006.3	434	43452.6	928	50431.0	758	44466.9	677	44466.9	775	47509.8
TOTAL	**373.83**	**7476.67**	**9991**	**6049295.8**	**####**	**3309209.7**	**9674**	**8136569.2**	**####**	**4806992.4**	**####**	**4282589.1**	**####**	**5276917.8**	**####**	**4937458.6**

	NORRKÖPING	HELSINBORG	STOCKHOLM	KUNGÄLV	NÄSSJÖ	MOTALA	SKÖVDE
INBOUND	19719225.1	8269223.3	23583035.2	#########	12992368.3	15761051.6	#########
OUTBOUND	6049295.8	3309209.7	8136569.2	4806992.4	4282589.1	5276917.8	4937458.6
GRAND TOTAL	**25768520.9**	**11578433.0**	**31719604.5**	#########	**17274957.4**	**21037969.4**	#########

APPENDIX B 3
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 3: seafreight going through Göteborg and airfreight going through Copenhagen **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			KOLBÄCK		BILLINGSFORS		HALMSTAD		SVENLJUNGA		TRELLEBORG		TROLLHÄTTAN		LINKÖPING	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	281	122670.0	235	77859.0	162	58122.0	86	36585.0	324	117873.0	148	44595.0	131	78930.0
BORÅS	182.25	3645.00	334	2686911.8	194	1419727.5	154	1146352.5	47	591583.5	321	2375446.5	97	707859.0	214	1915994.3
ALVESTA	63.00	1260.00	396	1010835.0	354	702450.0	116	345996.0	132	316953.0	224	692811.0	267	469602.0	246	704655.0
ANDERSTORP	110.25	2205.00	358	1680981.8	267	1027860.8	97	561503.3	50	364817.3	264	1305029.3	170	597224.3	208	1145166.8
MALMÖ	120.75	2415.00	569	2376118.5	436	1554294.0	136	713874.0	239	878818.5	33	843559.5	347	1102930.5	419	1789273.5
NORRKÖPING	12.75	255.00	132	133887.8	329	135468.8	349	132408.8	257	97614.0	490	211433.3	317	108426.0	43	88255.5
HELSINGBORG	13.50	270.00	513	249777.0	381	158179.5	81	64219.5	184	82660.5	96	112171.5	291	107433.0	363	184167.0
STOCKHOLM	100.50	2010.00	131	1053240.0	410	1238763.0	508	1379262.0	416	1104997.5	650	2004271.5	413	1057260.0	202	1031230.5
KUNGÄLV	304.50	6090.00	353	4610739.0	141	2033146.5	161	1960066.5	116	1429627.5	328	4013614.5	61	952476.0	295	3719163.0
HEIMDAL	17.45	348.90	1184	568584.9	1053	450586.9	1259	514540.3	1178	470962.7	1370	611674.0	1059	420180.3	1185	539120.3
STAVANGER	2.45	49.05	807	60517.9	676	43929.2	882	52920.0	801	46793.7	993	66575.6	682	39654.5	808	56375.6
NITTEDAL	7.52	150.45	371	116749.2	240	65867.0	446	93444.5	365	74653.3	557	135329.8	246	52755.3	372	104043.7
SKAARER	7.94	158.70	353	120151.8	222	66479.4	428	95569.1	347	75747.5	539	139751.2	228	52648.7	354	106749.6
STABEKK	2.15	43.05	403	34853.3	272	20293.8	478	28184.8	397	22807.9	589	40170.0	278	16542.0	404	31217.7
HOLMESTRAND	1.01	20.25	384	15990.4	253	9141.9	459	12853.7	378	10324.5	570	18491.3	259	7377.1	385	14280.3
FJELLSTRAND	5.84	116.70	393	93255.0	262	53787.0	468	75178.1	387	60602.3	579	107667.4	268	43616.6	394	83399.7
FARSUND	8.21	164.25	708	185577.9	577	130028.5	783	160135.5	702	139620.7	894	205862.7	583	115714.1	709	171707.0
FJELLSTRAND	4.32	86.40	393	69042.2	262	39821.8	468	55658.9	387	44867.5	579	79712.6	268	32292.0	394	61745.8
DROBAL	7.59	151.80	337	112377.5	206	61038.8	412	88863.7	331	69903.9	523	131124.8	212	47809.4	338	99558.0
JYVSKYL	4.28	85.50	695	95435.1	974	103326.8	1072	109303.2	980	97636.7	1214	135889.4	977	95606.1	766	94498.9
MNTYHARJU	11.18	223.50	538	212626.7	817	233255.8	915	248878.4	823	218381.9	1057	318375.8	820	213073.7	609	210179.4
HELSINKI	2.33	46.50	565	45556.1	844	49848.0	942	53098.4	850	46753.4	1084	67557.5	847	45649.1	636	45046.9
VANTAA	9.68	193.50	617	200137.1	896	217997.1	994	231522.8	902	205119.7	1136	291691.6	899	200524.1	688	198018.2
HELSINKIMEDIA	9.30	186.00	403	150585.6	682	167753.4	780	180754.8	688	155375.1	922	238591.5	685	150957.6	474	148548.9
TAMMISAARI	1.43	28.50	516	26455.1	795	29085.7	893	31077.8	801	27189.0	1035	39939.9	798	26512.1	587	26143.1
HELSINKI	1.35	27.00	565	26451.9	844	28944.0	942	30831.3	850	27147.2	1084	39227.0	847	26505.9	636	26156.3
ESPOO	3.38	67.50	528	63507.4	807	69737.6	905	74455.9	813	65245.5	1047	95445.0	810	63642.4	599	62768.3
ULVILA	5.10	102.00	536	96823.5	815	106238.1	913	113367.9	821	99450.0	1055	145084.8	818	97027.5	607	95706.6
HELSINKI	2.40	48.00	565	47025.6	844	51456.0	942	54811.2	850	48261.6	1084	69736.8	847	47121.6	636	46500.0
ESPOO	11.03	220.50	528	207457.4	807	227809.6	905	243222.5	813	213135.3	1047	311787.0	810	207898.4	599	205043.0
TOTAL	#####	########	####	**16474322.3**	####	**10574175.2**	####	**8910477.4**	####	**7123636.0**	####	**14965895.7**	####	**7150914.2**	**14301**	##########

APPENDIX B 3
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 3: seafreight going through Göteborg and airfreight going through Copenhagen **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			KOLBÄCK		BILLINGSFORS		HALMSTAD		SVENLJUNGA		TRELLEBORG		TROLLHÄTTAN		LINKÖPING	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	295	1251489.1	277	856826.0	210	671044.1	119	427649.0	351	1228120.3	190	524629.6	126	778810.2
MOTALA	17.64	352.80	170	199314.4	277	168162.1	290	161335.4	198	113195.9	432	271038.6	234	119264.0	45	122845.0
SKÖVDE	19.32	386.40	219	238177.0	190	148879.9	225	150328.9	131	96793.2	409	287520.2	103	77473.2	174	186882.4
KOLBÄCK	2.52	50.40	0	19477.1	289	24658.2	432	30562.6	352	24320.5	602	47716.2	292	20107.1	172	24270.1
BILLINGSFORS	16.80	336.00	289	231806.4	0	62428.8	303	158239.2	257	128620.8	469	271185.6	101	66662.4	320	214015.2
HALMSTAD	16.80	336.00	432	282256.8	303	169327.2	0	51340.8	106	75348.0	169	165345.6	214	106528.8	310	210487.2
BORÅS	8.40	168.00	334	123841.2	194	65436.0	154	52836.0	47	27266.4	321	109485.6	97	32625.6	214	88309.2
SVENLJUNGA	136.92	2738.40	352	2070367.3	257	1247752.0	106	723211.4	0	309302.3	272	1643724.6	144	666937.3	218	1450941.2
NOTODDEN	4.81	96.26	419	79552.6	288	46996.1	494	64641.3	413	52617.9	605	91441.2	294	38606.7	420	71423.1
OSLO	1.68	33.60	313	24027.4	182	12663.8	388	18822.7	307	14626.1	499	28177.0	188	9735.6	314	21189.8
OSLO	0.84	16.80	313	12013.7	182	6331.9	388	9411.4	307	7313.0	499	14088.5	188	4867.8	314	10594.9
ORJE	9.00	179.93	409	146803.3	278	85951.6	484	118932.4	403	96459.4	595	169024.4	284	70270.9	410	131608.3
ESPOO	14.53	290.64	528	273448.6	807	300274.7	905	320590.5	813	280932.6	1047	410965.0	810	274029.9	599	270266.1
SAVONLINNA	6.30	126.00	888	166175.1	1167	177804.9	1265	186612.3	1173	169419.6	1407	225792.0	1170	166427.1	959	164795.4
RAUMA	1.34	26.88	473	23737.7	752	26218.8	850	28097.7	758	24429.9	992	36456.0	755	23791.5	544	23443.4
VANTAA	1.85	36.96	617	38227.7	896	41639.1	994	44222.6	902	39179.4	1136	55715.4	899	38301.6	688	37823.0
HELSINKI	2.69	53.76	565	52668.7	844	57630.7	942	61388.5	850	54053.0	1084	78105.2	847	52776.2	636	52080.0
HELSINKI	8.57	171.36	565	167881.4	844	183697.9	942	195676.0	850	172293.9	1084	248960.4	847	168224.1	636	166005.0
KEMPELE	4.96	99.12	1031	145607.3	1310	154756.1	1408	161684.5	1316	148159.6	1550	192505.9	1313	145805.5	1102	144521.9
ULVILA	5.29	105.84	536	100468.6	815	110237.7	913	117635.9	821	103194.0	1055	150546.8	818	100680.3	607	99309.7
HELSINKI	1.76	35.28	565	34563.8	844	37820.2	942	40286.2	850	35472.3	1084	51256.5	847	34634.4	636	34177.5
HELSINKI	1.93	38.64	565	37855.6	844	41422.1	942	44123.0	850	38850.6	1084	56138.1	847	37932.9	636	37432.5
TOTAL	**373.83**	**7476.67**	**9878**	**5719760.7**	**####**	**4026915.8**	**####**	**3411023.4**	**####**	**2439497.5**	**####**	**5833309.0**	**####**	**2780312.5**	**10080**	**4341231.2**

