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Optimisation of European Hub-structure

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Annika Svensson & Caroline Wikefeldt

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Executive Summary

In 1999, Company X established a European distribution network for their first product line. The distribution network consists of A hubs which are managed by B different logistics providers. Over time, the annual volume of C elevators has organically grown to encompass three product lines with in excess of C elevators per annum. Despite outsourcing, benchmarking and re-bidding of the network, over the intervening period, Company X believes that further efficiencies could be achieved were the network to be reconfigured considering current and future needs, such as the expanded geographic coverage of Company X's European organisation. Company X's growing markets in the Eastern Europe has led to a need for a more flexible hub-structure. Additionally, Company X faces further challenges from the transportation market including an increased cost picture owing to higher fuel prices, expanded road tax system, more restricted working time directives, and higher driver salaries.

Given these circumstances, Company X commissioned a detailed investigation of today's network and which potential improvements that can be obtained by optimising the hub-structure. Therefore, the purpose of the master thesis is to propose a new optimised European hub-structure through the analysis of the present/future inbound and outbound flows, present/future supplier and customer bases, and likely developments within the European transportation market over the next five year period. The target of the thesis is to achieve a cost reduction of Z percent of total logistics costs with the new optimised hub-structure.

The methodology utilised throughout the thesis constitutes three phases; data collection, analysis, and evaluation of alternative distribution networks. The transaction and pricing data used in the calculations is based on calendar year 2007, has been applied in the mapping of the present situation. Through the analysis of today's network, it is concluded that the costs for the outbound transports are more than twice that of the inbound transports. Therefore, the optimal approach found was to reduce the distance between hubs and Company X's customers by optimising the distances of the outbound transports.

To ensure a future proof proposal, the thesis considers varying levels of European market growth and increased transportation costs. These were analysed and ultimately summarised into four different future scenarios in a scenario cross. Each scenario has been tested in a sensitivity analysis to investigate how the new hub-structure reacts to the uncertainties given in the cross. In order to evaluate the profitability of the new hub-structure, the total truck kilometres and the total costs have been compared with the existing network.

As a result of the evaluation the recommendations are following changes; AA**.** This would mathematically lead to a total reduction of Y million truck kilometres which equates to approximately cost savings of €X million (Z percent of present hub-network).

The sensitivity of the proposed hub structure can therefore be classed as minimal as all scenarios indicate comparable beneficial results. Depending of which scenario occurs in the next five years, the new hub-structure shows a reduction of truck kilometres between Y – Y million truck kilometres which leads to savings of €X – €X million annually (Z – Z percent of present hub-network in five years time).

In addition, further potential improvements have also been identified, such as milk-runs on inbound transports, pre-consolidation, commissioning at hub, further packing efficiency, better handling of return flows, and claim reduction actions. Potential improvements from

these areas are estimated to lead to 5 – 10 percent in cost savings. Moreover, Company X should expect to report reduced CO_2-emissions.

The proposed new hub-structure creates a good opportunity for Company X to work more progressively towards a full supply chain management solution. With this in place, Company X would also be able to experience ongoing improvements leading to transparent profit share instead of the current focus on trying to reduce cost increases. Clearly, such a fundamental change of the distribution network is a major project and needs to be carefully investigated. This thesis should therefore be seen as the first step in the process of fully optimising the wider European logistics network.

The thesis goal was to achieve a cost reduction of Z – Z percent, irrespective of which of the scenarios that will occur. Company X could reasonably expect a total cost saving, comparing with keeping the current structure, in the region of Z – Z percent of the total logistics cost, if they choose to implement this project.

Sammanfattning

Företag Xs Europeiska distributionsnätverk för hissar etablerades år 1999 för en produktlinje med den ursprungliga årliga volymen på C enheter. Idag består nätverket av A hubbar som drivs av B logistikpartners. Sedan 1999 har den årliga volymen ökat till att omfatta tre produktlinjer och cirka C hissar. Denna expandering samt en ökad prisbild gör att företag X bedömer att det finns stora besparingar att göra, både effektivitets- och kostandsmässigt vid ett förbättrande av nätverket. Målet är att strukturen ska kunna motstå framtida förändringar så som tillväxt och ökande priser. Företag X har en allt större tillväxt i östra Europa vilket leder till krav för en flexibel hub-struktur. Dessutom väntas transportpriserna inklusive bränslekostnader, vägskatter och striktare arbetstidsdirektiv att öka.

Med anledning av dessa omständigheter har företag X tillsatt en detaljerad undersökning av dagens nätverk och vilka potentiella förbättringar som kan fås genom en optimering av hub-strukturen. Syftet med det här examensarbetet att föreslå en ny optimerad hub-struktur för den Europeiska hissmarknaden genom att analysera dagens och framtida transportflöden, hur kund- och leverantörsmarknaderna förändras samt utvecklingen inom den Europeiska transportmarknaden. Målet med examensarbetet är att genom en ny optimerad hub-struktur uppnå en besparing på Z – Z procent av den totala logistikkostnaden.

Metodiken som använts genom arbetet består av tre faser; datainsamling, analys och utvärdering. All data angående prissättning och kartläggning av transporter är baserade på försäljningssiffror från år 2007. Genom analysen framgick det att kostnaderna för transporterna från hub till kund var mer än fördubblade mot transporterna från leverantör till hub på grund av betydligt sämre fyllnadsgrad av lastbilarna. Att minimera avståndet mellan hub och marknad ansågs därför vara ett naturligt steg för att minska de totala kostnaderna.

För att försäkra sig om att den föreslagna strukturen kan motstå framtida påfrestningar tar examensarbetet hänsyn till en varierande marknadstillväxt samt ökad prisbild för transporter. Dessa osäkerheter har analyserats och sammanfattats i fyra olika scenarion. De olika scenarierna har använts i en känslighetsanalys för att undersöka om den nya hub-strukturen är känslig mot dessa förändringar. För att utvärdera lönsamheten med den nya hub-strukturen har det totala antalet körda km samt kostnaden jämförts mellan det nuvarande och det nya nätverket, både i nuläget och för de fyra scenarierna.

Efter distansoptimeringen är rekommendationen att utöka dagens nätverk med AA**.** Detta skulle leda till en besparing av Y miljoner körda km samt en kostnadsbesparing på X miljoner euro (Z procent av dagens hub-struktur).

Resultatet av känslighetsanalysen visar att den nya strukturen inte är känslig för de parametrar som testats. För samtliga scenarion kommer kostnaderna att öka men genom införandet av förslaget blir den årliga besparingen oavsett scenario mellan Y – Y miljoner körda km vilket är årliga kostnadsbesparingar mellan X – X miljoner euro (Z – Z procent av dagens hub-struktur om fem år).

Ytterligare potentiella besparingsområden som har identifierats gäller de transporter som går mellan leverantör och hub. Där skulle det bland annat vara möjligt att utföra mjölkrundor eller förkonsolidering speciellt för de leverantörer som befinner sig i områdena runt A och B där avstånden dem emellan är mindre. För att ytterligare öka fyllnadsgraden i lastbilarna skulle förpackningarna kunna förbättras. Dessa förslag ger uppskattningsvis ytterligare besparingar

på Z – Z procent. Vidare kan företag X förvänta sig en minskning av koldioxidutsläppen genom sänkningen av körda km.

Den föreslagna hub-strukturen ger företag X en god möjlighet att arbeta progressivt med hela försörjningskedjan. Detta skulle leda till mer fokus på den gemensamma vinsten istället för att till varje pris nå kostnadsreduceringar.

Att ändra hub-strukturen är ett stort projekt som behöver övervägas noggrant. Detta examensarbete är ett första steg mot att optimera företag Xs Europeiska logistiknätverk vilket även inkluderar rulltrappor samt reservdelar. Målet med examensarbetet var att uppnå besparingar mellan Z – Z procent oavsett vad vilka utmaningar framtiden ger. Resultatet av examensarbetet och vad företag X kan vänta sig ifall de implementera förslaget är en årlig besparing mellan Z – Z procent.

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1. Introduction

This chapter aims to give an introduction to why the thesis is written and what the thesis includes. First, a short description of the background to the thesis problem is presented followed by the thesis purpose and problem analysis. Thereafter, the goals and limitations are outlined.

1.1 Background

The Company X Group is a supplier of escalators and a manufacturer of elevators[1]. The company employs over X people and its operations span worldwide. Company X installs and modernises transport systems for mostly every building type.

Company X's present European logistics network for elevators was deployed in 1999 to serve a single product line but the network today is handling three product lines across an ever expanding geography in greater and greater volumes. Despite such growth the network has not fundamentally changed since 1999. At present, the network is operated by B logistics providers whose main focus is transportation and warehousing services.

In the current economic climate, Company X is due to increases in fuel price, road taxes, working hour directives etc facing ever escalating costs for their transportations. The system has not been adapted to meet these challenges nor the move towards new markets. The haphazard development of the network and focus on an on-time delivery has resulted in poor loading ratios and therefore further cost pressures. To date, Company X's focus has been aimed primarily at controlling prices from its suppliers rather than fundamentally addressing underlying cost factors and efficiencies.

Over the past three years Company X´s business in Europe has been subject to steady, year after year, growth. Their expectation is further growth over the next couple of years. This growth will be even more dramatic in A. Realising their current distribution solution is less than optimal, and in an attempt to both mitigate escalating costs and improve the situation, Company X has commissioned an in-depth analysis of the present situation, a review of the European transportation market development, and a proposal of how to adapt its less than efficient hub-structure with a view to future secure its European logistics operations.

Already identified by Company X as a prerequisite is the need to ensure flexibility within the future hub-structure used by the logistics providers. The new hub-structure must be able to withstand future changes, at least over the next five years. Whilst today's supply chain is fully implemented in Company X's day-to-day habits, it is harder and harder to reap any further efficiency gains without fundamentally change the overall structures. Given the inefficiencies they are already aware of, they therefore feel the need for a more radical change which should allow access to further efficiencies currently inaccessible with today's network.

[1] Appendix A: Description of Elevator

1.2 Purpose

The purpose of the master thesis is to propose a new optimised European hub-structure for the elevator business of Company X through analysing the present and future;

- inbound and outbound flows,
- supplier and customer base,

and the future developments within the European transportation market.

1.3 Problem Analysis

Company X has today a sub-optimal logistic system due to the great expansion of both product lines and the amount of delivered goods. The system was originally designed to handle C units per year. However, the amount has grown to approximately C units per year. These insufficiencies along with issues such as the European market tends to turn more A oriented, increased road taxes and raised oil prices make out the problem basis for this thesis.

Company X does not consider the current system to be designed to support an end-to-end supply chain, nor does it fulfil the needs for a growing A market. The situation for the logistic providers is changing with road tax systems and more restricted working time directive for the drivers along with increasing freight capacity demand. These issues may lead to capacity shortages, raised costs and further reduction in service levels. Other risks which must be considered are general inflation, oil cost increases, increased price picture on raw materials and inventories. Altogether this will have an impact on the transportation costs for the large logistic companies as well as the market development for the suppliers and end-customers of Company X. Other identified logistic weaknesses within the elevator distribution are poor A factors and inefficient B which has lead to damaged C. In order to decrease such costs, the wish from Company X is to optimise the number of handlings steps.

1.4 Goal

The goal of the thesis is to define the optimal number and locations of the hubs from the perspectives of distance and cost optimisation. Additionally, consideration must be given to present and future supplier and customer bases. Company X's internal goal is to reach an Z – Z percent cost reduction within the new logistic system. Therefore, due to the thesis's limitations, the goal for the thesis is to achieve a reduction of Z – Z percent in total logistic costs for the new hub-structure.

The new hub-structure has to fulfil certain requirements. It has to be able to operate in a long-term environment but should also support and function in the short-term. With long-term perspective means approximate five years. The new proposed hub-structure must also allow levels of flexibility within the network. The inbound and outbound transportations are not permanent and future A supplier and customers are to be explored. Additionally, considerations must be taken to a potential global sourcing as well as dealing with an expansion of the product lines. Future risks such as oil price increases and new EU directive which could lead to an increased cost pressure will be taken into consideration in the thesis analysis.

1.5 Limitations

The thesis will only include analysis of the logistics flows of elevators. Hence, the distribution system of Company X's escalator area will not be covered in this thesis. Company X has three

different product lines of elevators which are called *A*, *B* and *C,* and these product lines will be studied. Owing to the fundamental delivery requirements, no consideration will be taken to the distribution of spare parts (*D)*. However, D will be included in the warehousing analysis since Company X is not ready to totally exclude them from the distribution network. Only the flow from supplier to site will be analysed. Therefore, the costs related to production at Company X´s internal plants or suppliers´ will not be considered.

The European market will be in focus for the thesis analysis. However, the new hub-structure should be able to transport to further global markets such as Russia and Asia. The thesis will only provide one proposal of a new hub-structure.

Regarding the design of the hubs internally, no consideration will be taken to this as well as how the packaging and handling processes of the goods and damaged goods are managed. Therefore, the thesis will not propose how a reduction of claims could be done.

1.6 Definitions

Cabotage*:* Foreign carriers performing domestic transports.

Euro 5 Standard: All vehicles equipped with a diesel engine will be required to substantially reduce their emissions of nitrogen oxides. The Euro 5 Standard will come into force on September, 1st 2009 for the approval of vehicles, and from January, 1st 2011 for the registration and sale of new types of cars.

Expanded zone Europe**:** Company X's definition of the whole of Europe excluding Turkey.

Inbound transports: Transports from supplier to hub.

LSP: Logistics providers.

Outbound transports: Transports from hub to site.

Postponement: A business strategy that maximizes possible benefit and minimizes risk by delaying further investment into a product or service until the last possible moment.

Primary data**:** Data gathered from the sole purpose only.

Quantitative data**:** Data which is represented out of numbers.

Qualitative data**:** Data which is represented in words or figures.

Supply chain**:** The system of organisations, people, technology, activities, information and resources involved in moving a product or service from raw material source to the final consumer.

Threshold level: The intensity level that is just barely perceptible.

2. Methodology

This chapter aims to describe the methodology that has been used throughout the master thesis. Firstly, the outline of the methodology will be presented and thereafter will each of the three phases of the work procedure be clarified and described. Lastly, a short discussion will be held regarding source criticism and the selected methodology.

The methodology used in the thesis is structured in a chronological way and the diagram below illustrates the work procedure for the thesis (*Figure 1*). The work procedure has followed and gone through three different phases; *Collection*, *Analysis*, and *Evaluation*. Each phase consist of the different work tasks which will be described in detail in the sections below.

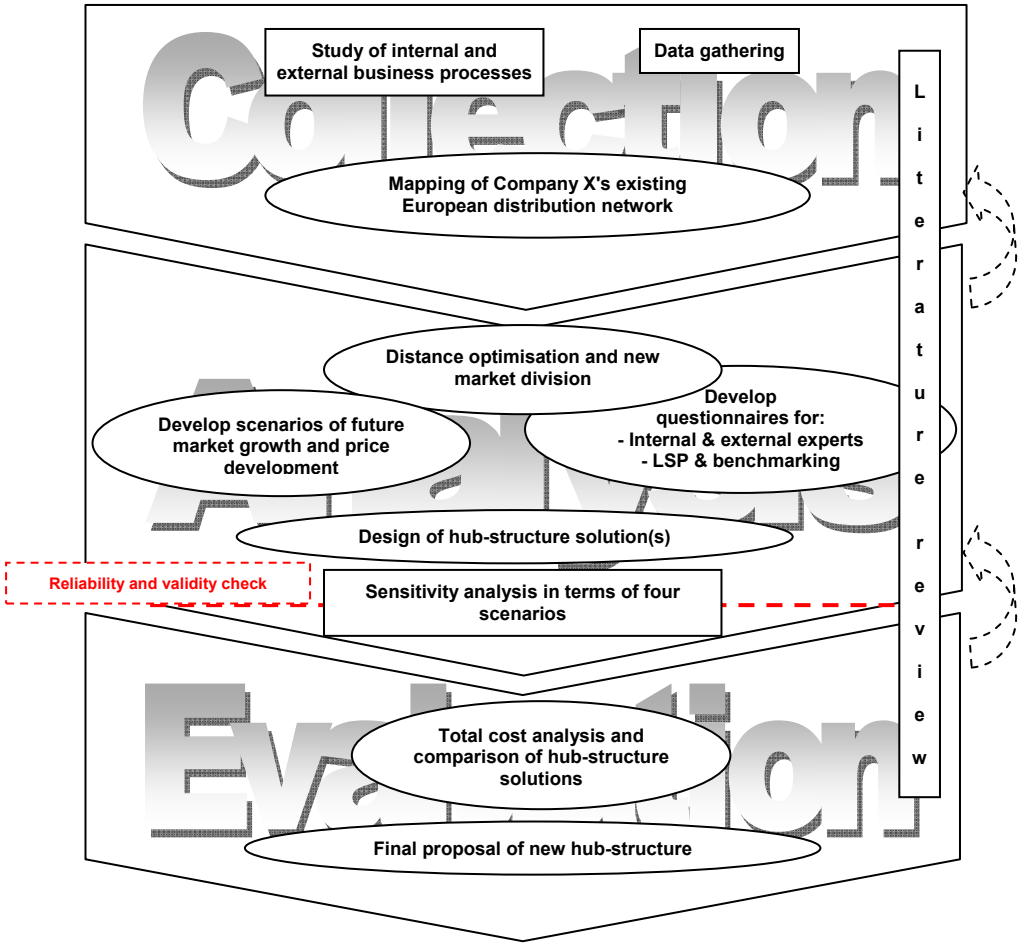

Figure 1: Illustrates the methodology's outline of the thesis.