	KOLBÄCK	BILLINGSFORS	HALMSTAD	SVENLJUNGA	TRELLEBORG	TROLLHÄTTAN	LINKÖPING
INBOUND	16474322.3	10574175.2	8910477.4	7123636.0	14965895.7	7150914.2	#########
OUTBOUND	5719760.7	4026915.8	3411023.4	2439497.5	5833309.0	2780312.5	4341231.2
GRAND TOTAL	**22194082.9**	**14601091.0**	**12321500.9**	**9563133.5**	**20799204.7**	**9931226.7**	#########

APPENDIX B 3
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 3: seafreight going through Göteborg and airfreight going through Copenhagen **2001**

CUSTOMERS LOCATIONS	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			GÖTEBORG		MALMÖ		COPENHAGEN		JÖNKÖPING		BORÅS		ALVESTA		ANDERSTORP	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	147	30474.0	291	105399.0	311	112707.0	0	29259.0	82	30150.0	118	63621.0	81	42408.0
BORÅS	182.25	3645.00	66	307091.3	288	2122848.0	308	2270835.0	82	906329.3	0	296703.0	154	1426106.3	73	828144.0
ALVESTA	63.00	1260.00	219	308574.0	191	605493.0	211	656649.0	118	360927.0	154	306306.0	0	289233.0	84	300825.0
ANDERSTORP	110.25	2205.00	138	352469.3	231	1152222.8	251	1241745.8	81	545958.0	73	348500.3	84	700638.8	0	331962.8
MALMÖ	120.75	2415.00	279	743578.5	0	676200.0	20	774249.0	291	1130461.5	288	926877.0	191	1038691.5	231	949336.5
NORRKÖPING	12.75	255.00	318	88956.8	458	194029.5	478	204382.5	170	86967.8	253	88497.8	285	134844.0	247	104524.5
HELSINGBORG	13.50	270.00	223	67257.0	63	93460.5	65	99319.5	236	110794.5	232	87750.0	169	109890.0	175	90261.0
STOCKHOLM	100.50	2010.00	477	1036758.0	617	1864978.5	637	1946584.5	329	1021080.0	412	1033140.0	444	1398457.5	406	1159468.5
KUNGÄLV	304.50	6090.00	22	231724.5	295	3591577.5	315	3838831.5	163	2032233.0	82	1020075.0	236	2907061.5	154	1901602.5
HEIMDAL	17.45	348.90	1161	430542.6	1440	625228.8	1460	639394.1	1179	488634.5	1144	447499.1	1274	546813.5	1246	508992.8
STAVANGER	2.45	49.05	784	41111.3	1063	68481.2	1083	70472.6	802	49278.1	767	43495.1	897	57457.2	869	52140.2
NITTEDAL	7.52	150.45	348	57223.7	627	141174.8	647	147283.0	366	82273.6	331	64535.5	461	107361.1	433	91052.3
SKAARER	7.94	158.70	330	57362.1	609	145916.7	629	152359.9	348	83785.7	313	65074.9	443	110248.9	415	93045.8
STABEKK	2.15	43.05	380	17820.5	659	41842.4	679	43590.3	398	24988.4	363	19912.8	493	32167.0	465	27500.3
HOLMESTRAND	1.01	20.25	361	7978.5	640	19278.0	660	20100.2	379	11350.1	344	8962.7	474	14726.8	446	12531.7
FJELLSTRAND	5.84	116.70	370	47082.6	649	112201.2	669	116939.2	388	66513.2	353	52754.2	483	85972.9	455	73322.6
FARSUND	8.21	164.25	685	120592.4	964	212243.9	984	218912.4	703	147940.0	668	128574.9	798	175328.7	770	157524.0
FJELLSTRAND	4.32	86.40	370	34858.1	649	83069.3	669	86577.1	388	49243.7	353	39057.1	483	63650.9	455	54285.1
DROBAL	7.59	151.80	314	52317.9	593	137022.3	613	143185.4	332	77592.6	297	59695.4	427	102905.2	399	86450.1
JYVSKYL	4.28	85.50	1041	94734.0	1181	129964.3	1201	133435.6	893	94067.1	976	94580.1	1008	110119.7	970	99953.8
MNTYHARJU	11.18	223.50	884	210794.0	1024	302887.2	1044	311961.3	736	209050.7	819	210391.7	851	251012.9	813	224438.7
HELSINKI	2.33	46.50	911	45174.8	1051	64335.1	1071	66223.0	763	44812.1	846	45091.1	878	53542.4	840	48013.6
VANTAA	9.68	193.50	963	198550.4	1103	278282.0	1123	286138.1	815	197041.1	898	198202.1	930	233370.7	892	210363.5
HELSINKIMEDIA	9.30	186.00	749	149060.4	889	225701.7	909	233253.3	601	147609.6	684	148725.6	716	182531.1	678	160415.7
TAMMISAARI	1.43	28.50	862	26221.4	1002	37964.9	1022	39122.0	714	25999.1	797	26170.1	829	31350.0	791	27961.4
HELSINKI	1.35	27.00	911	26230.5	1051	37355.9	1071	38452.1	763	26019.9	846	26181.9	878	31089.2	840	27878.9
ESPOO	3.38	67.50	874	62953.9	1014	90767.3	1034	93507.8	726	62427.4	809	62832.4	841	75100.5	803	67074.8
ULVILA	5.10	102.00	882	95987.1	1022	138016.2	1042	142157.4	734	95191.5	817	95803.5	849	114342.0	811	102214.2
HELSINKI	2.40	48.00	911	46632.0	1051	66410.4	1071	68359.2	763	46257.6	846	46545.6	878	55269.6	840	49562.4
ESPOO	11.03	220.50	874	205649.3	1014	296506.4	1034	305458.7	726	203929.4	809	205252.4	841	245328.3	803	219110.9
TOTAL	**1042.40**	########	####	**5195760.6**	####	**13660858.4**	####	**14502186.2**	####	**8458015.1**	####	**6227337.2**	####	**10748232.0**	####	**8102365.3**

APPENDIX B 3
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 3: seafreight going through Göteborg and airfreight going through Copenhagen **2001**

CUSTOMERS LOCATIONS	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			GÖTEBORG		MALMÖ		COPENHAGEN		JÖNKÖPING		BORÅS		ALVESTA		ANDERSTORP	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	191	387382.8	318	1103546.6	338	1176529.2	43	373361.5	126	384147.1	111	622149.4	108	474476.5
MOTALA	17.64	352.80	260	101588.8	399	246589.6	419	260913.2	111	98466.5	195	100953.7	226	164704.7	189	123127.2
SKÖVDE	19.32	386.40	155	68663.3	376	260742.7	396	276430.6	84	96889.8	109	75676.4	203	171059.3	139	114567.6
KOLBÄCK	2.52	50.40	357	19645.9	569	44223.5	589	46269.7	281	23063.0	334	21777.8	396	32525.6	358	26533.1
BILLINGSFORS	16.80	336.00	163	62529.6	436	247900.8	456	261542.4	235	137524.8	194	95793.6	354	202020.0	267	144782.4
HALMSTAD	16.80	336.00	145	56179.2	136	142060.8	156	155702.4	162	111770.4	154	81681.6	116	118053.6	97	84806.4
BORÅS	8.40	168.00	66	14154.0	288	97843.2	308	104664.0	82	41773.2	0	13675.2	154	65730.0	73	38169.6
SVENLJUNGA	136.92	2738.40	100	328471.1	239	1453953.5	259	1565132.5	86	692404.4	47	358045.8	132	1008142.0	50	556032.1
NOTODDEN	4.81	96.26	396	41465.7	675	95181.0	695	99089.3	414	57493.7	379	46144.1	509	73545.7	481	63110.7
OSLO	1.68	33.60	290	10733.5	859	39713.5	879	41077.7	308	16327.9	273	12366.5	403	21930.7	375	18288.5
OSLO	0.84	16.80	290	5366.8	859	19856.8	879	20538.8	308	8164.0	273	6183.2	403	10965.4	375	9144.2
ORJE	9.00	179.93	386	75614.7	665	176014.6	685	183319.6	404	105572.8	369	84359.2	499	135575.7	471	116071.6
ESPOO	14.53	290.64	874	271065.4	1014	390823.6	1034	402623.6	726	268798.4	809	270542.2	841	323366.1	803	288809.0
SAVONLINNA	6.30	126.00	1234	165141.9	1374	217060.2	1394	222175.8	1086	164159.1	1169	164915.1	1201	187815.6	1163	172834.2
RAUMA	1.34	26.88	819	23517.3	959	34593.2	979	35684.5	671	23307.6	754	23468.9	786	28354.4	748	25158.3
VANTAA	1.85	36.96	963	37924.7	1103	53154.0	1123	54654.6	815	37636.4	898	37858.1	930	44575.6	892	40181.1
HELSINKI	2.69	53.76	911	52227.8	1051	74379.6	1071	76562.3	763	51808.5	846	52131.1	878	61902.0	840	55509.9
HELSINKI	8.57	171.36	911	166476.2	1051	237085.1	1071	244042.3	763	165139.6	846	166167.8	878	197312.5	840	176937.8
KEMPELE	4.96	99.12	1377	144794.5	1517	185636.9	1537	189661.2	1229	144021.4	1312	144616.1	1344	162631.1	1306	150845.8
ULVILA	5.29	105.84	882	99600.7	1022	143212.1	1042	147509.2	734	98775.2	817	99410.2	849	118646.6	811	106062.3
HELSINKI	1.76	35.28	911	34274.5	1051	48811.6	1071	50244.0	763	33999.3	846	34211.0	878	40623.2	840	36428.4
HELSINKI	1.93	38.64	911	37538.8	1051	53460.4	1071	55029.2	763	37237.4	846	37469.2	878	44492.0	840	39897.7
TOTAL	**373.83**	**7476.67**	**####**	**2204357.2**	**####**	**5365843.4**	**####**	**5669396.3**	**####**	**2787694.9**	**####**	**2311594.2**	**####**	**3836121.1**	**####**	**2861774.2**

	GÖTEBORG	MALMÖ	COPENHAGEN	JÖNKÖPING	BORÅS	ALVESTA	ANDERSTORP
INBOUND	5195760.6	13660858.4	14502186.2	8458015.1	6227337.2	10748232.0	8102365.3
OUTBOUND	2204357.2	5365843.4	5669396.3	2787694.9	2311594.2	3836121.1	2861774.2
GRAND TOTAL	**7400117.8**	**19026701.8**	**20171582.5**	**11245710.0**	**8538931.4**	**14584353.0**	########

APPENDIX B 3
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 3: seafreight going through Göteborg and airfreight going through Copenhagen **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			NORRKÖPING		HELSINBORG		STOCKHOLM		KUNGÄLV		NÄSSJÖ		MOTALA		SKÖVDE	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	170	93672.0	236	85329.0	329	153774.0	163	37602.0	43	45549.0	111	71550.0	84	47340.0
BORÅS	182.25	3645.00	253	2214519.8	232	1712603.3	412	3431585.3	82	451433.3	126	1240029.0	195	1770376.5	109	1054316.3
ALVESTA	63.00	1260.00	285	807849.0	169	508662.0	444	1228563.0	236	359793.0	111	408807.0	226	652995.0	203	488817.0
ANDERSTORP	110.25	2205.00	247	1325756.3	175	904050.0	406	2062005.8	154	439787.3	108	708466.5	189	1057077.0	139	707253.8
MALMÖ	120.75	2415.00	1207	3886338.8	63	706146.0	617	2793430.5	295	839212.5	318	1308447.0	399	1690258.5	376	1375584.0
NORRKÖPING	12.75	255.00	0	87184.5	402	165329.3	162	173132.3	334	99054.8	165	97193.3	84	94133.3	213	101604.8
HELSINGBORG	13.50	270.00	402	206280.0	0	61087.5	561	296433.0	239	77949.0	263	130693.5	343	173097.0	321	138199.5
STOCKHOLM	100.50	2010.00	162	1029120.0	561	1638753.0	0	1022788.5	494	1118464.5	324	1101681.0	243	1077561.0	341	1071028.5
KUNGÄLV	304.50	6090.00	334	4217934.0	239	2906148.0	494	6257779.5	0	229897.5	207	2589772.5	276	3475867.5	171	2157991.5
HEIMDAL	17.45	348.90	1212	563299.1	1313	559949.6	1287	649023.8	1121	423843.7	1146	492367.7	1151	519686.6	1111	467997.0
STAVANGER	2.45	49.05	835	59774.8	936	59303.9	910	71826.4	744	40169.5	769	49802.9	774	53643.5	734	46376.8
NITTEDAL	7.52	150.45	399	114469.9	500	113025.6	474	151435.4	308	54335.0	333	83883.4	338	95663.6	298	73374.5
SKAARER	7.94	158.70	381	117747.5	482	116223.9	456	156740.1	290	54315.1	315	85483.8	320	97910.0	280	74398.6
STABEKK	2.15	43.05	431	34201.1	532	33787.8	506	44778.5	340	16994.0	365	25449.0	370	28819.8	330	22442.0
HOLMESTRAND	1.01	20.25	412	15683.6	513	15489.2	487	20659.1	321	7589.7	346	11566.8	351	13152.4	311	10152.3
FJELLSTRAND	5.84	116.70	421	91487.0	522	90366.6	496	120160.2	330	44842.0	355	67761.9	360	76899.5	320	59610.4
FARSUND	8.21	164.25	736	183089.5	837	181512.7	811	223445.7	645	117438.8	670	149697.5	675	162558.2	635	138224.6
FJELLSTRAND	4.32	86.40	421	67733.3	522	66903.8	496	88961.8	330	33199.2	355	50168.2	360	56933.3	320	44133.1
DROBAL	7.59	151.80	365	110077.8	466	108620.5	440	147375.0	274	49403.3	299	79216.8	304	91102.8	264	68613.6
JYVSKYL	4.28	85.50	726	94409.1	1125	120341.3	564	94139.8	1058	98209.6	888	97495.7	807	96469.7	905	96191.8
MNTYHARJU	11.18	223.50	569	209944.7	968	277732.3	407	209240.7	901	219879.3	731	218013.1	650	215331.1	748	214604.7
HELSINKI	2.33	46.50	596	44998.1	995	59101.5	434	44851.6	928	47065.0	758	46676.7	677	46118.7	775	45967.6
VANTAA	9.68	193.50	648	197815.1	1047	256503.6	486	197205.5	980	206416.1	810	204800.4	729	202478.4	827	201849.5
HELSINKIMEDIA	9.30	186.00	434	148353.6	833	204767.4	272	147767.7	766	156621.3	596	155068.2	515	152836.2	613	152231.7
TAMMISAARI	1.43	28.50	547	26113.1	946	34757.2	385	26023.4	879	27380.0	709	27142.0	628	26800.0	726	26707.4
HELSINKI	1.35	27.00	596	26127.9	995	34317.0	434	26042.9	928	27328.1	758	27102.6	677	26778.6	775	26690.9
ESPOO	3.38	67.50	559	62697.4	958	83170.1	397	62484.8	891	65697.8	721	65134.1	640	64324.1	738	64104.8
ULVILA	5.10	102.00	567	95599.5	966	126536.1	405	95278.2	899	100133.4	729	99281.7	648	98057.7	746	97726.2
HELSINKI	2.40	48.00	596	46449.6	995	61008.0	434	46298.4	928	48583.2	758	48182.4	677	47606.4	775	47450.4
ESPOO	11.03	220.50	559	204811.4	958	271689.1	397	204116.9	891	214612.7	721	212771.5	640	210125.5	738	209408.9
TOTAL	#####	**20848.05**	####	**16383537.1**	####	**11563215.2**	####	**20247347.2**	####	**5707250.3**	####	**9927704.9**	####	**12446211.7**	####	**9330391.7**