2.1 Collection Phase

In order to develop a hub-structure solution which is suitable for Company X, the first studies have been to carefully study the internal and external business environment. Through the study, a good understanding has been received for the elevator business and its complex processes. In this phase, all the necessary data was collected and reformed to fit in the working files of *Microsoft Excel*. The numerical data has been provided by X and is based on the full calendar year of 2007. Furthermore, the majority of the data has been collected for the

purpose of this thesis only and should therefore be considered as a *primary data* source. Regarding the nature of the data, the clear majority is from *quantitative data* whereas the information about the business processes has mainly been supported by *qualitative data*.

Based on the collected information, mappings of Company X's existing distribution network were performed. The mappings which have been done are three separate; a mapping of the flows between supplier to hubs (inbound flows), a mapping of the flows between hubs to sites (outbound flows), and a mapping of the market volume[2]. When the identification base on the mappings had been done, the analysis phase took over.

2.2 Analysis Phase

The analysis phase was the largest and most time consuming phase. This phase has involved several different work tasks. The first to be performed were the distance calculations[3]. These calculations together with the mapping of the market volumes have constituted the foundation of the realigned market division for Europe. In parallel with the work of distance optimisation and new market coverage, individual questionnaires have been developed for internal and external experts as well as logistics providers. The questionnaires were performed via the on-line based survey tool; *SurveyMonkey*[4]. The aim of the questionnaires was to get a picture of what the general views are regarding the future development of the transportation market in Europe as well as knowledge about the future expected market growth for Company X. Additionally, a fourth questionnaire was also developed for the use of benchmarking and here the main purpose was to receive information of best practice in designing distribution network. The internal questionnaire was sent out to internal employees with specific knowledge of the product lines and its markets. The questionnaire for the external experts was sent to high qualified people with knowledge in distribution and supply chain management. Moreover, well-known logistics providers and some companies with comparable distribution strategies to Company X's received questionnaires[5].

After performing the distance calculations, the realigned market coverage, and the country location analysis, it was time to conclude potential locations for new hubs. Two proposals of a new hub-structure were designed. In order to later evaluate the two proposals against each other as well as against the present network, the total amount of truck kilometres was calculated. The truck kilometres calculations have been done for each new hub location and also for the present ones. The calculations are based on the information of number of trucks and the kilometre distances[6]. It is from the truck kilometres of the total inbound and outbound the costs for each are calculated.

Based on the outcomes from the questionnaires, four different scenarios have been developed. The four scenarios cover different expectations of how much the transportations cost will increase and also how much the markets in Western and Eastern Europe will grow within a five year basis. The scenarios were, in order to examine how the new hub-structures react to different changes in the surrounding environment compared to the present network, later used in a sensitivity analysis. The sensitivity analysis had the meaning of secure the new hubs-structures' reliability and validity performance against the reality.

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[2] Chapter of Analysis: Analysis of Current Situation
[3] Chapter of Analysis: Distance Optimisation
[4] SurveyMonkey Home Page
[5] Appendix I; J: Questionnaires
[6] Chapter of Total Cost Analysis

2.3 Evaluation Phase

In the evaluation phase, the two hub-structures' proposals have been compared from the perspectives of total truck kilometres and total cost leadership. For each hub the truck kilometres and the costs were calculated and later summarised into the two proposals of new hubs. These two proposals have been compared and evaluated versus the present distribution network. Thereafter, the final proposal of a new optimised European hub-structure was presented based on the outcome from the evaluation process.

2.4 Source Criticism

Throughout the work process large amount of literature has been reviewed and critically evaluated. The literature was mainly used to provide knowledge about the several different strategies within distribution, transportation and supply chain management. The different sources of literature have also worked as a reliability and validity check against each other. During the phases of analysis and evaluation, literatures have been used to support the findings and conclusions. The theory has provided information of how to tackle the designing task of a new distribution network. The nature of the literature has mainly constituted of books and electronic articles.

One source which needs to be highlighted is the questionnaires. They have been used to collect information both regarding Company X internally and the general development of the transportation market. The questions were designed in an early stage which made it difficult to know exactly what type of information that was needed. Furthermore, there is always a risk of failure when designing questionnaires. The questions can be misleading or wrongly understandable. Additionally, it can be complicated to get respondents. In the four different questionnaires all together twenty-one respondents were collected. In the *External Experts*; three participants, *Internal Experts*; ten participants, *Benchmarking*; four participants, and *Logistics providers*; four participants[7]. Obviously, it was easier to receive participants for the internal questionnaire than for the external one. The internal employees had more to gain from completing the form compared to the external experts who rather performed it beased on kindness.

2.5 Discussion of Selected Methodology

The methodology was developed to suite the natural work flow in solving the problem of the thesis. Throughout the work procedure, the methodology has occasionally been modified and updated. The base of the methodology is the three different working phases. When a phase was completed, in order to avoid that changes were done in an already completed phase, the attempt was to make the transition to the new phase as clear as possible. Of course, there have been exceptions however by enlighten the different phases throughout the work procedure this goal has been easier to achieve. For instance, the used data had to be modified although the mapping of the existing distributions network had already begun. These two work tasks belong to the same phase, however, the example illustrate the main thought behind the importance of highlighting when work tasks enter a new phase.

An advantage of the methodology is that it is entirely developed after the design process of a distribution network. Designing a new distribution network can be done in several different ways but a common approach is to first map out the different transportation flows in the current situation. Then whether the approach is to optimise the distances, number of trucks or goods being transported there is no right or wrong way to follow. The available information has to be the deciding factor. Furthermore, the methodology has been adapted to suit the

[7] Appendix H: List of Participants

required time for each work tasks. Not covered in the methodology is when the documentation has been made. The documentation of each work tasks has more or less taken part throughout the whole project but with most emphasis on the later part.

3. Theory

The aim of this chapter is to present the reader with the different theories that have been used throughout the thesis. The theory chapter has the following structure: first, the logistics system's structure is presented and then the subject term distribution will be outlined. Second, different transportation modes and cooperation approaches between client and logistics providers will be presented. Third, the way of controlling the logistics system in terms of supply chain management will be described. Lastly, the logistics system is put in a larger perspective for the purpose of explaining how changes in the surrounding environment will affect the system.

3.1 Distribution

"Distribution links the customer to the supply chain."[8]. It is from the market strategy the distribution structure is determined. The distribution system has to fulfil the undertakings in terms of delivering with the right aspects of precision and quality[9]. Beyond the distribution's functional role of delivering products, it has to be flexible towards new business opportunities under the pressure from competition and new technologies. The distribution system deals with a large amount of complexity which arises from the several requirements it is exposed to. It is a constant push for flexibility and short respond time along with the traditional desire of minimising inventory. In addition, the distribution has to withstand seasonality, sales trends and spikes in the customer demand. However, it is also these different and sometimes conflicting aspects which make the role of the distribution so important in the supply chain. It integrates the supplier with the markets (*Figure 2*).

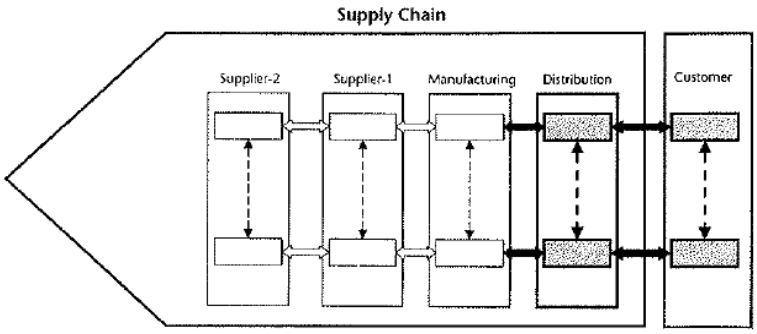

Figure 2: Illustrates how the distribution is connected in the supply chain**.**

Source: Schary, P. B et al 2003, p.110

3.1.1 Requirements on Distribution Network Design

When deciding upon which distribution network design or warehouse structure is most suitable for a particular situation, product, or company, there is no specific guideline to follow. The same type of design network can be adapted differently for similar companies. Literatures[10] reveal that many well doing supply chains often combine elements from several different design strategies to constitute for their distribution network.

[8] Schary, P. B et al, 2003, p. 109
[9] Jonsson, P et al, 2005, p. 25
[10] Kaminsky, P et al, 2003, p. 111; Schary, P. B et al, 2003, p. 125

In order to design an effective distribution network it is, however, important to carefully consider the specific characteristics of the particular situation the company is facing. This, since the distribution system has to fulfil certain requirements in order to meet its customer demand. A central starting point is therefore to clarify what kind of utility values the distribution channel should contribute to its end-customer as well as what kind of distributor role the company should play within the distribution channel. The utility values are created when different activities are performed in the distribution channel and these have as an only purpose to satisfy the customer[11]. Therefore, one of the main issues when designing is what activities should be performed and how the division between the activities in the supply chain should be managed. Should the logistic provider perform assembly and packing activities outside its normal duties? Moreover, a further fundamental issue is how to reduce the number of gaps always present between the manufacturing company and the consumer of the product. The overcome of these gaps is a basic condition in order to create utility value for the customer in a cost effective way. The literature[12] talks about four types of gaps and utility values as well as five types of roles existing in the supply chain (*Figure 3*).

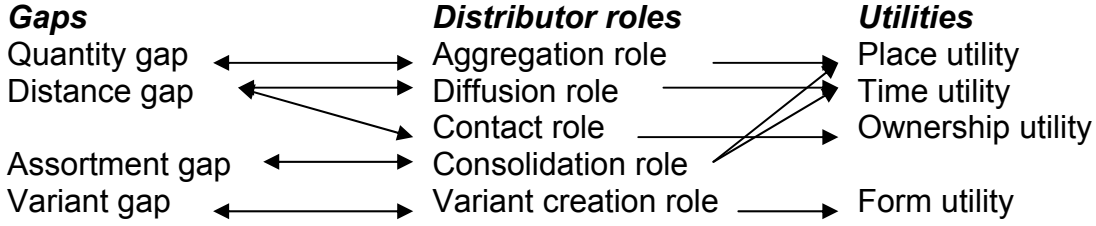

Figure 3: Illustrates the relations between the different types of gaps, roles and utilities.

Source: Johnsson, P et al, 2005, p. 263

The five categories of distributor roles have different functions in the supply chain. If a distributor works with the task to break down every shipment from the manufacturing company into customer specific quantities and later forward them to an advised customer. Then, the distributor has an *aggregation role* and creates *place utility* value for the customer by processing the products from the manufacturer into right quantity size shipments. By performing this, the distributor minimises the *quantity gap* which otherwise could occur when the market is not supplied with correct demanded amount of products.

Likewise, when a manufacture cannot ensure frequent deliveries to customer, this is becoming the distributor's responsibility. The manufacturer delivers infrequent deliveries to the distributor and the distributor in its turn delivers more frequently to the customer. This distribution function is called the *diffusion role*. The diffusion role reduces the *distance gap* that would exist between the manufacture and the customer, and satisfies the customer by ensuring a constant flow of products to the market.

The third role is the *contact role*. In this role, the distributor has the aim of maintaining an effective customer service by having good knowledge of the market and closeness to customer. In order to deal with guarantee issues, service undertakings, and refunds the distributor often uses higly technical equipments. By performing these activities, the

[11] Jonsson, P et al, 2005, p. 259
[12] Ibid, p. 263

distributor clarifies the ownership or the utility right of the product to the customer and hence the *ownership utility* will be created.

The *consolidation role* is the fourth role and as the name indicates the distributor has a function of consolidating products. When products are originated from several different suppliers, the distributor merges the components together and later forwards the new combined products to the customer. Through working after this concept, the customers get access to a much broader product range due to the many different manufacturers and thus the *assortment gap* can be diminished.

The last type of distributor role is the *variant creation role*. The role means that the distributor assembles customer specific product combinations from suppliers' standardised components. The distributor needs to be close to the market or have access to the customers' requirements in order to supply the customer with the right assembly of products as well as to be able to accomplish acceptable deliveries. By providing the customer with customer specific products, the distributor role reduces the *variant gap* and creates a *form utility* for the customer.

As a summary, designing the distribution network partly involves identification of what types of roles which need to be present and how the interplay between these roles should be organised in the supply chain. The designing phase, however, can only begin when it is identified which utility values the supply chain aims to create for its customer. When this analysis is done and the requirements between the transport driver and transport buyer are agreed, the next step is to compare and determine a suitable distribution system.[13]

3.1.1.1 Cross-Docking

The term of *cross-docking* means transforming the storage in the warehouses to "stock on wheels"[14]. In other words, the arriving goods are directly transferred to the departure area and made ready for the loading onto vehicles. On occasion, value-adding activities such as consolidation and packing can take part before moving to the loading area. The main idea is basically to create a flow stream of goods from arriving area to leaving area in the hub without any storage facilities. Cross-docking creates opportunities to reduce inventory and make faster deliveries to customer. It further enables for the businesses to better produce according to the demand due to the minimised lead times.[15]

In order to get use of the high efficiency the cross-docking technique can offer, it is necessary to have a proper track-and-trace system since the goods flow usually is very large and it would be impossible to manage without a real information system. The system has to provide specific information about for instance the destination, the delivery time, and the quantity. Moreover, this information needs to be accessible for all the involved parts in the supply chain to get use of the benefits that the cross-docking function offers. By the use of cross-docking, companies can minimise their logistics cost by eliminating the capital of the inbound flow.[16]

[13] Jonsson, P et al, 2005, p. 265
[14] Waters, D, 2007, p. 15
[15] Schary, P.B. et al, 2003, p. 335; Kaminsky, P et al, 2003, p. 233
[16] Lumsden, K, 2006, p. 572

3.1.1.2 Merge-in-Transit

Another concept to make the distribution system more effective is the use of the *merge-in-transit*. Merge-in-transit, just like cross-docking, is based on the thought of continuous goods flow and elimination of storage. However, logistics providers with merge-in-transit actions involve more value-adding activities than cross-docking does. Hence, the name; merge goods into one. This way of system, is also founded to take care of arriving goods from suppliers, consolidate them, and make them ready for loading on vehicles. Value-adding activities do not only consider modification of goods, it can also have the meaning of providing the customer with better logistics services; higher product range, shorter order time, and faster deliveries[17]. Moreover, a basic difference between the two concepts is that the merge-in-transit is more about consolidating units from different suppliers whereas cross-docking hubs mainly handle units from one single supplier[18]. This means that companies using the merge-in-transit system can to a larger extend offer a higher product variety than companies using the cross-docking system.

In addition to cross-docking, merge-in-transit put high requirements on the information exchange of the handled units. It is important that the consolidated product get correctly updated in the systems as well as the units being consolidated units. With fast and large material flows it is necessary to have the latest action move within the information system.[19]

3.1.2 Different Designs of Distribution Network

The next section will describe what kind of designs for distribution network that are most commonly used. First, the main differences between centralised and decentralised warehouse structure will be explained followed with a discussion of the distribution costs.