APPENDIX B 3
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 3: seafreight going through Göteborg and airfreight going through Copenhagen **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			NORRKÖPING		HELSINBORG		STOCKHOLM		KUNGÄLV		NÄSSJÖ		MOTALA		SKÖVDE	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	165	926033.6	263	903114.2	324	1526252.3	207	458567.8	0	373721.0	117	725870.9	126	552043.0
MOTALA	17.64	352.80	84	151739.3	343	206881.9	243	269539.2	276	115559.6	117	116688.6	0	99119.2	131	110197.1
SKÖVDE	19.32	386.40	213	218528.5	321	217659.1	341	334970.2	171	83964.7	126	131453.3	131	161708.4	0	67542.7
KOLBÄCK	2.52	50.40	132	24217.2	513	38551.0	131	32578.6	353	20583.4	295	26089.6	170	23156.3	219	20399.4
BILLINGSFORS	16.80	336.00	329	230949.6	381	210436.8	410	315621.6	272	108645.6	277	167580.0	277	192124.8	190	125764.8
HALMSTAD	16.80	336.00	349	238005.6	81	104596.8	508	350196.0	451	171796.8	210	143942.4	290	196711.2	225	138112.8
BORÅS	8.40	168.00	253	102068.4	232	78934.8	412	158163.6	82	20806.8	126	57153.6	195	81597.6	109	48594.0
SVENLJUNGA	136.92	2738.40	257	1675216.2	184	1148621.9	416	2589568.0	116	436911.7	119	911476.4	198	1338666.8	131	855339.2
NOTODDEN	4.81	96.26	447	78094.2	548	77170.0	522	101746.2	356	39617.4	381	58523.7	386	66061.2	346	51799.7
OSLO	1.68	33.60	341	23518.3	442	23195.8	416	31773.8	250	10088.4	275	16687.4	280	19318.3	240	14340.5
OSLO	0.84	16.80	341	11759.2	442	11597.9	416	15886.9	250	5044.2	275	8343.7	280	9659.2	240	7170.2
ORJE	9.00	179.93	437	144077.3	538	142350.0	512	188285.7	346	72160.1	371	107498.0	376	121586.3	336	94930.0
ESPOO	14.53	290.64	559	269961.0	958	358112.1	397	269045.4	891	282879.9	721	280453.1	640	276965.4	738	276020.8
SAVONLINNA	6.30	126.00	919	164663.1	1318	202878.9	757	164266.2	1251	170263.8	1081	169211.7	1000	167699.7	1098	167290.2
RAUMA	1.34	26.88	504	23415.2	903	31567.9	342	23330.5	836	24610.0	666	24385.5	585	24063.0	683	23975.6
VANTAA	1.85	36.96	648	37784.2	1047	48994.2	486	37667.8	980	39427.1	810	39118.5	729	38674.9	827	38554.8
HELSINKI	2.69	53.76	596	52023.6	995	68329.0	434	51854.2	928	54413.2	758	53964.3	677	53319.2	775	53144.4
HELSINKI	8.57	171.36	596	165825.1	995	217798.6	434	165285.3	928	173442.0	758	172011.2	677	169954.8	775	169397.9
KEMPELE	4.96	99.12	1062	144417.8	1461	174480.9	900	144105.6	1394	148823.7	1224	147996.1	1143	146806.6	1241	146484.5
ULVILA	5.29	105.84	567	99198.5	966	131299.8	405	98865.1	899	103903.1	729	103019.4	648	101749.3	746	101405.3
HELSINKI	1.76	35.28	596	34140.5	995	44840.9	434	34029.3	928	35708.7	758	35414.1	677	34990.7	775	34876.0
HELSINKI	1.93	38.64	596	37391.9	995	49111.4	434	37270.2	928	39109.5	758	38786.8	677	38323.2	775	38197.6
TOTAL	**373.83**	**7476.67**	**9991**	**4853028.3**	**####**	**4490523.8**	**9674**	**6940301.7**	**####**	**2616327.5**	**####**	**3183518.3**	**####**	**4088127.0**	**####**	**3135580.6**

	NORRKÖPING	HELSINBORG	STOCKHOLM	KUNGÄLV	NÄSSJÖ	MOTALA	SKÖVDE
INBOUND	16383537.1	11563215.2	20247347.2	5707250.3	9927704.9	12446211.7	9330391.7
OUTBOUND	4853028.3	4490523.8	6940301.7	2616327.5	3183518.3	4088127.0	3135580.6
GRAND TOTAL	**21236565.3**	**16053739.0**	**27187649.0**	**8323577.8**	#########	**16534338.6**	#########

APPENDIX B 4
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 4: seafreight going through Copenhagen and airfreight going through Göteborg **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			KOLBÄCK		BILLINGSFORS		HALMSTAD		SVENLJUNGA		TRELLEBORG		TROLLHÄTTAN		LINKÖPING	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	281	162342.0	235	127962.0	162	60003.0	86	63774.0	324	73584.0	148	94698.0	131	106290.0
BORÅS	182.25	3645.00	334	3490269.8	194	2434313.3	154	1184442.8	47	1142160.8	321	1478594.3	97	1722444.8	214	2470034.3
ALVESTA	63.00	1260.00	396	1288539.0	354	1053171.0	116	359163.0	132	507276.0	224	382788.0	267	820323.0	246	896175.0
ANDERSTORP	110.25	2205.00	358	2166963.8	267	1641622.5	97	584545.5	50	697882.5	264	762489.0	170	1210986.0	208	1480326.8
MALMÖ	120.75	2415.00	569	2908384.5	436	2226509.3	136	739110.8	239	1243604.3	33	249348.8	347	1775145.8	419	2156353.5
NORRKÖPING	12.75	255.00	132	190089.8	329	206448.0	349	135073.5	257	136131.8	490	148690.5	317	179405.3	43	127015.5
HELSINGBORG	13.50	270.00	513	309285.0	381	233334.0	81	67041.0	184	123444.0	96	45738.0	291	182587.5	363	225207.0
STOCKHOLM	100.50	2010.00	131	1496244.0	410	1798246.5	508	1400266.5	416	1408608.0	650	1509711.0	413	1616743.5	202	1336750.5
KUNGÄLV	304.50	6090.00	353	5952975.0	141	3728298.0	161	2023707.0	116	2349522.0	328	2515170.0	61	2647627.5	295	4644843.0
HEIMDAL	17.45	348.90	1184	645482.4	1053	547703.2	1259	518186.3	1178	523664.0	1370	525827.2	1059	517296.6	1185	592153.1
STAVANGER	2.45	49.05	807	71328.5	676	57582.2	882	53432.6	801	54202.7	993	54506.8	682	53307.5	808	63831.2
NITTEDAL	7.52	150.45	371	149908.4	240	107744.8	446	95016.7	365	97378.8	557	98311.6	246	94633.1	372	126912.1
SKAARER	7.94	158.70	353	155129.3	222	110653.6	428	97227.6	347	99719.1	539	100703.1	228	96822.9	354	130872.0
STABEKK	2.15	43.05	403	44341.5	272	32276.7	478	28634.7	397	29310.6	589	29577.5	278	28524.9	404	37761.3
HOLMESTRAND	1.01	20.25	384	20453.5	253	14778.5	459	13065.3	378	13383.2	570	13508.8	259	13013.7	385	17358.3
FJELLSTRAND	5.84	116.70	393	118975.7	262	86270.5	468	76397.7	387	78229.8	579	78953.4	268	76100.1	394	101138.1
FARSUND	8.21	164.25	708	221778.6	577	175747.5	783	161852.0	702	164430.7	894	165449.0	583	161433.1	709	196673.0
FJELLSTRAND	4.32	86.40	393	88084.8	262	63871.2	468	56561.8	387	57918.2	579	58453.9	268	56341.4	394	74878.6
DROBAL	7.59	151.80	337	145834.3	206	103292.3	412	90450.0	331	92833.3	523	93774.5	212	90062.9	338	122631.6
JYVSKYL	4.28	85.50	695	114279.3	974	127125.7	1072	110196.7	980	110551.5	1214	114852.2	977	119405.0	766	107494.9
MNTYHARJU	11.18	223.50	538	261886.1	817	295467.0	915	251214.0	823	252141.5	1057	263383.6	820	275285.0	609	244151.4
HELSINKI	2.33	46.50	565	55804.7	844	62791.3	942	53584.3	850	53777.3	1084	56116.2	847	58592.3	636	52114.9
VANTAA	9.68	193.50	617	242784.5	896	271857.8	994	233544.8	902	234347.9	1136	244080.9	899	254384.8	688	227430.2
HELSINKIMEDIA	9.30	186.00	403	191580.0	682	219526.5	780	182698.5	688	183470.4	922	192826.2	685	202730.7	474	176820.9
TAMMISAARI	1.43	28.50	516	32736.5	795	37018.7	893	31375.7	801	31493.9	1035	32927.5	798	34445.1	587	30475.1
HELSINKI	1.35	27.00	565	32402.7	844	36459.5	942	31113.5	850	31225.5	1084	32583.6	847	34021.4	636	30260.3
ESPOO	3.38	67.50	528	78384.4	807	88526.3	905	75161.3	813	75441.4	1047	78836.6	810	82431.0	599	73028.3
ULVILA	5.10	102.00	536	119304.3	815	134629.8	913	114433.8	821	114857.1	1055	119987.7	818	125419.2	607	111210.6
HELSINKI	2.40	48.00	565	57604.8	844	64816.8	942	55312.8	850	55512.0	1084	57926.4	847	60482.4	636	53796.0
ESPOO	11.03	220.50	528	256055.6	807	289185.8	905	245526.8	813	246441.8	1047	257533.0	810	269274.6	599	238559.0
TOTAL	#####	########	####	**21069232.5**	####	**16377230.0**	####	**9128339.5**	####	**10272734.0**	####	**9836233.0**	####	**12953968.9**	**14301**	**16252546.0**

APPENDIX B 4
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 4: seafreight going through Copenhagen and airfreight going through Göteborg **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			KOLBÄCK		BILLINGSFORS		HALMSTAD		SVENLJUNGA		TRELLEBORG		TROLLHÄTTAN		LINKÖPING	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	295	1647680.2	277	1357188.0	210	689829.0	119	699176.5	351	785820.8	190	1024991.5	126	1052045.4
MOTALA	17.64	352.80	170	277071.5	277	266364.0	290	165022.2	198	166486.3	432	184232.2	234	217465.9	45	176470.6
SKÖVDE	19.32	386.40	219	323339.5	190	256434.4	225	154366.8	131	155158.9	409	192446.5	103	185027.6	174	245615.2
KOLBÄCK	2.52	50.40	0	30585.2	289	38687.0	432	31089.2	352	31933.4	602	35315.3	292	34135.9	172	31930.9
BILLINGSFORS	16.80	336.00	289	305860.8	0	155954.4	303	161750.4	257	179373.6	469	188512.8	101	160188.0	320	265087.2
HALMSTAD	16.80	336.00	432	356311.2	303	262852.8	0	54852.0	106	126100.8	169	82672.8	214	200054.4	310	261559.2
BORÅS	8.40	168.00	334	160868.4	194	112198.8	154	54591.6	47	52642.8	321	68149.2	97	79388.4	214	113845.2
SVENLJUNGA	136.92	2738.40	352	2673910.7	257	2009985.6	106	751827.7	0	722937.6	272	969941.3	144	1429171.0	218	1867178.0
NOTODDEN	4.81	96.26	419	100769.2	288	73791.2	494	65647.2	413	67158.6	605	67755.4	294	65401.8	420	86055.2
OSLO	1.68	33.60	313	31432.8	182	22016.4	388	19173.8	307	19701.4	499	19909.7	188	19088.2	314	26297.0
OSLO	0.84	16.80	313	15716.4	182	11008.2	388	9586.9	307	9850.7	499	9954.8	188	9544.1	314	13148.5
ORJE	9.00	179.93	409	186459.4	278	136034.6	484	120812.7	403	123637.5	595	124753.1	284	120353.8	410	158957.4
ESPOO	14.53	290.64	528	337505.7	807	381174.4	905	323627.6	813	324833.8	1047	339453.0	810	354929.6	599	314443.4
SAVONLINNA	6.30	126.00	888	193945.5	1167	212877.0	1265	187929.0	1173	188451.9	1407	194789.7	1170	201499.2	959	183947.4
RAUMA	1.34	26.88	473	29662.1	752	33700.8	850	28378.6	758	28490.1	992	29842.2	755	31273.5	544	27529.2
VANTAA	1.85	36.96	617	46373.7	896	51927.0	994	44608.9	902	44762.3	1136	46621.3	899	48589.5	688	43440.9
HELSINKI	2.69	53.76	565	64517.4	844	72594.8	942	61950.3	850	62173.4	1084	64877.6	847	67740.3	636	60251.5
HELSINKI	8.57	171.36	565	205649.1	844	231396.0	942	197466.7	850	198177.8	1084	206797.2	847	215922.2	636	192051.7
KEMPELE	4.96	99.12	1031	167453.3	1310	182346.1	1408	162720.3	1316	163131.7	1550	168117.4	1313	173395.6	1102	159588.2
ULVILA	5.29	105.84	536	123795.8	815	139698.2	913	118741.9	821	119181.1	1055	124504.9	818	130140.9	607	115397.4
HELSINKI	1.76	35.28	565	42339.5	844	47640.3	942	40654.9	850	40801.3	1084	42575.9	847	44454.6	636	39540.1
HELSINKI	1.93	38.64	565	46371.9	844	52177.5	942	44526.8	850	44687.2	1084	46630.8	847	48688.3	636	43305.8
TOTAL	**373.83**	**7476.67**	**9878**	**7367619.2**	**####**	**6108047.4**	**####**	**3489154.7**	**####**	**3568848.8**	**####**	**3993673.9**	**####**	**4861444.2**	**10080**	**5477685.3**

	KOLBÄCK	BILLINGSFORS	HALMSTAD	SVENLJUNGA	TRELLEBORG	TROLLHÄTTAN	LINKÖPING
INBOUND	21069232.5	16377230.0	9128339.5	10272734.0	9836233.0	12953968.9	16252546.0
OUTBOUND	7367619.2	6108047.4	3489154.7	3568848.8	3993673.9	4861444.2	5477685.3
GRAND TOTAL	**28436851.7**	**22485277.4**	**12617494.2**	**13841582.8**	**13829906.9**	**17815413.0**	**21730231.4**

APPENDIX B 4
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 4: seafreight going through Copenhagen and airfreight going through Göteborg **2001**

CUSTOMERS LOCATIONS	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			GÖTEBORG		MALMÖ		COPENHAGEN		JÖNKÖPING		BORÅS		ALVESTA		ANDERSTORP	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	147	81873.0	291	61110.0	311	61470.0	0	57303.0	82	71532.0	118	62253.0	81	61731.0
BORÅS	182.25	3645.00	66	1347921.0	288	1225995.8	308	1233285.8	82	1474220.3	0	1134688.5	154	1398404.3	73	1219434.8
ALVESTA	63.00	1260.00	219	668367.0	191	295470.0	211	297990.0	118	557235.0	154	595980.0	0	279657.0	84	436086.0
ANDERSTORP	110.25	2205.00	138	982107.0	231	609682.5	251	614092.5	81	889497.0	73	855429.8	84	683880.8	0	568669.5
MALMÖ	120.75	2415.00	279	1433181.8	0	81989.3	20	86819.3	291	1506718.5	288	1482085.5	191	1020337.5	231	1208586.8
NORRKÖPING	12.75	255.00	318	161772.0	458	131286.8	478	131796.8	170	126696.8	253	147122.3	285	132906.0	247	131898.8
HELSINGBORG	13.50	270.00	223	144355.5	63	27027.0	65	22464.0	236	152860.5	232	149823.0	169	107838.0	175	119245.5
STOCKHOLM	100.50	2010.00	477	1610713.5	617	1370418.0	637	1374438.0	329	1334238.0	412	1495239.0	444	1383181.5	406	1375242.0
KUNGÄLV	304.50	6090.00	22	1970724.0	295	2093133.0	315	2105313.0	163	2981055.0	82	2420166.0	236	2860777.5	154	2555364.0
HEIMDAL	17.45	348.90	1161	530171.0	1440	539382.0	1460	540079.8	1179	542993.1	1144	527711.3	1274	544161.9	1246	546447.2
STAVANGER	2.45	49.05	784	55117.5	1063	56412.4	1083	56510.5	802	56920.1	767	54771.7	897	57084.4	869	57405.7
NITTEDAL	7.52	150.45	348	100184.7	627	104156.5	647	104457.4	366	105713.7	331	99124.0	461	106217.7	433	107203.1
SKAARER	7.94	158.70	330	102678.9	609	106868.6	629	107186.0	348	108511.1	313	101560.1	443	109042.8	415	110082.3
STABEKK	2.15	43.05	380	30113.5	659	31250.0	679	31336.1	398	31695.6	363	29810.0	493	31839.8	465	32121.8
HOLMESTRAND	1.01	20.25	361	13760.9	640	14295.5	660	14336.0	379	14505.1	344	13618.1	474	14572.9	446	14705.6
FJELLSTRAND	5.84	116.70	370	80406.3	649	83487.2	669	83720.6	388	84695.0	353	79583.6	483	85086.0	455	85850.4
FARSUND	8.21	164.25	685	167493.9	964	171830.1	984	172158.6	703	173530.1	668	166336.0	798	174080.4	770	175156.2
FJELLSTRAND	4.32	86.40	370	59529.6	649	61810.6	669	61983.4	388	62704.8	353	58920.5	483	62994.2	455	63560.2
DROBAL	7.59	151.80	314	95664.4	593	99671.9	613	99975.5	332	101243.0	297	94594.2	427	101751.5	399	102745.8
JYVSKYL	4.28	85.50	1041	119148.5	1181	108927.0	1201	109098.0	893	107388.0	976	114236.6	1008	109469.9	970	109132.2
MNTYHARJU	11.18	223.50	884	274614.5	1024	247895.0	1044	248342.0	736	243872.0	819	261774.4	851	249314.3	813	248431.4
HELSINKI	2.33	46.50	911	58452.8	1051	52893.8	1071	52986.8	763	52056.8	846	55781.4	878	53189.0	840	53005.4
VANTAA	9.68	193.50	963	253804.3	1103	230671.4	1123	231058.4	815	227188.4	898	242687.7	930	231900.1	892	231135.8
HELSINKIMEDIA	9.30	186.00	749	202172.7	889	179936.4	909	180308.4	601	176588.4	684	191487.0	716	181117.5	678	180382.8
TAMMISAARI	1.43	28.50	862	34359.6	1002	30952.4	1022	31009.4	714	30439.4	797	32722.3	829	31133.4	791	31020.8
HELSINKI	1.35	27.00	911	33940.4	1051	30712.5	1071	30766.5	763	30226.5	846	32389.2	878	30884.0	840	30777.3
ESPOO	3.38	67.50	874	82228.5	1014	74158.9	1034	74293.9	726	72943.9	809	78350.6	841	74587.5	803	74320.9
ULVILA	5.10	102.00	882	125113.2	1022	112919.1	1042	113123.1	734	111083.1	817	119253.3	849	113566.8	811	113163.9
HELSINKI	2.40	48.00	911	60338.4	1051	54600.0	1071	54696.0	763	53736.0	846	57580.8	878	54904.8	840	54715.2
ESPOO	11.03	220.50	874	268613.1	1014	242252.3	1034	242693.3	726	238283.3	809	255945.4	841	243652.5	803	242781.5
TOTAL	######	**20848.05**	####	**11148921.3**	####	**8531195.7**	####	**8567788.8**	####	**11706141.3**	####	**11020303.9**	####	**10589786.8**	####	##########