3.1.2.1 Centralised Warehouse Structure

Of the same reason as when designing the distribution network, there is no best practise for choosing upon right level of centralisation. *"The level of centralisation should be decided after the particular situation, and it is the situation on the market and the characteristic of the product that determine how the warehouse structure should look like."*[20] This is in other words a complex task due to the several elements that have to be considered[21]. In the model of the centralised warehouse, all suppliers deliver the products to one warehouse and later the products are distributed to each market (*Figure 4*). The inbound transports are carried out between the suppliers and the hub. High level of centralisation usually means that the distribution structure is optimised for its supplier base. When the suppliers distribute to one warehouse instead of to several, the transportation cost from factory to hub can be lowered[22]. A centralised warehouse is preferable when products are sourced from many suppliers. With many suppliers along with many local warehouses, the pattern of the inbound transports can become very complex especially if each of the suppliers has to deliver to each local market.

[17] Lumsden, K, 2006, p. 659
[18] Jonsson, P et al, 2005, p. 278
[19] Lumsden, K, 2006, p. 659
[20] Jonsson, P et al, 2005, p. 284
[21] Schary, P.B et al, 2003, p. 118
[22] Ibid, p. 119; Kaminsky, P et al, 2003, p. 52

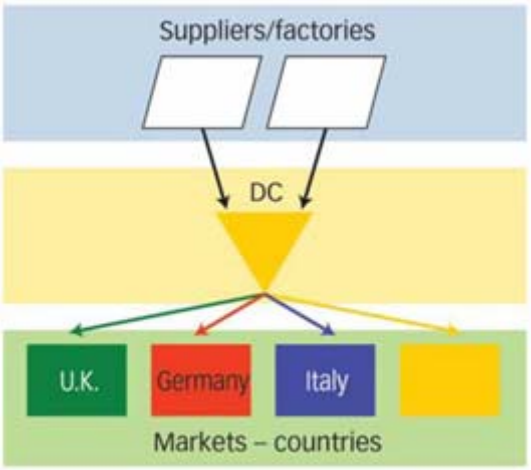

Figure 4: The distribution flow of centralised structure.

Source: Lasgaa, M, 2007

The effects of having one warehouse instead of several are that the cost for warehousing can be reduced and the possibility to provide customers with a broader product range. By having all products stored in one warehouse enables the opportunity to deliver a complete order to customer. The fewer number of storage locations a company has the better service level is possible to obtain with the given location[23]. Hence, for businesses with high product availability and variety, the centralised warehouse structure is preferable. Another benefit with centralised storage is the potential of minimising incorrect consolidations of the products. When products are transported to several different storage facilities, there is always a risk of delivering products to wrong storage. A further risk to avoid is obsolescence; products loose in value due to not being sold at the market the products were intended and transported to. This can occur when the demand at the specific market has changed. Furthermore, the turnover of products in stock will be positively influenced with a centralised warehouse structure[24].

"As general rule, then, centralization of a European logistics network worked best for business profiles that included high-value goods and a strong overlap in product portfolio among the various national markets. For these types of businesses, cost savings were largely achieved through investing less working capital in inventory, reducing their storage capacity, and creating economics of scale in their centralised warehouses operations."[25]

3.1.2.2 Decentralised Warehouse Structure

In order for the distribution system to manage its diffusion or aggregation role, it is sometimes necessary to have more than one warehouse. Many businesses, therefore, are using hierarchical of storage. This can mean having local warehouses at each market or regional warehouses supported by a central hub. The decentralised warehouse structure can be designed differently and should be optimised after the certain circumstances. Low level of centralisation enables shorter and more reliable deliveries to the markets due to having each market covered by its own warehouse. If the centralised warehouse structure was optimized after its supplier base, the decentralised is optimised for its customer market[26]. The advantage with the decentralised structure is mainly the shorter distances to the customer by having

[23] Kaminsky, P et al, 2003, p. 52
[24] Jonsson, P et al, 2005, p. 280
[25] Lasgaa, M, 2007, p. 3
[26] Kaminsky, P et al, 2003, p. 231

warehouses serving each market (*Figure 5*). It is important to be close to the market for fast moving products which require fast and reliable deliveries. If the transport cost is high in relation to the product value, this also indicates to choose a low level of centralisation. The transports costs are important to minimise at markets where customers buy often and in small volumes. The cost for the inbound transports increases with the number of hubs and conversely decrease the outbound transport cost with number of hubs[27]. Furthermore, if the customer requires an order quantity flexibility, the decentralised storage model is most suitable[28].

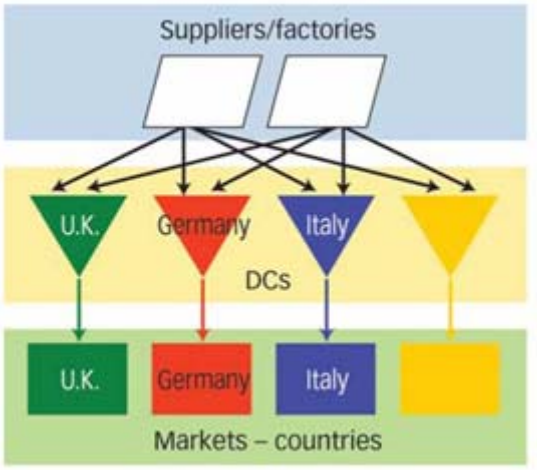

Figure 5: The distribution flow of decentralised structure.

Source: Lasgaa, M, 2007

A risk with decentralised storage is the potential imbalance between warehouses. This can lead to loss in sales because one warehouse does not have enough stocks and therefore cannot meet the demand. Conversely, imbalances can give rise to a too high level in stock and cause products becoming obsolete. Therefore, the safety stock increases when moving from a centralised to a decentralised storage and the amount of increase depends on the variation and relation between the demands at the different markets.[29]

3.1.3 Distribution Costs

When calculating the costs for a distribution system, the total cost (*Figure 6*) can be divided between[30]:

- Transport costs
- Inventory costs
- Warehousing costs
- Service costs

The transport costs are based on distances and type of transport used. Due to the outsourcing of the transportations, it is not always easy to locate the exact cost factors. There are many different ways of structuring cost models and this is a part of the negotiation between the purchaser and the vendor of transportations. The inventory costs are the costs for binding of

[27] Schary, P.B et al, 2003, p. 119
[28] Jonsson, P et al, 2005, p. 280
[29] Kaminsky, P et al, 2003, p. 51
[30] Schary, P.B et al, 2003, p. 118

capital which occurs when the products are stored in warehouses, manufacturing or in transports. Besides interest the inventory cost include the risk of the products becoming obsolete and the insurance against risks such as fire. The warehousing costs are based on rental of buildings, personnel, equipment and administration. Furthermore, the service costs are the costs for having a short order cycle time and delivery time.

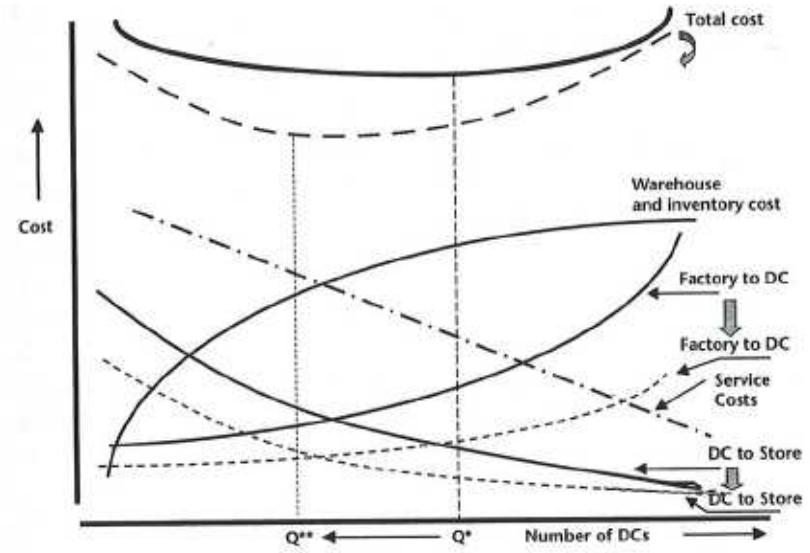

Figure 6: Illustrates total cost related to number of distribution centres (DCs).

Source: Schary, P.B et al, 2003, p. 119

As explained before, the total cost is dependent on the number of distribution centres (DCs). When the number of DCs is increasing, most of the costs are increasing such as transportation costs from supplier to DC, warehouse costs due to the absence of economy of scale, and inventory costs since the need of safety stock in all the warehouses to fulfil the delivery service that the customers demand. The decreasing cost for an increasing number of DCs is the transportation costs from DC to customer and the service costs. This since the distance to the market decreases thus the driven kilometre, delivery time, and order cycle time.

This is shown in *Figure 6* and if the distribution system has "*advanced information technology, communication and transport systems"*[31] the fewer number of DCs is an advantage which is shown in the figure as the dashed lines.

[31] Schary, P.B et al, 2003, p. 123

3.2 Transportation

To be able to deliver to the consignee, the goods have to be transported from the shipper, through the distribution network. This can be done in different ways and by different modes. The transportation modes on today's market are road, rail, air, and sea[32]. In the flollowing sub-chapters the performers of the transports will be described first, and secondly, the several transport approaches will be clarified. Lastly, the different modes will be presented more closely.

3.2.1 Logistics Providers

In our modern economy, manufacturing companies are extremely focused on their core competences and logistics is seldom seen as one of those. The market has changed from being local or regional to global and the logistics has therefore increased its complexity. For a company to be cost competitive within transportation, its network has to have a full coverage. This is a reason why the market has been split up between logistics providers and carriers where the first arranges the logistics and not often owns any asset and the later executes the transports. Logistics providers have been employed for a long time but the relationships are increasingly turning into long term commitments between logistics providers and carriers as well as between them and customers. This is due to a deeper cooperation where the LSP is doing more value adding activities which require trust which has automatically led to longer commitments[33]. When the LSP is having this role, the definition third-party logistics or 3PL can be used, which is another term for the logistics provider and is defined by its position between the supplier and customer. The term fourth-party or 4PL logistics can also be used. The difference is explained as following;

The definitions of a *3PL* are many but the main are that any outsourced logistic activities that previously has been done by the manufacturing company itself is third-party logistics[34]. The activities do not only include transportation but also warehousing and inventory management. The relationships between carrier and LSP are for long term and both are integrated in the client's value chain. The development of the 3PL has been moving from being asset owners towards a skill-based consultancy. The benefits from outsourcing the logistics to a 3PL is that these companies can provide time, resources and expertise which the client company often has difficulties with. They offer the latest technology in planning, execution and geographical flexibility without the client company investing capital[35]. With the help of a 3PL the client company achieves a faster access to new markets[36]. There are risks with employing a 3PL and it is important to have the loss of control in mind, which is the typical consequence by any outsourcing. The involved companies should therefore have an affective communication and the client company ought to know its own costs before engaging cooperation.

The *4PL* is, in addition to the work of a 3PL, also optimizing the client's supply chain including both value-adding activities and strategic planning. The cooperation is therefore more seen as a joint venture between the parties. Further differences between a 3PL and a 4PL are that the 4PL is hired solitary for organising and employing logistics providers for the performing of the transportations. As shown in *Figure 7*, the assets are mostly dedicated with specialized equipment for the 4PL[37].

[32] White Paper, 2007, p. 25; Jonsson, P et al, p. 94
[33] Schary, P.B et al, p. 226
[34] Ibid, p. 227
[35] Waters, D, 2007, p. 199
[36] Schary, P.B et al, p. 228
[37] Ibid, p. 228

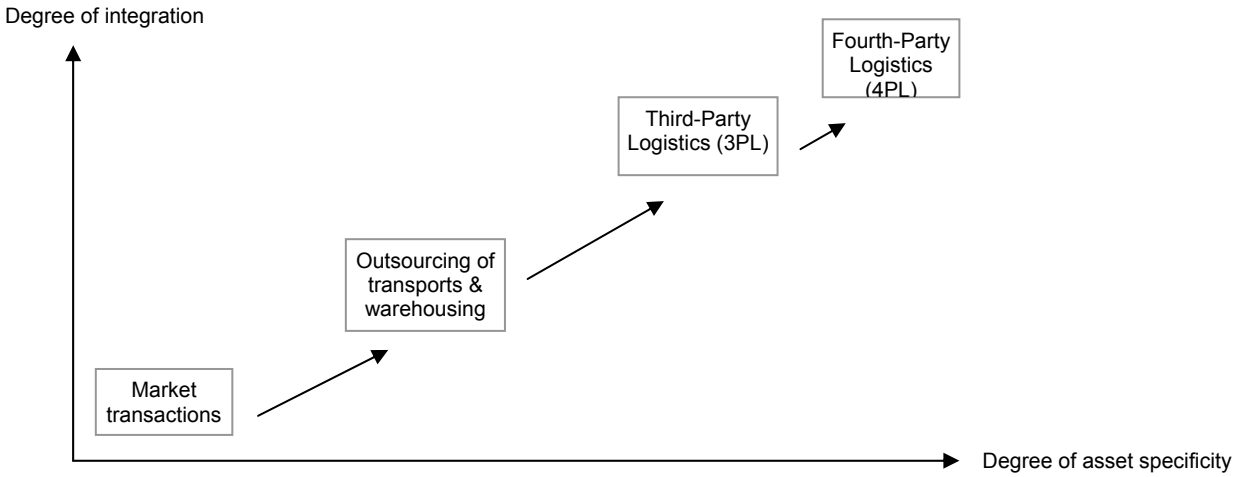

Figure 7: Illustrates the integration of the logistics providers.

Source: Schary, P.B et al, p. 228

3.2.2 Hub-and-Spoke Networks

The hub-and-spoke network was developed for the needs of the logistics provider. They wanted to be able to perform more frequent deliveries as well as achieve better transport services. A changeover to a hub-and-spoke system also meant a way to structuralise and reduce the number of transport relations between the suppliers and the hub.

There are different ways to design a hub-and-spoke network. One approach is the *one terminal network* which is based on one central hub together with several local hubs or forwarding hubs (spokes) (*Figure 8*). This type of structure is suitable when a limited quantity of goods have to cover a large geographical area. The transportation distance will here be longer due to the goods first need to be transported to the central hub for repacking and resorting, and later distributed to the local hubs instead of being delivered direct to the local hub. As a result, the transit time before reaching the final hub will be longer. However, this model benefit the delivery time from local hub to customer since the local hub is located at its market. When all goods arrive to one central hub, it is possible to achieve a higher loading ratio in the trucks when distributing to the local hubs, instead of each supplier serving each local hub.[38]

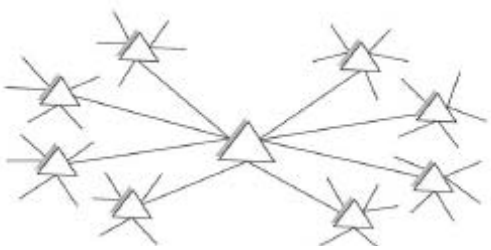

Figure 8: Illustrates one terminal network.

Source: Lumsden, K, 2006, p. 631

Another hub-structure alternative is the *hieratical multi terminal network*. This approach is based on a number of central hubs with several to them belonging hubs. Here, the smaller

[38] Lumsden, K, 2006, p. 631

hubs are serving the central hubs. The small hubs collect all the goods from the local suppliers within its defined area and reorganise the goods to later be transported to the central hub (*Figure 9*). From the central hub the goods are transported to another central hub where they are ready for distribution to the intended market. The hieratical multi terminal network suits when suppliers do not have enough volume themselves to fill a truck and gives the opportunity to arrange concentrated transportation flows. As a result, it is possible to increase the loading ratio. A further benefit is the shorter distances the model gives rise to. Both distances from supplier to hub and hub to customer are optimised. The products can then be delivered with high time precision due to the short delivery times.[39]

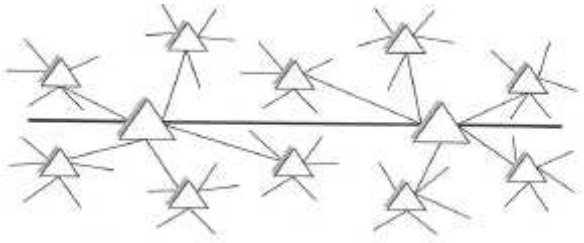

Figure 9: Illustrates a hieratical multi terminal network.