APPENDIX B 4
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 4: seafreight going through Copenhagen and airfreight going through Göteborg **2001**

CUSTOMERS LOCATIONS	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			GÖTEBORG		MALMÖ		COPENHAGEN		JÖNKÖPING		BORÅS		ALVESTA		ANDERSTORP	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	191	900687.5	318	661247.2	338	664842.4	43	653427.6	126	797415.4	111	608487.6	108	667448.9
MOTALA	17.64	352.80	260	202330.8	399	159783.1	419	160488.7	111	153432.7	195	182062.4	226	162023.4	189	161000.3
SKÖVDE	19.32	386.40	155	178999.8	376	165669.0	396	166441.8	84	157090.9	109	164509.8	203	168122.6	139	156047.6
KOLBÄCK	2.52	50.40	357	34037.6	569	31822.6	589	31923.4	281	30915.4	334	33364.8	396	32142.6	358	31943.5
BILLINGSFORS	16.80	336.00	163	158474.4	436	165228.0	456	165900.0	235	189873.6	194	173040.0	354	199466.4	267	180852.0
HALMSTAD	16.80	336.00	145	152124.0	136	59388.0	156	60060.0	162	164119.2	154	158928.0	116	115500.0	97	120876.0
BORÅS	8.40	168.00	66	62126.4	288	56506.8	308	56842.8	82	67947.6	0	52298.4	154	64453.2	73	56204.4
SVENLJUNGA	136.92	2738.40	100	1110421.2	239	780170.2	259	785647.0	86	1119047.2	47	987604.0	132	987330.1	50	849999.4
NOTODDEN	4.81	96.26	396	68953.9	675	71495.3	695	71687.8	414	72491.6	379	68275.2	509	72814.1	481	73444.6
OSLO	1.68	33.60	290	20328.0	859	31446.2	879	31513.4	308	21562.8	273	20091.1	403	21675.4	375	21895.4
OSLO	0.84	16.80	290	10164.0	859	15723.1	879	15756.7	308	10781.4	273	10045.6	403	10837.7	375	10947.7
ORJE	9.00	179.93	386	126993.2	665	131743.3	685	132103.1	404	133605.5	369	125724.7	499	134208.3	471	135386.8
ESPOO	14.53	290.64	874	354057.6	1014	319311.6	1034	319892.9	726	314080.1	809	337360.4	841	321157.2	803	320009.2
SAVONLINNA	6.30	126.00	1234	201121.2	1374	186057.9	1394	186309.9	1086	183789.9	1169	193882.5	1201	186858.0	1163	186360.3
RAUMA	1.34	26.88	819	31192.9	959	27979.4	979	28033.2	671	27495.6	754	29648.6	786	28150.1	748	28043.9
VANTAA	1.85	36.96	963	48478.6	1103	44060.0	1123	44133.9	815	43394.7	898	46355.2	930	44294.7	892	44148.7
HELSINKI	2.69	53.76	911	67579.0	1051	61152.0	1071	61259.5	763	60184.3	846	64490.5	878	61493.4	840	61281.0
HELSINKI	8.57	171.36	911	215408.1	1051	194922.0	1071	195264.7	763	191837.5	846	205563.5	878	196010.1	840	195333.3
KEMPELE	4.96	99.12	1377	173098.2	1517	161248.4	1537	161446.7	1229	159464.3	1312	167403.8	1344	161877.8	1306	161486.3
ULVILA	5.29	105.84	882	129823.3	1022	117170.2	1042	117381.9	734	115265.1	817	123742.8	849	117842.3	811	117424.2
HELSINKI	1.76	35.28	911	44348.7	1051	40131.0	1071	40201.6	763	39496.0	846	42321.9	878	40355.0	840	40215.7
HELSINKI	1.93	38.64	911	48572.4	1051	43953.0	1071	44030.3	763	43257.5	846	46352.5	878	44198.4	840	44045.7
TOTAL	**373.83**	**7476.67**	**####**	**4339320.9**	**####**	**3526208.2**	**####**	**3541161.6**	**####**	**3952560.4**	**####**	**4030481.1**	**####**	**3779298.4**	**####**	**3664395.0**

	GÖTEBORG	MALMÖ	COPENHAGEN	JÖNKÖPING	BORÅS	ALVESTA	ANDERSTORP
INBOUND	11148921.3	8531195.7	8567788.8	11706141.3	11020303.9	10589786.8	#########
OUTBOUND	4339320.9	3526208.2	3541161.6	3952560.4	4030481.1	3779298.4	3664395.0
GRAND TOTAL	**15488242.2**	**12057404.0**	**12108950.4**	**15658701.7**	**15050785.0**	**14369085.1**	#########