Source: Lumsden, K, 2006, p. 631

Figure 10 shows how the distribution network can look like when an expansion of the structure is done. This model has the basic structure of the one terminal network, described above, but with a further layer. The layer shows how *the consolidation points and the break points* can be designed. In the break points, the goods are distributed to the customer and in the consolidation points is where the goods are grouped together from the manufacturers. The number of branches from the central hub depends on the particular situation of the market and which function role the distributor aims to act within the system. More branches are possible to add or distract. The consolidation points provide a possibility for the logistics provider to perform value-adding activities. The goods are here typically repacked and labelled but more complex activities such as basic assembly and cutting can also be done.[40]

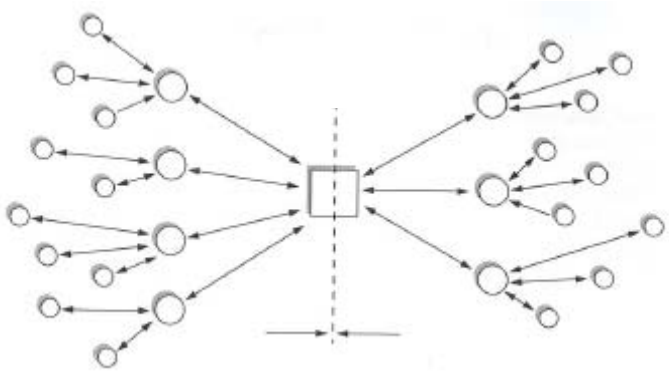

Figure 10: Illustrates the consolidation points and the break points of an expanded view over the hub-structure.

Source: Lumsden, K, 2006, p. 635

A hub-structure can have different number of layers which will affect the transportation time. The more layers, the longer time is necessary for the transports. However, the numbers of

[39] Lumsden, K, 2006, p. 633
[40] Ibid, p. 632

layers will positively affect the frequency of deliveries to customer. With several layers the delivery frequency can be higher and more end-destinations can be served. The high flexibility the model provides is important when business have a volatile market. With this approach is it possible for the logistics provider in an early stage to create concentrated transport flows without disadvantage the transport buyer. High resource and capacity utility of the vehicles can therefore be attained. The transport buyer, however, has to be aware of that the goods by the use of several spokes and layers will be handled more times than in a one terminal network. The goods are therefore more exposed to damages and losses, and an effective follow-up system of goods is required. Further disadvantages with the hub-and-spoke network are that the structure leads to longer lead times and larger transportation work.[41]

3.2.3 Different Modes

The limiting factor within the transportations is the infrastructure. This is varying throughout Europe and also between the different modes and they therefore have their advantages towards each other. The road mode is the only one that in general can go directly from supplier to customers without going through transloading stations or terminals. On the other hand, the sea and rail modes have an advantage towards both the road and air modes regarding the volumes transported which can be a lot larger in both number and size. This makes the transportation by sea and rail a lot cheaper than especially air freight. However, since the sea transportation takes a lot longer time than by road or air, the capital binding are a lot higher. The delivery service is for the same reason a lot higher with air transportation.

There has been a much efficient deregulation in the road sector. Today, cabotage[42] is allowed which has led to an increasing international competition. Shortly after the deregulation the market experienced an over capacity which therefore led to lower prices. Gradually the competition sifted out many smaller companies from the market and left today is the middle sized, family owned section[43]. The large increase of road transportation as a consequence to the deregulation has created an over stressed situation with traffic jams and large environmental pollution. Therefore the road transportation has started facing new regulations in form of road taxes, working hour directives and prohibitions to enter larger cities, always or only during day time. The road transports within Europe are often performed by trucks with the standardized length of 16.5 meters with a maximum weight of 40 tonne[44]. These are operated by the road carriers which in their turn are hired by the logistics providers.

The railway mode, on the other hand, has not had the same development as the road system in Europe rather a decrease, due to regulations and monopoly. The railway has been controlled and own by each country's state and still is in some countries. The standardisation of the railway systems in Europe has therefore been slowed down. However, there have been changes since 1993 when the EU proposed a directive regarding a dividing of the rail network. The tracks, signals etc was split from the operational companies which opened up the market but it is still difficult for new companies to establish due to the differences between countries. Furthermore, cabotage is still an issue regarding the railway transportations. It is regulated both by law but also naturally by the different electric systems. The rail transportations across the borders are therefore complicated and time consuming which in the end does not make this mode as competitive as for example road transportations. Further disadvantage with the rail mode is the shortages of tracks and it is therefore only a

[41] Lumsden, K, 2006, p. 621, 630
[42] Chapter of Introduction: Definitions
[43] Horstmann, U, 20/12/07
[44] Jonsson, P et al, 2005, p. 94

smaller amount of companies that can be supplied directly with train. If rail is to be used, an unavoidable change from rail to road has to be made which takes time and costs money. However, train is still a competitive mode for larger distances due to its sparse fuel consumption. The European Union is moreover trying to make the railway mode more competitive by; "*…supporting the development of a system of key rail freight routed running across Europe on which operators will be able to compete for customers: Trans-European Rail Freight Freeways*"[45].

The sea shipping is the most competitive mode for the longer distances (*Figure 11*) and it has been increasing hugely since the sourcing became global. This is due to the large loading capacity which is increasing as the ships constantly are becoming larger and also low prices[46]. The inland water transport is on the other hand not as competitive as the road transportation even though it is the cheapest mode. It is slow by today's measurement which therefore results in a higher level of capital binding. However, the sea mode will perhaps become more competitive due to the increase of the road regulation.

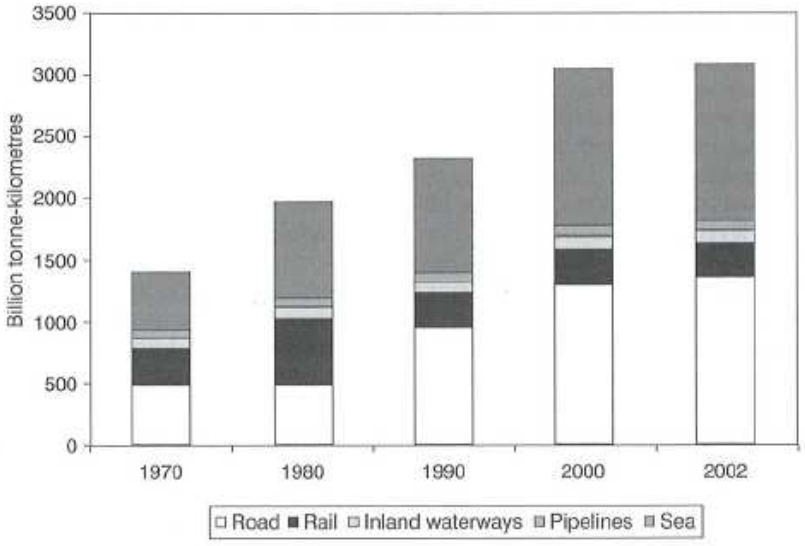

Figure 11: The dividing between different transports modes.

Source: Waters, D, p. 361

The air transports is in general the fastest and gives the highest service speed but are very expensive comparing to the other modes. The product must therefore be of high value and the end customers must pay for the short lead time and high service level[47]. The volume is also restricted thus this mode is most suited for special deliveries or delayed orders. Due to the short delivery time, the air mode is also preferable for products with short life cycles[48].

3.2.1.1 Intermodal

An intermodal transport is a mixture of two or more different modes under one delivery. It is few companies today that have the possibility to be supplied directly with another mode than by road. However, the large increase of road transports has made the European Union increase the taxes and regulation which works in favour of the combined transports. The most

[45] Schary, P.B et al, 2003, p. 224
[46] Jonsson, P et al, 2005, p. 92
[47] Ibid, p. 96
[48] Horstmann, U, 04/03/08

common intermodal transport is the combination between sea and road[49]. Moreover, it is frequent to combine the use of road and rail. The *Modalohr Technique*[50] is one way of easily tranship semi-trailers from the road onto the rail wagon. Due to the low height of the rail wagon and the flexible trans-loading mechanism, the trucks are able to be loaded easily. For the intermodal transport to be competitive, the transloading time needs to be short and the costs low. This demands effectiveness and standardised units for example containers.

3.2.1.3 Optimising Road Transportations

When optimising the transportations, the vehicle utilisation is often the main target of improvements. For high density products, the maximum weight limit is faster reached and the truck fully loaded even if there is vacant place left. For low density products, the truck is full when there is no more vacant place even if the permitted weight is far from reached. The maximum utilisation, non-dependent by weight or volume, is constrained by the lean thinking. This means the delivery just-in-time is more important, since it often is a market winning concept, than filling the trucks. The low truck utilisation becomes particularly poor if the demand is fluctuating or if the date of delivery is varying. Another factor is the limiting packages which make the products non-stackable and can also add unnecessary volume.

The most cost and pollution adding transports are the empty running trucks which are due to the trade imbalances and therefore the lack of returning goods. There are on the other hand possibilities to improve these which for instance can be the use of the return loading for the *reverse logistics* i.e. the back travelling of products in need of for example repair.

When improving the transportations, *milk-runs* can be an option. Milk-runs can be explained as a fully loaded truck dropping of or picking up goods at different destinations along the way. Assuming the trucks are maximally loaded, this type of transportation could decrease the total amount of driven kilometre. The deliveries can furthermore be parted in sequences which can be declared as the components constituting the product is sorted and being delivered in correct order and just in time for them to be assembled[51]. For the costs to decrease this solution is demanding a non-specific-company distribution. To simplify the planning of the transportation, the delivery can be done with fixed standards meaning the delivery for certain areas takes place on certain days[52]. Simplifying the planning does not necessary mean that the planning decreases, rather the opposite. The result however is more effective and optimised transports.

3.2.1.4 Construction Logistics

The logistics surrounding a construction site is highly complicated. Due to changes in the drawings or of interior details, the time schedules which are set up by the construction companies are seldom kept and it is therefore a highly difficult task to optimise the operations within this area. As a result of constantly changing delivering dates; the storage times becomes longer. This affects almost all the suppliers who are delivering the construction material and it complicates the ambition to work towards the term lean production.

Moreover, the storage space on a construction site is often limited[53]. When construction is taking place on the country side the storage can in addition to indoors take place outside the construction site, either on the street or a nearby area. This type of storage near the

[49] Lumsden, K, 2006, p. 550
[50] Lohr Home Page, 2007; Modalohr Home Page, 2008
[51] Lumsden, K, 2006, p. 564
[52] Jonsson, P et al, 2005, p. 166
[53] Horstmann, U, 10/12/07

construction site is fairly problematic with both vulnerability to weather conditions which can lead to poor quality of the products and also exposure to a high risk of theft[54]. For natural reasons, this kind of outside storage is far more restricted in the cities. These factors are important to have in consideration when planning the deliveries.

[54] Prof. Wandel, S, 09/01/08

3.3 Supply Chain Management

Due to the increased globalisation during the late 20th century, the competition between companies increased and numerous companies began to concentrate on their core competence(s). The reasons behind this specialisation and globalisation respond was the concept of further dividing labour among firms on a global level in order to become more competitive[55]. As a result of the new business focusing, many companies outsourced large parts of their external transport and warehousing activities as well as large production facilities to companies that would manage them more cost efficiently. Third-party logistics and contract manufacturers became more frequent actors on the market. The increase of outsourced activities also led to the number of involved business partners within the companies' logistic systems expanded. As a consequence, it became more important to concentrate on the relation boundaries and the flows in between the new supply chain partners to achieve logistic effectiveness[56]. The new transformed market situation resulted in that logistics management was no longer enough to satisfy the supply chain. The logistic concept had to be modified in order to accomplish the real benefits and there of the need for management of the entire supply chain began to grow[57].

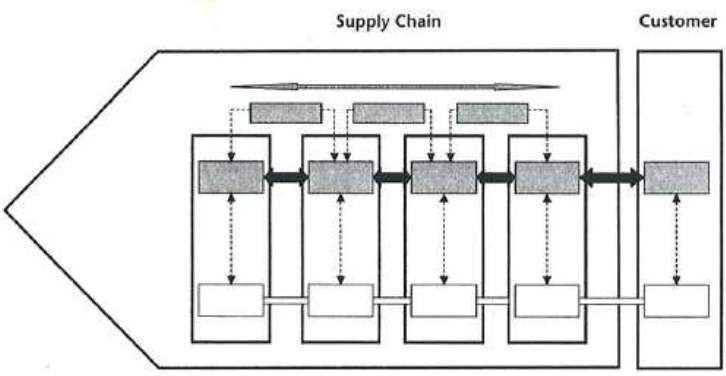

Figure 12: Supply chain management.

Source: Schary, P.B et al, 2003, p. 258

The concept of *supply chain management* is closely linked to the concept of logistics, however, supply chain management aims to more emphasize the importance of integrating the own company's flows with other companies in the supply chain (*Figure 12*). *Logistics management,* on the other hand, puts more focus on the creation of effective material flows. It is important to have both effective external flows between the companies as well as to have effective internal material flows, in order to achieve efficiency. In the model of supply chain management, there are just these external flows of relations, material, and information that are emphasised.[58] "*Within the structure of the supply chain, each firm faces its own unique environment: technology, competition, customer base, internal organisation and culture. Members of a supply chain are also part of a system that competes with other systems, in the area defined by the final market the context of the system as a whole."*[59] It is the collaboration and the exchange of information in the supply chain management concept that give the

[55] Smith, A, 1776
[56] Jonsson, P et al, 2005, p. 65
[57] Waters, D, 2007, p. 23
[58] Jonsson, P et al, 2005, p. 21; Kaminsky, P et al, 2003, p. 2
[59] Schary, P.B et al, p. 261

possibility to reduce the organisational boundaries[60]. Today, however, the information flow is considered to be more important than the material flow for reaching logistics effectiveness[61].

The business organisation in the supply chain management's philosophy is based upon *"...the idea of partnership in the marketing channel and a high degree of linkage between entities in the channel."..." The goal is to maximise profit through enhanced competitiveness in the final market – a competitiveness that is achieved by a lower cost to serve, achieved in the shortest time-frame possible."*[62] Traditional business organisations are usually grounded to maximise the revenues and minimise the costs although other entities in the supply chain could suffer. This is not in the same extend the case of the supply chain management's philosophy.

Moreover, the changed business situation has given rise to new organisational structures which has directly influenced the supply chain. The *traditional management* is based upon a hierarchical structure (*Figure 13*). Top managers made decision of hopefully adequate information and later passed it further to lower management tiers where operations take place. This management structure is slow and much effort has to be spent finding the right person in charge. In addition, the work flows through the traditional organisation have little direct link to the activities in the supply chain but are just a series of separate and disconnected tasks. The requirement of quick responses and flexibility in the new supply chain environment, this management model has proved to be unworkable. In the decentralised or *lateral management,* business decisions are made at the point where the work takes place[63] (Ibid.). *"Operating units make their own decisions, connecting and negotiating with each other with full authority – across functional activity centers."*[64] The organisation is process-driven and the work flow follows the same direction as the products throughout the company. Therefore, the operation units become to a larger extend more involved with the processes and can more focus on customers rather than on individual functions. The lateral management renders a possibility to higher inter-functional communication and coordination. These advantages are especially relevant to the supply chain that operates in a volatile environment where visibility and flexibility are necessary to be effective logistically.

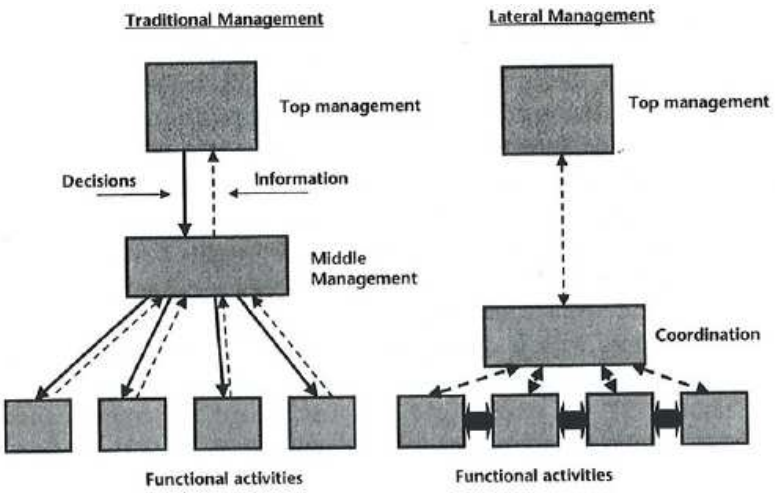

Figure 13: Illustrates the difference between traditional and lateral management.

Source: Schary, P.B et al, 2003, p. 259

[60] Waters, D, 2007, p. 161
[61] Jonsson, P et al, 2005, p. 67
[62] Waters, D, 2007, p. 23-24
[63] Schary, P.B et al, 2003, p. 266
[64] Ibid, p. 260

3.3.1 Differentiating Service Levels

Deciding upon right level of service is difficult. There is a constant trade-off between cost and income. Companies having a high service level in for instance product variety results in high inventory costs due to a large number of different products need to be kept in storage. Other companies which promise short delivery times receive large costs by the compulsory of keeping products in local storages than if they would by keeping the goods in a centralised warehouse. However, since the service level affects not only the cost but also the income, it is why companies on the whole are considering increasing the service level. A description of service level can therefore be availability (time for delivery), serviceability, and performance (quality of work). The relation between income and service level is used to be described as an *s-curve* (*Figure 14*). Companies need to identify their position on the s-curve, since a change in the service level in the beginning and the end of the curve does not result in any large income increases. It is therefore important to be aware of the potential outcomes and the required resource effort when changing the service level.[65]

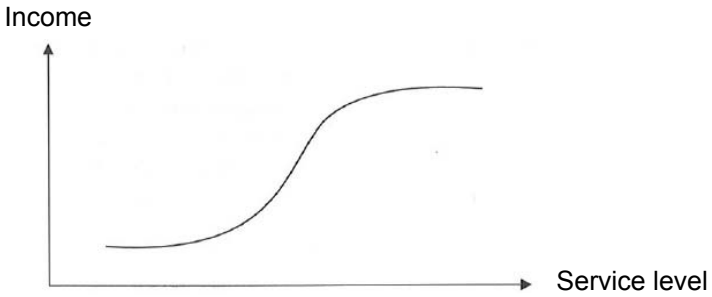

Figure 14: Illustrates the relation between service level and income.

Source: Jonsson, P et al, 2005, p. 122

In order to receive a favourable relation between the required resources and the expected improvements, it can be desirable to differentiate on where the resources should be focused. In general, the service level should be higher for products with; high profit margin, high volume, low variability, and short lead time.[66]

There are different service level strategies to choose between. Here, two strategies will be further described. The first service level strategy is the differentiating of customer service dimensions. This strategy can be shaped differently, but is predominately focusing on dimensions which have the largest impact for the customer and where the company has the weakest competitive strength. By identifying the service level importance for customer and the actual performed service level, it is possible to find out where the service level is too high or too low. Potential over and under performances in services can lead to unnecessary costs or loss in incomes. A small improvement of the service level can result in higher value-added for the customer and lead to large income. Therefore, it is these over and under performances that should be dealt with first in order to avoid unnecessary costs or loss in incomes. Other dimensions to measure is service level dimensions which are less expensive to improve compared to others, but is just as important for the customer.[67]

Second, the service level can additionally be shaped by differentiating customers and products. It is common that a minority proportion of the customers stand for a large share of

[65] Jonsson, P et al, 2005, p. 122
[66] Kaminsky, P et al, 2003, p. 47
[67] Jonsson, P et al, 2005, p. 124

the company's total contribution margin. The same is valid for a small share of the products. In general, respectively, 20 percent of the customers or the products stand for 80 percent of the contribution margin. A uniform service level for all customers and all products can therefore involve huge amount of costs or a too low service level. Valuable customers can get wrongly prioritized by providing them with an incorrect service level and, conversely, customers and products with low requirements can receive a too high service level. Both alternatives of incorrect service level can lead to unnecessary expenses. By differentiating the customer service undertakings and concentrating on profitable customer and products, the total logistics costs can be reduced as well as utility value for the customers and products can be created.[68]

3.3.2 Strategic Modelling

"Models are essential for planning the supply chain."[69] Models are a careful representation of the reality and can provide a better understanding of a complex system. By modelling the potential actions in the supply chain, management decisions can be made on a more solid foundation by experiments and testing variables. The possible impacts of changes in one or more variables in the supply chain system can be analysed before potential implementation in the reality occur. Furthermore, through modelling, the outcomes of the current situation can be expressed in more specific terms and can provide a possibility to identify which part of the chain will be affected and how. Boundaries and relationships are possible to model and enable a greater understanding of the potential consequences during discussions or negotiations. In supply chain management, models can be used for different purposes: *1) to test alternative courses of action, 2) to determine optimal policies, 3) to predict future events, 4) to communicate concepts and relationships, and 5) to determine optimal location choices*[70].

It is important to be aware of the model's limitations. Models are not providing a perfect or complete picture of the reality of the supply chain. Limitations and simplifications have to be made to certain extend because of the complex reality. Some circumstances and surrounding factors are almost difficult to predict and moreover convert into useful uses. It is the complexity of the supply chain which creates the difficulties of modelling a perfect system. The organizational relationships, boundaries in the channel and the dynamic of the customer market emphasize some issues the model has to manage. However, due to the complexity the supply chain possess, there is a need of creating a simplified model in order to provide the management with the best information to support decisions.

3.3.3 Management Tools

For a company to be successful in its competitive environment, it is vital that the company is working in line with the trends on the market. To do this, the company has to evaluate the market, the company, and the competition and then set up strategies which everyone in the company should work after. There are different tools and methods of developing and determining distribution strategies such as *Location Analysis, Scenario Planning, SWOT-Analysis*, *Sensitivity Analysis* and *Benchmarking*.

3.3.3.1 Location Analysis

Strategies concerning distribution systems can include analysis of where the hub(s) should be located. When performing location and system analysis, models are a useful tool. Location and system analysis are normally based upon cost minimisation. Cost minimisation of sub-processes within the supply chain can lead to sub-optimization of the total channel, which

[68] Jonsson, P et al, 2005, p. 125
[69] Ibid, p. 387
[70] Ibid, p. 387

should not be encouraged. *Location analysis* is a systematic assessment and is appropriate to perform by the use of models. The location analysis or the selection of country should be evaluated on following basis[71]:

- Cost versus response time
- Infrastructure and its performance
- Quality and availability of human resources
- Public inducements for investment
- Structure of tariffs and duties
- Non-tariff barriers of quotas
- Overly zealous inspections
- Restrictive trade agreements
- Political stability

Additionally, the location analysis should assess the factor that industries of today have more intangible assets and are more unpredictable in the sense of not drawn to act only within a certain market. *"In a "weightless" economy, the bulk resources that once dominated location analysis are no longer the major issue."*[72] Therefore, minimising the physical movement costs has not the same importance anymore as "*...the reduction of total cycle times, for responses to changing markets, flexibility in meeting changing demand and reduced pipeline inventories."*[73] Furthermore, Porter's (1998) concept of *cluster* building is another factor the location analysis ought to consider. By locating facilities within a cluster benefits can be achieved in terms of collective thinking, joint investment and risk taking which minimizes the risk that the subcontracted firms in the supply chain will try to reach maximum profits on behalf of the subcontractor[74].

The normal procedure of performing a location analysis is to rely on quantitative methods and data. Some situation can also require the usage of qualitative data. First, different assessment elements are identified which each potential location site will be evaluated from. Second, the elements are given an individual weight in order to separate the importance from each other. At last, the selected location sites are estimated through experts and managers and given the different location sites a ranking and the optimal solution is decided. In reality, however, the optimal solution is often based on a "soft analysis" and the perception of the management. This taken places, although, the large number of potential risks for the supply chain without decisions based on a complete analysed model[75].

3.3.3.2 Scenario Planning

To maintain the present market shares or even increase these, a company has to be able to do estimations of the future as close to the reality as possible[76]. If the prediction becomes true it will create advantages towards the competitors. It is therefore essential that every company has a strategy of how to move forward. However, what is the correct strategy for each company? The common way of thinking when solving problems is to ask the questions; how did we do it in the past and how do our competitors do? This does not lead to new thinking and when innovative strategies have to be done the scenario planning is a necessity. The

[71] Jonsson, P et al, 2005, p. 390
[72] Schary, P.B et al, 2003, p. 389
[73] Ibid, p. 390
[74] Berggren, C et al, 1999
[75] Schary, P.B et al, 2003, p. 390
[76] Brandhold, H et al, 2003, p. 12

visioning or imagining of what is to come is the key for a successful strategy and is the foundation in the scenario planning.

A scenario is an estimation of the future development and is a strategic tool used by companies' management department when making strategic decisions[77]. It must not be mistaken for forecasts, prognoses nor visions. The forecast is based on both present and historical data. From this base, the result of the forecast does not consider new aspects or risks. The vision on the other hand is a wish of how the future will appear. The scenarios describe different futures edified by diverse aspects with a wide perspective and qualitative variables. The scenario based future is therefore uncertain but never the less some times necessary.

According to the literature[78] the technique used when doing a scenario is most often the model *TAIDA* which stands for; *Tracking, Analysing, Imaging, Deciding* and *Acting*. In the first step a thorough research of possible risks or changes has to be done followed by an adequate analysis where the imagination decides the consequences from the changes. During this phase the scenarios are starting to develop. Next the direction of which the company should move in is decided and also what kind of strategies that is needed.

There are several different proceedings to do the *tracking* for instance using media or interviewing experts[79]. By doing this the trends can be discovered. The dominating model for scenario planning is the scenario cross which is based on two different uncertainties. The cross model below (*Figure 15*) represents the *analysing* part of the TAIDA. Through using the model, four different scenarios can be provided. The difficulties are to find the uncertainties and not discharge or prefer scenarios before the analysis is done. This is in fact occurring regularly since people by nature only want to have one scenario[80]. In general, several different scenario crosses are developed where the management members are voting for the best cross to be used for strategic planning.

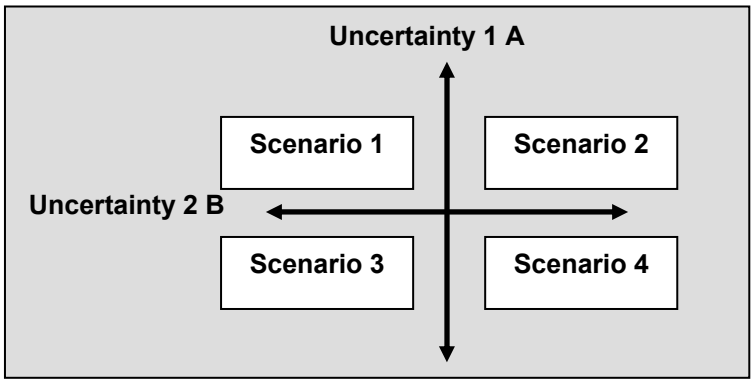

Figure 15: Illustrates the scenarios cross.

Source: Brandhold, H et al, 2003, p. 67

When the uncertainties are determined, it is time to decide the scenarios. The *imagination*[81] of the future is used to identify what will happen if the uncertainties occur, only one or both. It is also important that the scenarios become realistic. The result of the scenarios gives the

[77] Brandhold, H et al, 2003, p. 24
[78] Ibid, p. 47
[79] Ibid, p. 55
[80] Ibid, p. 55
[81] Ibid, p. 76

direction of the strategies. The question that has to be asked is following; if this happens, how will we be successful? The answer gives an input on how the strategy should be designed. To successfully lead a company it is essential to make *decisions*[82] and then act. A scenario is not well defined and as it is based on visions it may be difficult to take the decision in the direction of a scenario. It therefore needs to engage the decision makers. The next step after deciding the strategy is to *act*. This is one of the most difficult steps in the TAIDA method. Often when it comes to companies, there are many layers of managers and for a strategy to be a success, everybody has to not only fully understand the concept of the strategy but also see it through.

There are many ways to fail in the strategic work. Therefore, it is important to have a clear purpose with understandable questions under the preparation of the scenario planning. Additionally, the team must have a wide perspective viewing the future and the scenarios should reach over a reasonable amount of time for example five years. Otherwise the scenarios tend to involve only the current situation which more often is of less importance and will not help the company to move forwards. Furthermore, the difficulty when doing a scenario is to find the right uncertainties. They should have large enough impact to be able to create scenarios that are clearly separated from each other and also be the most important when relating to the asked questions of the future. It is easy to fall into old habits when deciding the strategy and do what has always been done because it feels safe. To be successful this chain has to be broken.[83]

3.3.3.3 SWOT-Analysis

SWOT-Analysis is among others used to assess individual projects within a company e.g. a new distribution network. It evaluates the ***S**trengths*, ***W**eaknesses,* ***O**pportunities*, and ***T**hreats* that a company or a project will be exposed to in the future[84]. The analysis represents internal and external aspects; both positive and negative (*Figure 16*). A company's strengths are internal factors that make the business competitive for example competences and resources. The weaknesses is also based on internal factors but can be described as the opposite of the strengths which is a shortness of competences and resources. The opportunities and threats are external factors that can improve or limit the company's current market share. Based on this analysis, the company can decide on a suitable strategy which will help the company to be competitive in the future.

	Positive	Negative
Internal	**Strengths** Internal capabilities that may help a company reach its objectives	**Weaknesses** Internal limitations that may interfere with a company's ability to achieve its objectives
External	**Opportunities** External factors that the company may be able to exploit to its advantage	**Threats** Current and emerging external factors that may challenge the company's performance

Figure 16: The SWOT-Analysis used for marketing analysis.

Source: Kotler, P et al, p. 52

[82] Brandhold, H et al, 2003, p. 81
[83] Ibid, p. 96
[84] Kotler, P et al, p. 52

3.3.3.4 Sensitivity Analysis

A sensitivity analysis is used when finding parameters or uncertainties which a model is sensitive to. It is performed as a test where one or multiple parameters are changed. The different results is then compared and analysed. If the model is insensitive to changes in the parameter, the result can be that estimations will be used instead of fixed values. A sensitivity analysis does not only provide the sensitivity of some parameters, it also gives the answer if the model is useful or not and how it can be changed. The analysis can be applied for business and environmental areas as examples. In the business model, important information for decision making can be received e.g. cost drivers or quantities. It is significant that the analysis is carefully done with reflection of future risks and different dependencies of the parameters, otherwise the result will be incorrect.[85]

3.3.3.5 Benchmarking

Benchmarking is a suitable supply chain management tool when there is *"...clear purpose, systematic data collection and analysis and the focus is specific and not too large."*[86] The benchmarking method can be described as a comparative measurement and organisational learning where the internal processes are judged against "best practice" in order to establish needs of improvements[87]. There are several usages for benchmarking. Practically useful is the method when determining new strategy and making process comparisons. Its great advantage is the ability to look beyond organisational boundaries when looking for the best practice of the present industry.

The usage of benchmarking in context of logistics and supply chain management has been used by both Bagchi (1996) and Gilmour (1999). Description of the benchmarking work method varies. In general, benchmarking should be a continuous process, tracking performance, with a defined focus. Conflict can occur in regards to the danger of sub-optimisation in the supply chain as result of benchmarking towards industries with different working strategies.[88]

[85] Breierova, L, 2001
[86] Schary, P.B et al, 2003, p. 258
[87] Spendolini, M.J, 1992
[88] Schary, P.B et al, 2003, p. 286

4. Present Situation

The aim of this chapter is to provide the reader with a clear understanding of Company X's distribution system and furthermore give a picture of the present and future happenings in the transportation market in Europe. First, the distribution network of Company X will be described and then the transportation situation in the European countries.

The current European logistic system was first deployed in 1999. Since then, the products using the system have expanded into greater volumes. To understand the system, the business concept as well as the products and processes need to be explained.

4.1 Business Concept and Strategy

Company X's strategy is to gain "*XX*"[89]. The elevator and escalator business is strongly regulated due to safety requirements. Therefore the maintenance is just as profitable as the new installation business but since there are laws which forces the proprietor to keep their elevator maintained, the elevator companies is regulated in pricing. However, it is an open market meaning the customer does not have to employ the company who did the installation to do the maintenance. Company X is therefore constantly striving to improve their A to win market shares. When focusing on the core competences the company has been decreasing its own production and trying to make the products more standardised. Due to safety regulations, the quality has a key role and the motto Company X is trying to work after is; "*XX*"[90]. They are at the same time working towards being a A company.

Company X's largest competitors globally are A and B, where A is ahead of Company X and B is behind. Together, these three companies are holding X percent of the global elevator market shares. C and D are also large competitors and can be seen as future threats to these three top companies and their positions. On A markets are the E companies with a strong trademark the largest competitors. The elevator business is a relatively narrow business with few sub suppliers so many of these work for all three leading companies.