APPENDIX B 4
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 4: seafreight going through Copenhagen and airfreight going through Göteborg **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			NORRKÖPING		HELSINBORG		STOCKHOLM		KUNGÄLV		NÄSSJÖ		MOTALA		SKÖVDE	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
INBOUND FLOWS																
JÖNKÖPING	9.00	180.00	170	121032.0	236	58311.0	329	181134.0	163	87705.0	43	70686.0	111	98739.0	84	88551.0
BORÅS	182.25	3645.00	253	2768559.8	232	1165488.8	412	3985625.3	82	1466019.0	126	1749053.3	195	2320953.8	109	1888839.0
ALVESTA	63.00	1260.00	285	999369.0	169	319536.0	444	1420083.0	236	710514.0	111	584766.0	226	843318.0	203	777294.0
ANDERSTORP	110.25	2205.00	247	1660916.3	175	573079.5	406	2397165.8	154	1053549.0	108	1016394.8	189	1390142.3	139	1212088.5
MALMÖ	120.75	2415.00	1207	4253418.8	63	343654.5	617	3160510.5	295	1511427.8	318	1645701.8	399	2055044.3	376	1928498.3
NORRKÖPING	12.75	255.00	0	125944.5	402	127053.8	162	211892.3	334	170034.0	165	132804.0	84	132651.0	213	159987.0
HELSINGBORG	13.50	270.00	402	247320.0	0	20560.5	561	337473.0	239	153103.5	263	168399.0	343	213880.5	321	200016.0
STOCKHOLM	100.50	2010.00	162	1334640.0	561	1337052.0	0	1328308.5	494	1677948.0	324	1382377.5	243	1381171.5	341	1531218.0
KUNGÄLV	304.50	6090.00	334	5143614.0	239	1992039.0	494	7183459.5	0	1925049.0	207	3440241.0	276	4395762.0	171	3552297.0
HEIMDAL	17.45	348.90	1212	616331.9	1313	507579.7	1287	702056.6	1121	520960.0	1146	541091.6	1151	572387.9	1111	547877.7
STAVANGER	2.45	49.05	835	67230.4	936	51941.5	910	79282.0	744	53822.6	769	56652.8	774	61052.5	734	57606.8
NITTEDAL	7.52	150.45	399	137338.3	500	90443.0	474	174303.8	308	96212.8	333	104893.7	338	118389.1	298	107820.0
SKAARER	7.94	158.70	381	141869.9	482	92403.1	456	180862.5	290	98489.2	315	107646.2	320	121881.6	280	110732.9
STABEKK	2.15	43.05	431	40744.7	532	27326.0	506	51322.1	340	28977.0	365	31460.9	370	35322.5	330	32298.3
HOLMESTRAND	1.01	20.25	412	18761.6	513	12449.7	487	23737.1	321	13226.3	346	14394.7	351	16211.1	311	14788.6
FJELLSTRAND	5.84	116.70	421	109225.4	522	72850.0	496	137898.6	330	77325.4	355	84059.0	360	94527.0	320	86328.8
FARSUND	8.21	164.25	736	208055.5	837	156858.8	811	248411.7	645	163157.7	670	172635.0	675	187368.2	635	175829.6
FJELLSTRAND	4.32	86.40	421	80866.1	522	53935.2	496	102094.6	330	57248.6	355	62233.9	360	69984.0	320	63914.4
DROBAL	7.59	151.80	365	133151.4	466	85835.3	440	170448.6	274	91656.8	299	100415.7	304	114032.2	264	103368.2
JYVSKYL	4.28	85.50	726	107405.1	1125	107507.7	564	107135.8	1058	122008.5	888	109435.7	807	109384.4	905	115767.0
MNTYHARJU	11.18	223.50	569	243916.7	968	244184.9	407	243212.7	901	282090.5	731	249224.9	650	249090.8	748	265775.0
HELSINKI	2.33	46.50	596	52066.1	995	52121.9	434	51919.6	928	60008.3	758	53170.4	677	53142.5	775	56613.8
VANTAA	9.68	193.50	648	227227.1	1047	227459.3	486	226617.5	980	260276.9	810	231822.7	729	231706.6	827	246151.4
HELSINKIMEDIA	9.30	186.00	434	176625.6	833	176848.8	272	176039.7	766	208394.4	596	181043.1	515	180931.5	613	194816.4
TAMMISAARI	1.43	28.50	547	30445.1	946	30479.3	385	30355.4	879	35312.9	709	31122.0	628	31104.9	726	33232.4
HELSINKI	1.35	27.00	596	30231.9	995	30264.3	434	30146.9	928	34843.5	758	30873.2	677	30857.0	775	32872.5
ESPOO	3.38	67.50	559	72957.4	958	73038.4	397	72744.8	891	84486.4	721	74560.5	640	74520.0	738	79558.9
ULVILA	5.10	102.00	567	111103.5	966	111225.9	405	110782.2	899	128525.1	729	113526.0	648	113464.8	746	121079.1
HELSINKI	2.40	48.00	596	53745.6	995	53803.2	434	53594.4	928	61944.0	758	54885.6	677	54856.8	775	58440.0
ESPOO	11.03	220.50	559	238327.4	958	238592.0	397	237632.9	891	275988.8	721	243564.3	640	243432.0	738	259892.3
TOTAL	#####	########	####	**19552440.7**	####	**8433922.9**	####	**23416250.8**	####	**11510305.0**	####	**12839135.1**	####	**15595309.6**	####	**14103552.8**

APPENDIX B 4
COMPARISON OF THE INTEGRATION OF TOTAL DISTANCES TRANSPORT AND RELEVANT VOLUMES

Va: airfreight Volume (CBM) **Vs: seafreight Volume (CBM)** **D: Distance (KM) from distribution center to customers' locations**

Solution 4: seafreight going through Copenhagen and airfreight going through Göteborg **2001**

CUSTOMERS' LOCATION	Va	Vs	ALTERNATIVE GATEWAYS/DISTRIBUTION CENTERS													
			NORRKÖPING		HELSINBORG		STOCKHOLM		KUNGÄLV		NÄSSJÖ		MOTALA		SKÖVDE	
			D	VD	D	VD	D	VD	D	VD	D	VD	D	VD	D	VD
OUTBOUND FLOW																
NÄSSJÖ	89.88	1797.60	165	1199268.8	263	633294.5	324	1799487.5	207	958929.7	0	624755.9	117	997398.4	126	963603.5
MOTALA	17.64	352.80	84	205364.9	343	153926.6	243	323164.8	276	213761.5	117	165957.1	0	152409.6	131	190970.6
SKÖVDE	19.32	386.40	213	277261.3	321	159660.5	341	393703.0	171	191519.2	126	185414.0	131	220074.1	0	156009.0
KOLBÄCK	2.52	50.40	132	31878.0	513	30985.9	131	40239.4	353	34612.2	295	33127.9	170	30769.2	219	31938.5
BILLINGSFORS	16.80	336.00	329	282021.6	381	160003.2	410	366693.6	272	202171.2	277	214502.4	277	242877.6	190	202692.0
HALMSTAD	16.80	336.00	349	289077.6	81	54163.2	508	401268.0	451	265322.4	210	190864.8	290	247464.0	225	215040.0
BORÅS	8.40	168.00	253	127604.4	232	53718.0	412	183699.6	82	67569.6	126	80614.8	195	106974.0	109	87057.6
SVENLJUNGA	136.92	2738.40	257	2091453.0	184	737588.0	416	3005804.8	116	1199145.4	119	1293894.0	198	1752302.2	131	1482295.9
NOTODDEN	4.81	96.26	447	92726.3	548	62720.8	522	116378.4	356	66412.5	381	71967.0	386	80601.8	346	73839.3
OSLO	1.68	33.60	341	28625.5	442	18152.4	416	36881.0	250	19441.0	275	21379.7	280	24393.6	240	22033.2
OSLO	0.84	16.80	341	14312.8	442	9076.2	416	18440.5	250	9720.5	275	10689.8	280	12196.8	240	11016.6
ORJE	9.00	179.93	437	171426.4	538	115342.8	512	215634.7	346	122243.1	371	132624.9	376	148764.5	336	136124.5
ESPOO	14.53	290.64	559	314138.2	958	314487.0	397	313222.7	891	363779.6	721	321040.9	640	320866.6	738	342562.8
SAVONLINNA	6.30	126.00	919	183815.1	1318	183966.3	757	183418.2	1251	205335.9	1081	186807.6	1000	186732.0	1098	196137.9
RAUMA	1.34	26.88	504	27500.9	903	27533.2	342	27416.3	836	32092.0	666	28139.3	585	28123.2	683	30129.8
VANTAA	1.85	36.96	648	43402.1	1047	43446.5	486	43285.7	980	49714.9	810	44279.9	729	44257.8	827	47016.8
HELSINKI	2.69	53.76	596	60195.1	995	60259.6	434	60025.7	928	69377.3	758	61471.9	677	61439.6	775	65452.8
HELSINKI	8.57	171.36	596	191871.8	995	192077.4	434	191332.0	928	221140.1	758	195941.6	677	195838.8	775	208630.8
KEMPELE	4.96	99.12	1062	159484.1	1461	159603.0	900	159171.9	1394	176413.8	1224	161838.2	1143	161778.7	1241	169178.0
ULVILA	5.29	105.84	567	115286.2	966	115413.2	405	114952.8	899	133363.7	729	117799.9	648	117736.4	746	125637.4
HELSINKI	1.76	35.28	596	39503.0	995	39545.4	434	39391.9	928	45528.8	758	40340.9	677	40319.7	775	42953.4
HELSINKI	1.93	38.64	596	43265.2	995	43311.6	434	43143.5	928	49864.9	758	44182.9	677	44159.7	775	47044.2
TOTAL	**373.83**	**7476.67**	**9991**	**5989482.4**	**####**	**3368275.4**	**9674**	**8076755.9**	**####**	**4697459.2**	**####**	**4227635.6**	**####**	**5217478.3**	**####**	**4847364.7**

	NORRKÖPING	HELSINBORG	STOCKHOLM	KUNGÄLV	NÄSSJÖ	MOTALA	SKÖVDE
INBOUND	19552440.7	8433922.9	23416250.8	11510305.0	12839135.1	15595309.6	14103552.8
OUTBOUND	5989482.4	3368275.4	8076755.9	4697459.2	4227635.6	5217478.3	4847364.7
GRAND TOTAL	**25541923.1**	**11802198.3**	**31493006.7**	**16207764.2**	**17066770.6**	**20812787.9**	**18950917.4**