4.2 Product Groups

Company X has the two main ranges; *elevators* and *escalators*. There are different product lines within these sections and for the various market segments. This is due to Company X's immediate market share thus the diversity in market requirements. The European elevator business is divided into two groups; *N* and *M*.

The new installations are furthermore subdivided into two different product lines; *A* and *B* which are elevators standardised down to a few variations. The A is a relatively simple elevator which is sold for both commercial and residential use but is most commonly sold in the residential market. It is highly standardised with only variations in for example size and colour. This product line is the largest among N in Europe. The B is a more specialised elevator which also is sold in both the residential and the commercial market. It comes in more variations and can be specialised according to customer's wish. The commercial market for B is often shopping centres and airports, where there is a use of a large elevator which

[89] Company X Home Page A
[90] Company X Home Page B

moves only a few storeys. The freight market for B consists of hospitals where beds are transported or industrial building where heavy goods are transported.

The C is a product line consisting of spare parts for a renovation of an already installed elevator and it can be divided into; *R* and *T*. The T is a change of only a few parts of the elevator whereas the R is a change of a complete elevator. It is a large difference between these two logistically where the volume of the packages can vary from a shoebox for the T to a whole elevator for the R.

4.3 Distribution

Company X's distribution of elevators on the global market is divided into U. The European market is separated into A areas with one large warehouse or hub in each of these areas. The hubs are located in V.

The B logistics providers responsible for the European elevator distribution are a mix of well known European players with a good coverage. They all have good knowledge of the elevator industry and some are also managing the distribution for the competitors. I has an extremely good coverage of larger parts of Europe which is their main competitiveness while L for example is a smaller company, still with good knowledge of the elevator business but have a very strong coverage of S and the T countries which makes them competitive towards for example I. They all do the pick up at the suppliers, consolidate at their own hub, and store the elevators until they deliver them to the site. When doing the site delivery, they can offer a truck with crane possibilities for the unloading of the elevator.

Figure 17: Illustrates Company X's present hub-structure in Europe. (Modified)

Source: Logistics Positioning Paper, 2007

The current distribution system consisted first of X hubs which were taken in to use for the optimisation of the product line, *S*; a first version of A. From 1999 both the B hubs have been taken into use to better serve the market.

There are E external suppliers (*Figure 22*) and F internal factories. On the inbound, from supplier to hub, the transportations are done on an X basis. On the outbound, the deliveries are mostly Y. However, for some countries for example P, the sales office is responsible for Z.

To keep trace of the elevators in the Company X system, each elevator has a commission number. The supplier pre consolidates all the components which he delivers for one elevator into one commission. All the components with the same commission number are then consolidated in the hub into an elevator (*Figure 18*).

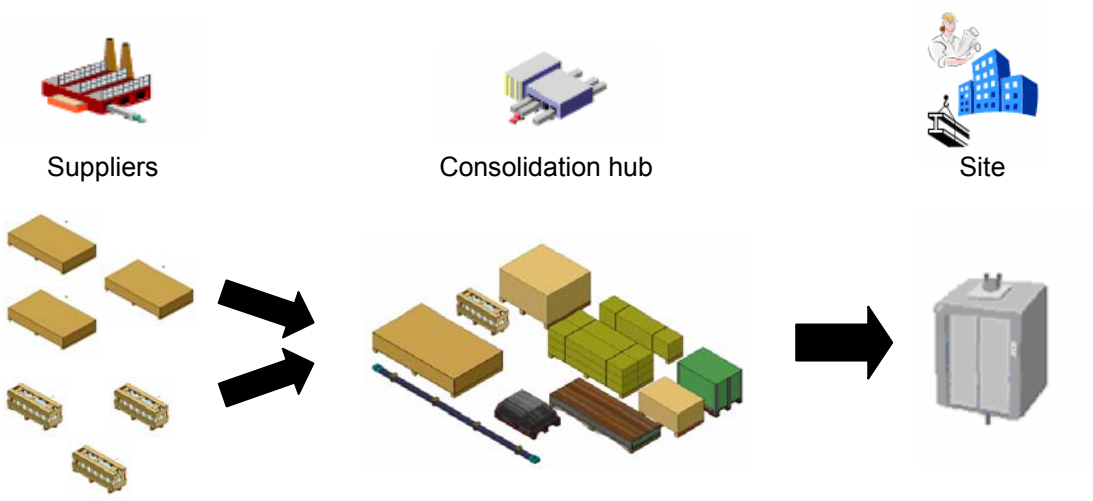

Figure 18: Description of the commission based system.

The price for the transport is Z meaning Company X pays the logistics provider A. The full truck price based on fuel, salaries, road taxes etc[91] is divided by the B. Due to the strict regulations from Company X, the LSPs do not often have the possibility to add non-Company X goods in the transports to improve the loading ratio, expect at special occasions. XX. This system is of course adopted to encourage the 3PL to always go with full truck. The price is also varying depending on how new the LSPs truck fleet is.

4.4 Inbound and Outbound Transportations

Company X is in the present situation mostly using road as a transportation mode since they find this mode to be the most competitive one[92]. This is based on the loading of the trucks which often must be done from the side due to the length of the components. It is therefore difficult to use for example containers for the distribution. The sea mode deliveries from A are used by the suppliers of Company X. However, in the future Company X will most probably source directly from B[93].

For the inbound transports to be optimised the volume C units is demanded[94]. This number was founded when the M hub was under consideration and is still a number frequently used in discussions regarding new hubs. The inbound and outbound flow is strongly differentiated due to the products. On the inbound the same sort of components is transported in the same truck which means the loading can be maximised as long as the weight is acceptable. It is also flexible towards changing of mode since the loading could occur in containers instead of trucks. The outbound on the other hand endures of fully consolidated elevators consisting of

[91] Chapter of Analysis: Cost Elements in Transportation Costs
[92] Internal employee, 13/11/07
[93] Ibid, 29/01/08
[94] Internal employee, 17/01/08

packages with large variances in design, volume and weight. Many of the packages are also non-stackable which make the loading of the trucks complicated and time-consuming. The outbound transportation is difficult to change since it would mean a change in the process i.e. the one delivery would have to be split into several deliveries which would require more warehousing and storage place.

The inbound transportations have increased in number the last years since the pressure of delivering on-time in the hub. The supply base however is more or less the same, therefore the transportations is from a distance point of view unchanged. The supply base is changing first when the product line is changing which is in approximately every D – D years[95]. The suppliers deliver to some or all hubs depending on the distance and demand/supply.

4.5 Information Flow

When the customer orders an elevator, the order goes from K (in the specific country) to L. The sourcing of components for the elevators are mostly made centralised from M but the purchasing orders go straight from K to L who manage and delegate further on. L is then letting the suppliers know approximately when the goods should be produced so they can plan in advance. The pull release tells the supplier and the LSP that the order is set and which date the product should be finished (*Figure 19*). When the product is produced, the LSP is informed that the product is ready for collecting. After picking up the goods, the LSP has F days to bring it into the hub and then F days to consolidate and to deliver. The elevator is first ready for delivery when all its parts have been consolidated.

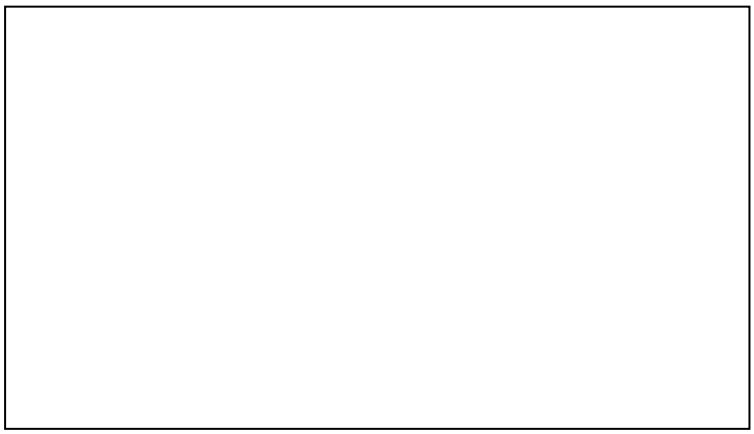

Figure 19: Illustrates the process lead time for new installations of elevators. (Modified)

Source: A General Presentation

K is organising and planning the installation and the technicians from Company X are sent when the site is ready. The technicians are receiving the elevator at the site. The delivery of the elevator can not be done without Company X employees while the drivers are only permitted to unload the elevator next to the truck since they often do not have the legal allowance to enter the construction area due to requirements of safety equipment[96]. Moreover, most of the deliveries of the elevators are done on Mondays at 8 am. This is due to the K who finds it easier to plan week by week and they do not have to pay the technicians extra for

[95] Ibid, 29/01/08
[96] Internal employee, 06/02/08

staying at the location over the weekends since it takes them approximately G to install a commodity. This does on the other hand lead to a shortness of trucks and difficulties to optimise the transportations.

The planned lead time for an elevator is between G to G weeks (*Figure 19*) where the delivery time is set to F days but the storage levels at Company X's warehouses are approximately F days. Since the construction site has an unreliable time schedule, the date for delivery is seldom the one first agreed. The seller from Company X who is responsible for the site has as a task X. This is why the storage time is far beyond the F days settled.

4.6 Supply Chain Management

The management of Company X is classic with a large number of management levels. The logistics planning and supply chain management are independently dealt with in the different departments. There is by other words no particular logistics department working on the varying topics. However, there is one independent supply chain manager who has projects focusing on the entire company. The logistic service is negotiated and purchased centralised from C, D and K are the buyers of the service. The purchaser from C and the internal clients decide how the logistic solutions should be designed.

The planning of the products is managed individually by each P who has a higher focus on the supply chain management than the departments mentioned above. The Ps cooperate on a project basis where one of the current projects is X. Even if the product lines work individually, the service level is the same for them all, which is a decision made from a top executive level. The service level includes the F plus F days for delivery.

5. Development and Trends

The aim of this chapter is to give the reader an insight of how the developments for design of distribution network, transportation and supply chain management have changed focused over the years. The chapter also presents what the future trends are within these fields. Firstly, distribution network design will be presented, secondly, transportation, and, lastly, supply chain management.

5.1 Distribution Network Design

The distribution network designs in Europe have constantly been changing. European companies have for a long time experienced mergers and acquisitions, and due to this been forced to constantly redesign their distribution network. In below text, the major network structures over the last 15 years will be described.

Prior to 1985, *traditional decentralised logistic networks* with limited European supply chain awareness dominated. Suppliers delivered to country specific warehouses or distribution centers. At this time, there were no logistic providers offering a full coverage over Europe so transports were arranged to cover local areas. All management of the distribution centre was done by each country and no or limited diversification in service level to customer existed.

The years between 1985 and 2000, a time when European companies fully began to operate as continental or global actors, *centralised logistics network* with moderate European awareness were adapted. This shift in distribution layout was mainly driven by the need for cost savings in the supply chains which was achieved by the economy of scale that arises from one warehouse. A centralised warehouse served as the hub and the distribution flow to end-customer followed a hub-and-spoke pattern. The hub was now used to satisfy the customer demand for the whole of Europe. Instead of the self-owned warehouses in the decentralised model, the management of the centralised warehouse has been outsourced to either an asset based or non-asset based third-party logistics provider. These logistics providers delivered fully loaded trucks to the hub and from the hub they delivered through logistic providers with strong local networks. With the centralised distribution model, the companies had to make sure that the operations in the single warehouse was more efficient than the sum of the existing local warehouses in order to obtain cost savings in inventory. However, cost savings were hard and not always achievable due to uncertainties in customer demand. Additionally, a centralised warehouse did not automatically lead to savings in form of economics of scales. The issue of demand uncertainty, however, was something both decentralised and centralised networks had to deal with but under different circumstances.

The decentralised model had an advantage here since the local warehouses had closeness to its market and the lead times for shipments from suppliers were shorter. For the centralised model the conditions were others. The warehouse had to keep enough stock to cover the demand fluctuations while long lead time shipments from suppliers in other continents were in transit. The result of this became that companies had to have an overlap in their product portfolios for the different European countries, which not many companies had at the time. Products were produced after local requirements and sold exclusively for each market. Consequently, a reduction in inventory in the centralised warehouse was hard to achieve when an overlap in the product portfolios was necessary.

From 2000 and beyond, the trend in designing an effective European distribution network is the usage of a *hybrid logistics network* with full European supply chain awareness. The hybrid or multilayered distribution model is based on the strategy of customer-service differentiation and the structure is to have a central warehouse that is supported by local or country specific satellite facilities. In this model, companies focus on customer service as their main supply chain driver by having different distribution channels for different products (*Figure 20*). In addition, another driving factor for the development of the hybrid model has been the need for many companies to limit their continuously increase of transportation costs. When the situation is as it is today with constantly rises of fuel costs, however not the only factor, the centralised model is not the most appropriate solution due to the larger market distances. Through the usage of differentiated distribution channels and satellite driven inventories in the hybrid model, it is possible to diminish these issues. The shipment deliveries are done either directly to customer or passing through a forwarding hub and then distributed on the market. The management of the operation in the central warehouse and its satellite facilities are often outsourced to third-party logistics providers. Generally, the logistics providers are responsible for central purchasing, stock level policies for the satellite facilities, and call-offs of products. The satellite facilities are used for managing the inventory through using a push mechanism which automatically goes off when inventory needs to be replenished.

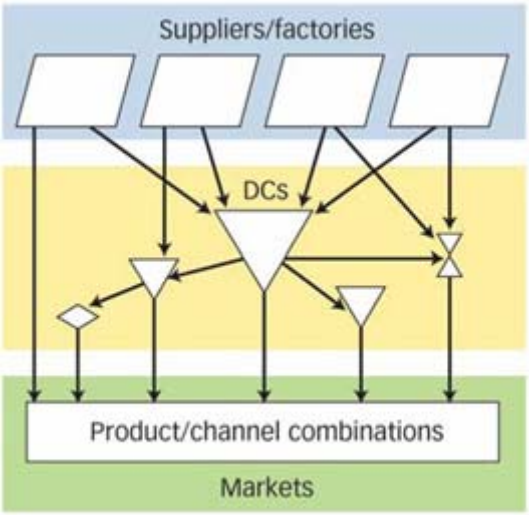

Figure 20: The distribution flow of hybrid model.

Source: Lasgaa, M, 2007

The hybrid distribution model enables flexibility due to the visibility that exists within the supply chain. Here, the supply chain renders a possibility for the centralised warehouse to have knowledge of current stock level, actual demand, and sales forecasts. Through this visibility, companies have an easier task to continuously work with supply chain improvements as well as cross-docking and merge-in-transit activities. This network design, to summarise in a few words, allows global thinking, European management and local actions.[97]

[97] Lasgaa, M, 2007; Jonsson, P et al, 2005; Appendix I: External Questionnaire

5.2 Transportation

"There has been a trend towards broadening the scope of transportation and logistics services with wider geographic coverage. There has also been a shift from asset based to skill-based logistics providers."[98] The trend for the future transportation market is an even more divided structure with specialisations in different areas[99]. The players would be lead logistics providers, 4PL, pan-European, niched, or e-commerce. These companies will become more designers and managers of the clients supply chain.

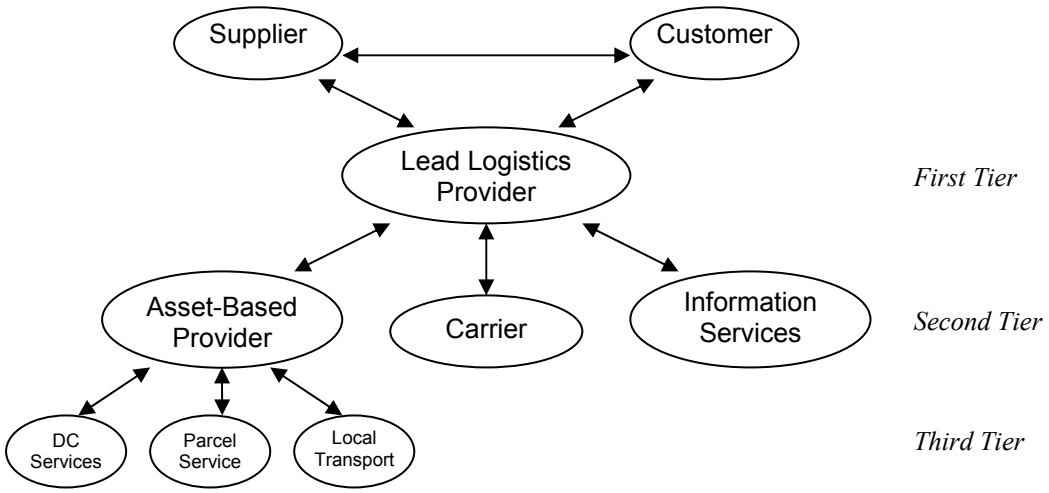

Figure 21: A future tier structure for transportations.