APPENDIX C

SUMMARY OF THE COMPARISON

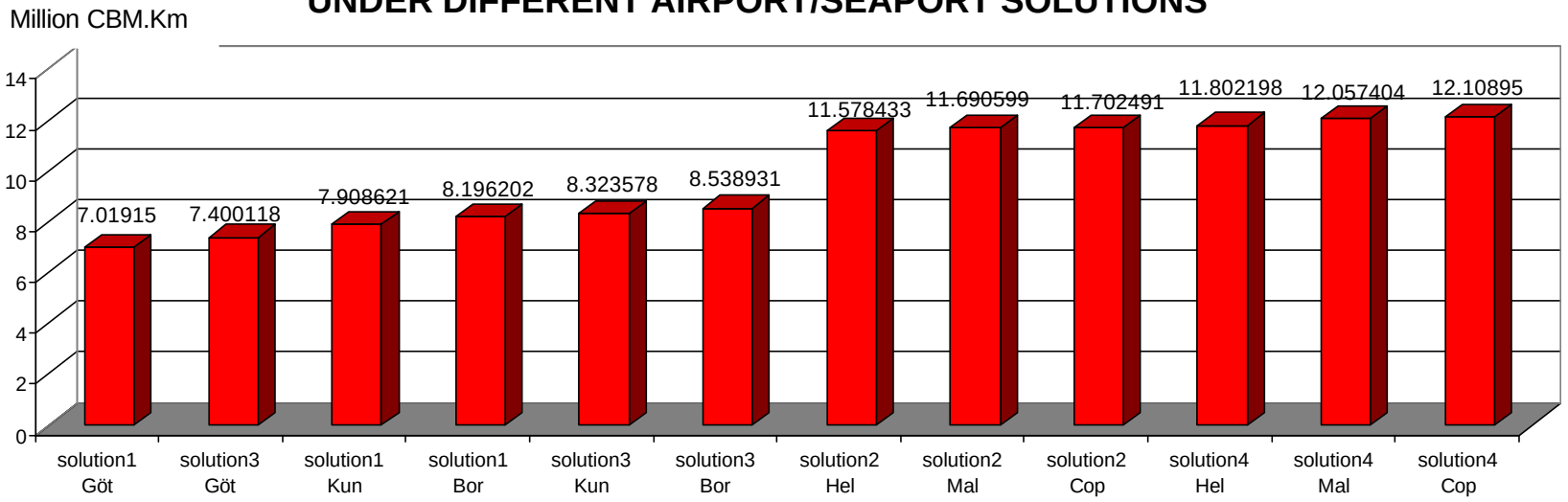
SOLUTIONS			ALTERNATIVE GATEWAYS						
No.	SEAPORT	AIRPORT	NORRKÖPING	HELSINBORG	STOCKHOLM	KUNGÄLV	NÄSSJÖ	MOTALA	SKÖVDE
1	GÖTEBORG	GÖTEBORG	**18** 21,009,968	**13** 16,277,504	**21** 26,961,051	**2** 7,908,621	**10** 12,903,037	**14** 16,309,157	**8** 12,124,659
2	COPEN-HAGEN	COPEN-HAGEN	**19** 25,768,521	**1** 11,578,433	**21** 31,719,604	**12** 16,622,721	**13** 17,274,957	**16** 21,037,969	**15** 19,292,230
3	GÖTEBORG	COPEN-HAGEN	**19** 21,236,565	**13** 16,053,739	**21** 27,187,649	**2** 8,323,578	**10** 13,111,223	**14** 16,534,339	**9** 12,465,972
4	COPEN-HAGEN	GÖTEBORG	**19** 25,541,923	**1** 11,802,198	**21** 31,493,007	**12** 16,207,764	**13** 17,066,771	**16** 20,812,788	**15** 18,950,917
No.	SEAPORT	AIRPORT	KOLBÄCK	BILLINGSFORS	HALMSTAD	SVENLJUNGA	TRELLEBORG	TROLLHÄTTAN	LINKÖPING
1	GÖTEBORG	GÖTEBORG	**20** 21,865,516	**11** 14,186,134	**9** 12,305,922	**4** 9,337,952	**19** 21,166,010	**5** 9,516,269	**15** 17,198,276
2	COPEN-HAGEN	COPEN-HAGEN	**20** 28,765,418	**18** 22,900,235	**4** 12,633,073	**6** 14,066,764	**5** 13,463,102	**14** 18,230,370	**17** 21,956,829
3	GÖTEBORG	COPEN-HAGEN	**20** 22,194,083	**12** 14,601,091	**8** 12,321,501	**4** 9,563,134	**18** 20,799,205	**5** 9,931,227	**15** 17,424,874
4	COPEN-HAGEN	GÖTEBORG	**20** 28,436,852	**18** 22,485,277	**4** 12,617,494	**6** 13,841,583	**5** 13,829,907	**14** 17,815,413	**17** 21,730,231
No.	SEAPORT	AIRPORT	GÖTEBORG	MALMÖ	COPENHAGEN	JÖNKÖPING	BORÅS	ALVESTA	ANDERSTORP
1	GÖTEBORG	GÖTEBORG	**1** 7,019,150	**16** 19,393,507	**17** 20,578,042	**7** 11,013,447	**3** 8,196,202	**12** 14,595,683	**6** 10,804,105
2	COPEN-HAGEN	COPEN-HAGEN	**10** 15,869,210	**2** 11,690,599	**3** 11,702,491	**11** 15,890,964	**9** 15,393,514	**8** 14,357,755	**7** 14,164,833
3	GÖTEBORG	COPEN-HAGEN	**1** 7,400,118	**16** 19,026,702	**17** 20,171,583	**7** 11,245,710	**3** 8,538,931	**11** 14,584,353	**6** 10,964,140
4	COPEN-HAGEN	GÖTEBORG	**10** 15,488,242	**2** 12,057,404	**3** 12,108,950	**11** 15,658,702	**9** 15,050,785	**8** 14,369,085	**7** 14,004,798

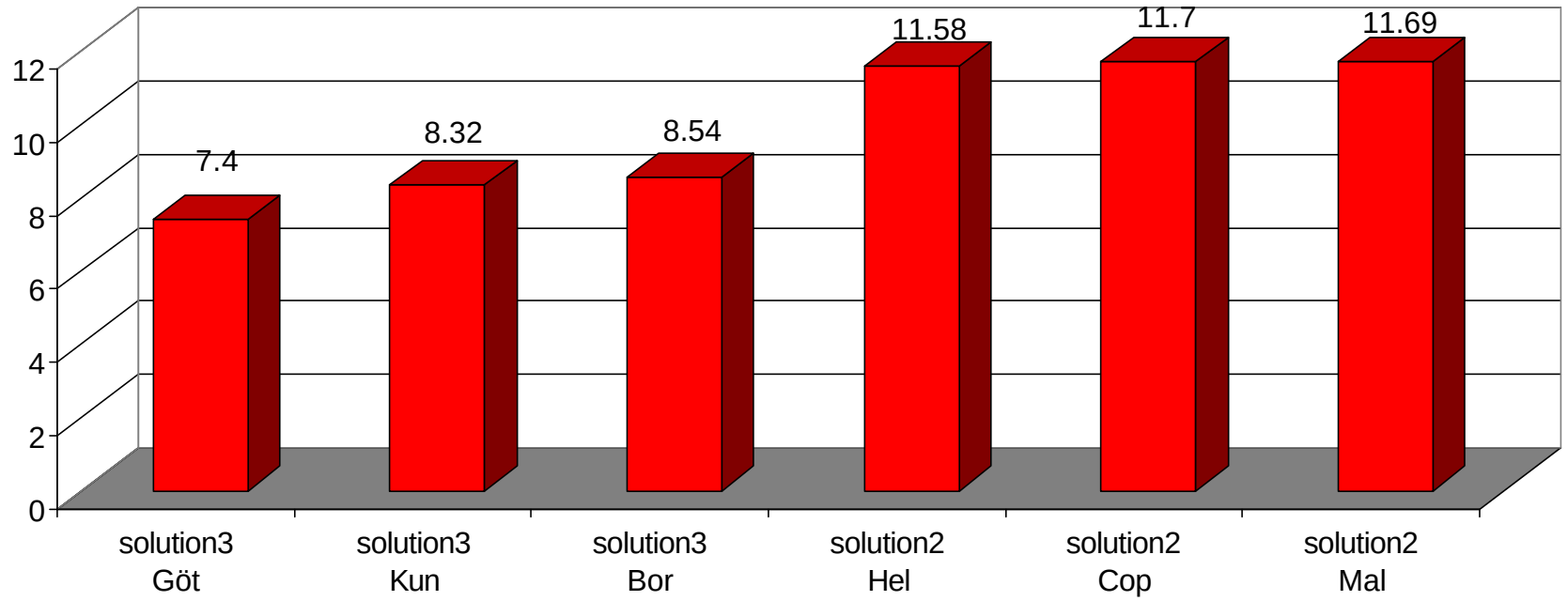
APPENDIX D

RANKING LIST OF ALTERNATIVE GATEWAYS

SOLUTIONS			ALTERNATIVE GATEWAYS		
No.	SEAPORT	AIRPORT	1	2	3
1	GÖTEBORG	GÖTEBORG	GÖTEBORG	KUNGÄLV	BORÅS
2	COPEN-HAGEN	COPEN-HAGEN	HELSINGBORG	MALMÖ	COPENHAGEN
3	GÖTEBORG	COPEN-HAGEN	GÖTEBORG	KUNGÄLV	BORÅS
4	COPEN-HAGEN	GÖTEBORG	HELSINGBORG	MALMÖ	COPENHAGEN

DISTRIBUTION OF BEST ALTERNATIVE GATEWAYS
UNDER DIFFERENT AIRPORT/SEAPORT SOLUTIONS

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