Source: Schary, P.B et al, 2003, p.244

The tier system shown in *Figure 21* describes a future scenario where the first tier represents the lead logistics provider or the 4PL. They would have a similar working method to each other including single handily working between the customer and supplier employing the second tier with more asset owned companies and information services. For special transportations, the first tier would employ niche logistics providers. Furthermore, the pan-European companies are the multinational and incredibly large companies with good coverage all over Europe within transportation, warehousing and value adding activities. These companies are few and most of the logistics providers have to work aligned with each other to achieve this kind of service. The e-commerce is companies delivering small shipments ordered on the internet.

5.3 Supply Chain Management

In the 1970s, the concept of total cost was given authority and companies started to properly review their businesses from the total cost perspective. It was also the time when companies first began to look on how to change the service levels between the different customers. These changes in management led to that executives introduced performance measurements on cost versus service trade-offs. This led to a different approach on the physical distribution flow. Distribution strategies of finished-goods were redesigned to only perform what the customer really required and asked for.

[98] Schary, P.B et al, 2003, p. 245
[99] Ibid., p. 238

During the 1980s, integrated management began to be used more commonly. Mainly companies in the low-value, consumer goods businesses adapted to this approach. The supplier base got more involved with the buying company. Inbound and outbound flows were identified during the early years but not yet integrated and managed jointly. The year of 1985, the term of physical distribution was changed and replaced by logistics. The change was based upon the need of a broader view of the physical movement of goods. Now the inbound and outbound flows were managed together and in combination with the inventory. This was moreover the very beginning of the concept of supply chain management.

In the 1990s, companies fully began to adapt end-to-end perspective when managing their supply chain business. Both supplier and customers were deeply involved and influenced the organisations. As a result, companies achieved higher supply chain efficiency as well as large increases in effectiveness and customer relevancy. Supply chain management gave attention to profitability and customer satisfaction. It has later become clear that companies which collaborate for a successful supply chain have three characteristics in common. *"First, they acknowledge their dependency. Second, they are willing to share strategic information. And third, they acknowledge and comply with cross-organizational leadership."*[100]

Year 2000 and beyond, has been characterised of the respond to pull management instead of push management. The actors within the supply chain are working jointly in order to satisfy the customer with last-minute changes. Supply chains compete against other supply chains and not as before when company were competing against company[101]. Supply chain management is starting to be seen as a core competence. Nowadays, companies focus on the creation of event visibility and real-time connectivity in the supply chain in order to receive a better overview of the actions taking place[102]. The management of the supply chains is changing from being a system influenced by the three corporate functions of purchasing/sourcing, logistics/transportation, and operations management to a system based on the capabilities of the modern firm; engineering, marketing, financing, accounting as well as purchasing/sourcing, logistics/transportation, and operations management. This change in focus emphasizes even more to work jointly across corporate boarders. Design in all forms is becoming more and more important, e.g. product design, process design, and supply chain design. The supply chain can in many cases be seen as the tactical supply chain, however, it is likely in the future to change to a more powerful supply chain; the strategic supply chain.[103]

The trends within supply chain management are, in other words, going towards an even higher focus on the supply chain's downstream; the customer[104]. New directions within supply chain management propose that it is time for an update of Michael Porter's *"the four Ps"* (product, price, promotion and place) to also include *"the four Rs"* (reliability, responsiveness, resilience and relationships)[105]. Suggestions are even also made saying the term of supply chain management is no longer appropriate and should be replaced with a term which more emphasize the value of network optimization; value network.[106]

[100] Bowersox, D.J, 2007, p. 4
[101] Waters, D, 2007, p. 24
[102] Bowersox, D.J, 2007, p. 4
[103] Melnyk, S.A, 2006
[104] Ibid.
[105] Waters, D, 2007, p. 27
[106] Melnyk, S.A, 2006

5.4 Description of the European Transportation Situation

In order to develop an optimised distribution network for the European market, it is important to be familiar with the lie of the land in Europe[107]. Europe is constituted of 48 different countries where almost each country has its own cultural traditions and language. In terms of area, Europe is the second-smallest continent. However, when seeing at the population size represents Europe the third largest continent. With these factors in mind, it is understandable why Europe is a complex case when deciding upon the best supply chain solution. Furthermore, it is also why different approaches work for similar business companies. The distribution structure has to achieve high levels of customer service to the differentiated European customer base which is influenced of cultural, political, economical, and infrastructural differences.

Out of the 48 countries in Europe, 27 are members of the European Union (EU) where the members are working jointly to maintain a common trade policy and a regional development policy. The European Commission is one of the several institutes in EU and they have developed a guideline, *White Paper*, for the European transportation market. In the 2006 version of White Paper, several directives have been outlined regarding how to decouple economic growth from the growth of problems which are closely linked to transport. The main problems to be diminished are pollution, noise, safety, and greenhouse gases.

According to the White Paper, one of the most important cause to the imbalance in the transport system is that logistics providers and transport users do not always, and not everywhere, pay the costs that respective transport mode are causing. As a result, a majority of the country members have introduced road tax systems. The road tax system aims to internalize some of the transport related costs to the sellers and buyers of the transports. Having a harmonised charging system will promote the use of better environmental vehicles, roads which are used for transport will be better optimised, and roads with low environmental impact will get a competitive advantage. In the long term the logistics providers will be encouraged to change their behaviour and deal with the real transportation costs. They will need to reorganize their logistics chains and even more adapt their choice of transport mode due to economical signals. The incomes from the road tax systems can be used for financing new transport corridors for road distances which are affected by congestion problems and landscape areas which are particular sensitive, i.e. the Alpine region. In this sensitive areas, White Paper have suggested that EU Member States should have the possibility to increase the road charges with 25 percent compared to average road charge in order to cross-finance other infrastructure which is of large European interest. In areas where it is not possible to avoid the Alps passes alternative transport modes and intermodal transports will take advantage of the harmonised charging system[108]. Furthermore, the charge per tonne for small to middle size trucks which run the Trans European network will be higher than for the heavy freight vehicles. Consequently, the logistics providers will thus to some extend be encouraged to use heavy freight vehicles and better optimise the transportations on road[109].

Regarding the freight rail network in Europe, White Paper has given direction of better support for creation of new infrastructure. This direction would give rise to a better linkage of the European freight rail network better than it is today as well as an attempt to eliminate bottlenecks in the system. Several "special" projects, *Essen list*, have been listed and planned

[107] Lasgaa, M, 2007
[108] Road Transport Policy, 2007
[109] White Paper, 2007

to be completed in the next couple of years[110]. For instance is a high capacity freight rail route crossing the Pyrenees planned to be implemented in 2020. As well as a European satellite navigation project *Galilieo,* which is scheduled to be finished in 2008.

Concerning the maritime and inland waterway transport systems, White Paper points out the need of better developed motorways of the seas. Furthermore, programmes for linking up the transport modes are stated. White Paper also outlines the work of linking the future Member States to the EU's trans-European network with high qualitative infrastructure in order to maintain the modal share of 35 percent for rail transport.

The following sections is mainly based on *Cnt Transport / Europe* article and will clarify more in detail changes and forthcoming actions within the transportation sector in a number of the more infrastructural important countries in Europe.

5.4.1 Belgium

A new road tax disc or vignette system for both cars and trucks is under agreement and soon to be implemented in the regions which make up for Belgium. Furthermore, the movement of trucks has been more strictly regulated than previously. Trucks are no longer allowed to overtake when it is raining or use the third lane of motorways. Moreover, they are limited to the speed of 90 kilometres per hour for vehicles of over 3.5 tonnes.

The railway sector in Belgium has experienced more actors and therefore a more intense competition than previous years. New actors are for example the SNCF, Rail4Chem, DCL and Trainsports. A new rail tunnel under the Escaut will ease rail traffic movements between the various basins of the port of Antwerp. This is an attempt to mitigate the likely major problems with rail services to ports in the forthcoming years.

Regarding the maritime ports in the Flemish area, the port of Antwerp and the port of Zeebrugge are both showing a strong increase of growth. In the Port of Antwerp, a further basin with a capacity of 7 million containers is going to be added on the Deurganck Dock. Investments are continuously made on infrastructure to ensure that the region maintain a develop plan for minimum of tonnage. The region of Wallonia has started to subside the river transport of containers on regular routes.

5.4.2 France

In France, there are a number of transportation projects running. The first to enter the market is a new "rail motorway" between Luxemburg and Perpignan which will transport truck trailers with the use of Modalohr technique[111]. Similar railway carriage of carrying road trailers and road tractors, so called Rail-Routes[112] are used between France and Italy. Next potential launch in the nearest future is the Seine-Escaut canal project which will probably come into service in 2013.

5.4.3. Germany

In Germany the first effects of the implementation of the road charge for heavy trucks have been evaluated. The conclusion was that there has been a reduction in the proportion of trucks running empty, a continuing of the tendency of own goods transport to shift to third-party haulage, and various transfers to other transport modes. However, it has been difficult to

[110] Appendix K: Essen List
[111] Chapter of Theory: Intermodal
[112] Ibid.

distinguish to what proportion these behaviour changes are due to the road charge for heavy trucks or are driven by the increase of the fuel price.

A study is being performed of the mobility of the population expected in 2050. The study aims to identify which regions of Germany will see the greatest growth and which one will see the greatest reduction in population.

5.4.4. Poland

In Poland, the road network is in a poor condition, however under gradual improvement. The government has drawn up a multi-annual programme for "infrastructure and development" where 58 percent of the budget will go to roads, 25 percent to rails, 10 percent to urban transport, and the rest will go to airports and maritime ports. In regards to road charges, Poland is likely to introduce a vignette and/or toll system. Throughout the whole country logistics activities is growing. It is both from domestic and international companies and they are predominantly located near the ports or in the regions of Warsaw, Poznan and Wroclaw[113].

The railway system is expanding under the Master Plan, Rail 2030. There are several new freight railway companies who are in good condition to compete on the market. The capital, Warsaw, is the centre of the network and improvements are being done in the Lodz area. The maritime ports in Poland are expanding due to the increased goods traffic.

5.4.5 Spain

The Spanish high-speed rail line is being constructed further. Two sections are going to be added to the network; one between Malaga and Barcelona and another will get to the French boarder. However, in Barcelona this has raised questions regarding the suburban trains and the quality of their service due to the high-speed rail tunnel under Barcelona. Furthermore, economic liberalisation of the railway sector is under pressure. The old operator has signed an agreement with the State to 2010 in order to ensure financial balance and renew its high-speed stock. However, five competitors have been approved for licences to operate at the market.

5.4.6 Sweden

Sweden has introduced an urban congestion charge in Stockholm with its purpose to move towards new infrastructures and public transport. The ruling government has put more focus and effort on supporting the road network than improving and expanding the railway structure. Further governance support is beeing given to the purchase of "green" vehicles. Environmental factors and improvements are also being investigated in the railway sector through the research programme "the green train", which is a high-speed train.

5.4.7 Switzerland

The Swiss government has just as the Swedish taken actions against climate change. In Switzerland, the government offers a subsidy for purchase of clean vehicles and act ahead of the Euro 5[114] standard[115]. In the beginning of 2006, Switzerland increased the road charge for trucks by 50 percent which led to huge revenues. Regarding the sensible ecosystem in the Alps, a ceiling of 650,000 heavy trucks per year from 2009 has been put as a goal. Moreover, Switzerland is now a full member of the European Union Galileo project.

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[113] Horstmann, U 12/02/08

[114] Chapter of Introduction: Definitions

[115] European Union Homepage, 2008

6. Analysis

The aim of this chapter is to give the reader an understanding how the analyses have been performed in order to propose a new hub-structure. The analyses have been done on the current situation of hub-structure, new potential locations for hubs, future challenges within transportation market, and on the total cost of changing hub-structure. This chapter is structured in the same order as above mentioned analyses were performed.

6.1 Analysis of the Present Situation

The sub-chapter analyses Company X's present logistics system. First, today's transportations flows and market areas are generally analysed and later examined in a SWOT-Analysis.

6.1.1 Distribution and Transportation

Company X is working with B logistics suppliers for the European elevator business. Due to the restrictions of delivering in F days on the inbound and F days on the outbound, the logistics providers do not have much freedom to optimise the transportations themselves. They receive reprimands if they do not deliver in time. The term 3PL can be used but they do not use the advantage with a modern 3PL, which would demand more integration into the management and optimisation of the transports. Furthermore, in terms of distribution roles, the logistics providers are having the role of consolidation but if some of the sourcing will be done in A, the logistics providers would presumably have a variant creation role with assembly added to the working tasks since the lead-times will become much longer and will therefore demand standardised components (*Figure 3*).

6.1.1.1 Inbound

The inbound transportations, Y million vehicle kilometres, are C of the outbound transportations. This is due to the loading ratio of the inbound transportations which is much higher than of the outbound. *Figure 22* shows the inbound transportation for 2007 but the figure does not consider the differences in volume. Interesting is the location of the suppliers (Blue dots in *Figure 22*), which is more D European based than expected since many of the purchasers are talking about sourcing from E. The transports are not widespread but more focused on particular stretches due to the fixed locations of the suppliers and hubs. The current hubs are not bad located considering there are G both in the surroundings of H[116]. However, the purchasing within Company X has become more centralised and most of the suppliers are now delivering to all hubs. The closeness to the hubs is therefore not a large benefit in the over all perspective and the transportations on the inbound are still not as optimised as they could be. However, since the close distances between the suppliers, there are opportunities for an optimisation of the inbound flows.

[116] Chapter of Theory: Location Analysis

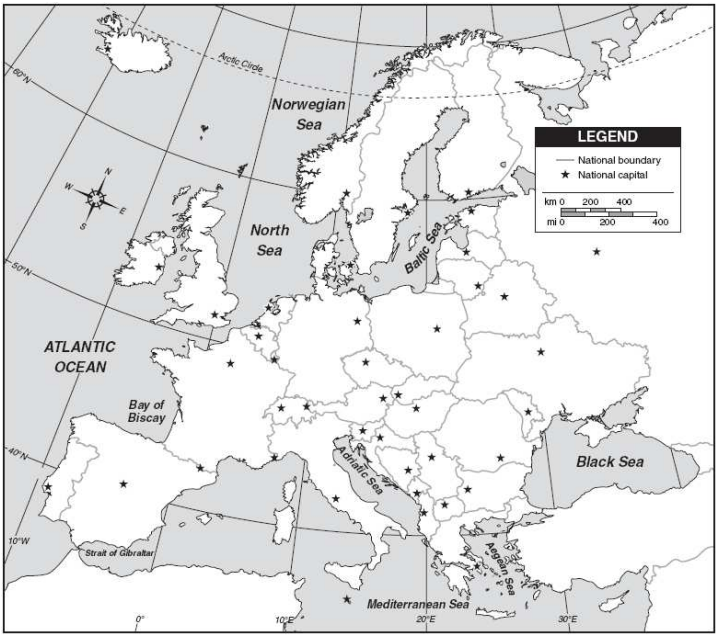


Figure 22: The inbound transportation flows. (Modified)

The clusters around the hubs of I are the remains from the time when Company X used to have factories in these areas. Company X is not making use of the clusters for the transportations i.e. the transportations of goods from these areas are not coordinated together. One reason for this is the total focus on "*XX*" which Company X has adopted after long delays from the component suppliers. To avoid reprimands, the logistics providers are forced to leave for the hub even if the truck is not yet fully loaded which could have been the case if they had waited one or two days more. However, the close distances between the suppliers give the opportunity to introduce for instance milk-runs or a pre-consolidation in the nearest hub[117]. In order for this to be implemented it is of course a requirement that the logistics providers are given more freedom. Instead of forcing the logistics providers to do the inbound transportations within F days, they would have to deliver to site in F days but be given the freedom to coordinate and optimise the transports within these ten days themselves. If this were to be done, the pre-consolidation and the milk-runs would be a successful way to cut down the costs. It would also open up for the possibility to do the longer transportations on the inbound by rail. This would of course demand an adequate volume filling more than one container per week.

A further example would be for the LSPs to have a hub-and-spoke network where another layer of warehouses is added prior the current hubs[118]. The disadvantage with all these suggestions is the current insufficient packaging of the goods, which would by adding another handling step increase the risk of damaged goods.

If the sourcing is moved more towards A, the transportations on the inbound would indeed increase. Sourcing from A involves B, which would more or less force Company X to have some kind C. If Company X starts sourcing from A, a change of the network would be impossible to avoid.

6.1.1.2 Outbound

The outbound transportations are shown in *Figure 23*. The lines represent the flow in both distance to the markets and volume delivered. The largest flow is in A. The longest distances

[117] Chapter of Theory: Optimising Road Transportations
[118] Chapter of Theory: Different Types of Hub-and-Spoke Networks

are from B. The outbound transportations of Y million vehicle kilometres are twice the amount as of the inbound. Since the difference in driven kilometre, the outbound costs are also the double the inbound costs. It is therefore important to decrease the distances to the market by moving the existing hubs or adding more hubs. There is much to suggest that a decentralised network is the favourable although considerations must be taken to the increase of inbound transportation costs and the fact that the network will probably be more complex to control and manage[119]. Thus, by moving to a decentralised hub-structure the costs for outbound transports decrease whereas the costs for inbound transports increase.

The trends in distribution are to have a multilayered satellite system to be able to cut down the transport costs. One way can be to have a virtual hub structure[120]. The requirement for the virtual network is to employ only one logistics provider who would be a third or even a fourth-party logistics, which would coordinate and manage all planning and executing of the transportations. By moving the virtual hubs as close as possible to the market, the transportation costs would decrease but it would also work in favour for a higher service level[121]. However, for a virtual network to be implemented successfully, the changing must be a slow process. Company X is a large company with many layers of management and to change all in one time towards a virtual network would be too radical. Nevertheless, a suggestion is to work in the direction of a virtual hub-structure.

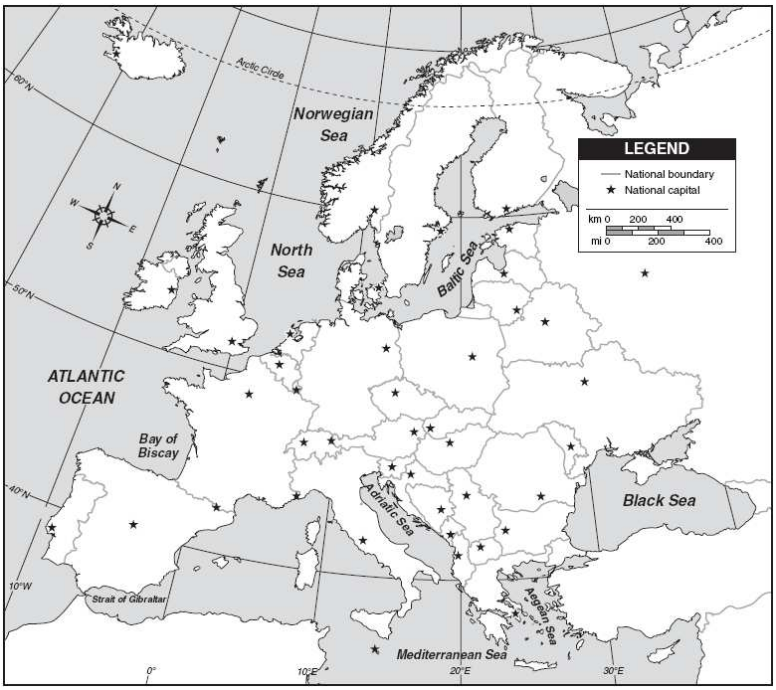


Figure 23: The outbound transportation flows. (Modified)

By looking at *Figure 23*, it is possible to distinguish that the hubs are not optimally located. If the centre of gravity moves more towards A, the hubs will be even further displaced from the market than today. In B, the hub is much more Eastern located than the market but missing in the figure is the fact that C is the biggest market in B. The location is therefore not as bad as it may appear to be. The location of the hub is outside D where the communication to the rest of the country is very good. The advantage with B is that it is a logistic centre created by the

[119] Chapter of Theory; Decentralised Warehouse Structure
[120] Dr. Laurence, P 19/2/08; Chapter of Developments and Trends: Distribution Network Design
[121] Chapter of Theory: Differentiating Service Levels

government who has made it easier for the logistics companies to settle there[122]. The B hub, which serves E, is located west of its market centre. It is by far the largest hub in both volume and driven kilometre. When the F countries were included in the network, most of the countries were added to F. The delivered amount of elevators to the Eastern Europe is in the current situation over C units, hence the larger amount of driven kilometre and costs. The advantage with G as a hub location is the closeness to H, which still is the main market in Central Europe. The I hub has its advantage with being close to J and if sourcing from K or L, a hub close to a harbour is a good base for a well working network. The I hub is located well regarding both infrastructure and closeness to the market. The M market is by far the largest market for the I hub even though the map does not show it. All the hubs are well located considering road communications.

The hubs are according to Company X, thought to be merge-in-transit hubs where a consolidation from many different suppliers is occurring[123]. The goods are however not only passing through the hubs but also stored for the average amount of F days. The long storage time gives yet another reason to discuss the pressure Company X put on the logistics providers to deliver within F days on the inbound. For the F days to decrease, the changing or approving of the processes might be the key for a good solution. If the employees responsible for sales would do a A, the storage time would most probably decrease. A lot can happen on a construction site in G to G weeks, which the current lead-time is, but adding this element is a step in the right direction.

The forwarding hubs that Company X is using, can be described as cross-docking hubs i.e. the elevators is delievered from one hub in the prior layer and they are only passing through the hub to be loaded into another truck[124]. Company X should however decide if they want this type of system to be used throughout their network and in that case work towards a shared profit with the logistics providers. As mentioned before, the closeness to the market is playing a key role for the cost reduction and having a system with a layer of forwarding hubs is therefore a good solution. The question is how many and where these forwarding hubs would be located. If they were located close to larger cities, it would very much make the deliveries easier since there are and more regulations are coming of how, when, and if the trucks can enter the cities. However, looking on the transportation flow, the larger cities have large amount of deliveries, which already gives the possibilities to fill the trucks. Outside the cities, the volumes are lower which means these trucks have a much lower loading ratio and is therefore in greater need of a hub to optimise the transports. For the deliveries outside the larger cities, the suggestion of a virtual network and hubs is by far the best. Then the elevators would use the logistics providers' network which is not dedicated for Company X and the transportations costs would most certainly decrease.

The future transportations on the outbound will probably move its centre a bit more towards the A parts of Europe. This since Company X is expecting B while the C if not even slightly decrease. If the market moves more towards A, the transportations would increase significantly. At least D is therefore unavoidable if the market keeps growing. By outsourcing the transportations and storages to an LSP, the binding of the capital is minimal and will not have an impact on the risks. The units sold in E last year, well beyond the limit of C units per hub for optimised inbound transportations. If there is an F, the G hub could very much stay at the same location since it would become more in the centre of gravitation without the H countries.

[122] Internal employee, 16/01/08
[123] Chapter of Theory: Merge-in-Transit
[124] Chapter of Theory: Cross-Docking

6.1.1.3 Market

The elevator market is dependent on population and size of the country since this influence the building of high residences in need of elevators. Therefore, it is almost exclusively cities constituting the market. The bubbles in *Figure 24* are representing the sold volume for 2007 in each larger city and its surroundings. In M, the sold quantity was C elevators, in Z C, in P C, and in W C. The colour of the bubbles illustrates which hub is serving which market. Blue is X, yellow is Y, green is U, and red is V. The purple bubble in B illustrates the amount of commission exported by sea. The variation in number of bubbles per country is depending on the difference between the largest and the smallest domestic market. The comparison between S and G serves well as an example where S has fewer bubbles since the larger cities have much more deliveries than smaller cities. The amount delivered to the smaller cities is therefore added to the nearest larger city. The bubbles in G are more due to the relatively same amount of delivered elevators to each city.

Company X's largest market is A followed by the B. The elevator market has grown with Z percent per year for Company X the last years. The growth has been even higher in the C parts where the expectations are higher than Z percent per year in average in the future.

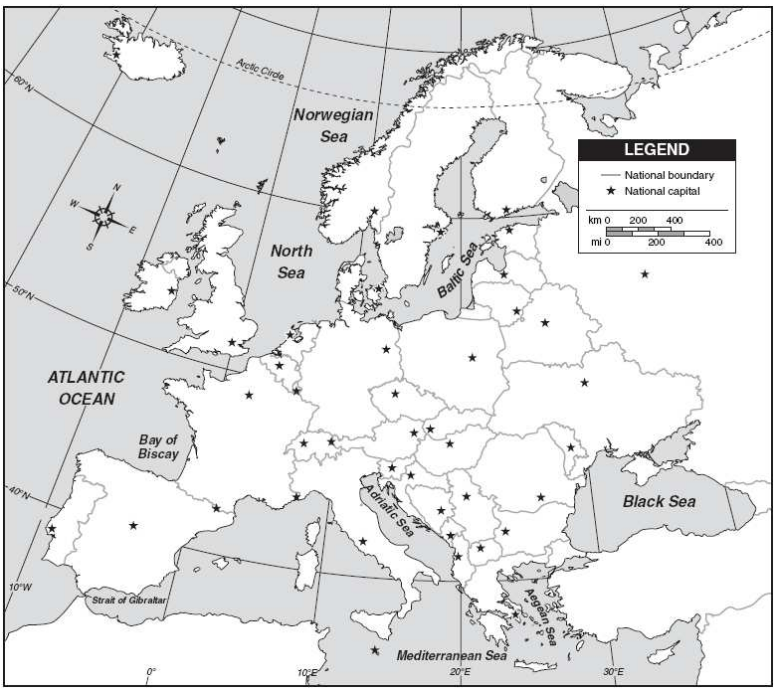


Figure 24: Mapping of current customer market. (Modified)

There is a connection between the largest market of M and the largest market of N[125]. Since M is a service of an already installed elevator, one can draw a connection between service and N instead, meaning the N business is successful where the service business is large. There is a logical reason for this since the core competence is X, which therefore draws the marketing focus. However, to be able to provide X, they first have to enter the market. If the entering is late or not successful enough, the high X level will not have its influence on the N business. In A, B, and C the entering of the market was successful and they have through X built a strong trademark which is illustrates in the N business.

[125] Appendix B: Market

6.1.2 SWOT-Analysis

Company X's advantages and disadvantages towards their competitors is analysed in the following SWOT analysis, where the logistics is the main area of evaluation. The analysis is based on today's situation and will constitute as a foundation for a proposal of a future network.

6.1.2.1 Strength

The strength with Company X's existing network is the A delivery. This is a requirement since the staff performing the installations are expensive to have on site without working. The distribution system is therefore designed for the deliveries to be done within an hour's range from decided point in time. There is also strength in the B, which the current system holds. Since the transportation is outsourced, there is no country in Europe that cannot be covered by at least one of the logistics providers already employed. The lack of asset bindings gives the flexibility to change system and to employ other logistics providers than the already existing. The present network has a good coverage of the Western European elevator market although the number of hubs may not be optimal. However, more hubs could lead to a volume below C units per hub.

Company X is winning business on A within the escalator business. The competitors are sourcing most of their components out of China while Company X still is sourcing from B. This gives Company X the advantage to be able to offer a delivery of an escalator much quicker and with a more specific delivery time than the competitors do. This is worth considering as the elevator business within Company X is planning to source from D. It would demand E, which would have to be stored in F.

6.1.2.2 Weakness

The focus on A has forced Company X to put a lot of pressure and surveillance on the logistics providers and has not allowed these companies to work according to their best ability. The F days on the inbound has been a massive centre of attention with punishment if exceeded but the outbound however has been put off the attention since these problems are more complex. In total the system has led to better delivery safety from suppliers but also longer storage times. The lack of trust is influencing the cooperation between Company X and their logistics providers in a way that they are not working towards shared profits as the theory of supply chain management is aiming for.

Furthermore, a lot of focus within Company X is put on cost reduction. They do not see any profit in long term by adding costs for improvements. This restrains Company X from making decisions that could be a much better solution for the future. One example for this is the number of handling steps, which must be held down since the packages are not good enough. Adding costs for improving the packaging may not be an option even if lot of money can be saved in the end a by adding another handling step for instance forwarding hubs.

6.1.2.3 Opportunities

The opportunity Company X has in the current situation is to be market leader in A. It is important for them to be present in these countries before the construction market is blooming in full, which is to expect in the nearest future. If B, the service level would be improved and the costs for the outbound deliveries would decrease.

6.1.2.4 Threats

One threat to Company X's development is A, which would influence the economic development thus the construction business in both Western and Eastern countries. The

transportation costs are more than likely to rise with increasing in road taxes, fuel, and the working hour directives will strongly affect the personnel costs. This will influence the entire elevator business but it is the one best prepared and most cost efficient who will have the biggest success. The cost efficiency does not necessary mean lowest cost but money best spend.

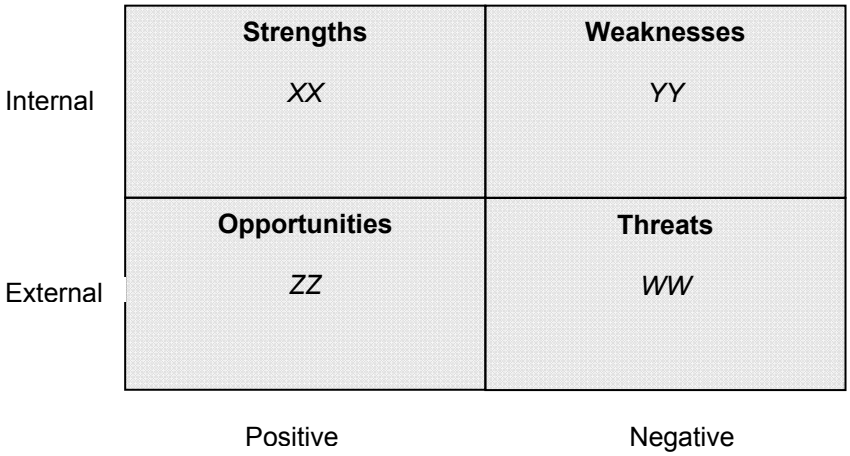


Figure 25: A summary of the SWOT analysis.

Source: Kotler, P et al, p. 52

6.1.2.5 What will make Company X win market shares?

Their strategies are to focus on high service, high quality and to be a low cost company[126]. These three strategies are somewhat misleading since it is very difficult to be a low cost company and still have a reputation of having high quality products[127]. The demands from the customers differ with the markets. In Europe, there is a difference between North and South and West and East. In well-developed Western countries quality is a key function for the trademark. It is important for entrances in new market to have the appropriate product and for the Eastern parts of Europe the costs is more of importance even though the quality must be at a certain level, a so-called threshold level[128].

The question to be asked in this thesis is following; *how can Company X win business by changing its hub-network?* A is one of the main goals due to the large expense in letting the technicians wait at the site before the elevator arrives. The flexibility gives the company the opportunity to serve different markets when required but it does not give an advantage towards the competitors who are in the same position. B for the escalators is more interesting since it is actually giving advantages towards the competitors. This might be adoptable in the elevator part as well. The discussion regarding sourcing in C[129] has opened the idea of producing to stock i.e. postponement[130]. Company X is ordering by full customisation even if some of the components are entirely standardised by product line. It would therefore be a good idea to evaluate which of the products that could be made to stock in order to shorten the lead-time. This would even decrease costs by increasing the loading ratio in the trucks and optimising the production at the suppliers. The products would preferably be of lower value and volume but if the transport costs go up greatly, all standardised products can be taken into consideration.

[126] Chapter of Present Situation: Business Concept and Strategy
[127] Dr. Laurence, P, 19/2/08
[128] Chapter of Introductions: Definitions
[129] Internal employee, 29/01/08
[130] Chapter of Introduction: Definitions

6.2 Analysis of New Potential Hub Locations

This sub chapter will describe the analysis of how the optimal numbers of hubs and their locations have been decided. The sections below follow the work procedure which has been used when analysing a new optimal hub network. The first section covers the description of the distance optimisation analysis. Thereafter, a new dividing of the country markets is explained which is based on the mapping of today's elevator volumes and the distance optimisation analysis. For the purpose of providing further information on where to locate A, the last section describes a country selection.

6.2.1 Distance Optimisation

When analysing where the hubs should be located, it has been made through an optimisation of the distance to main market. The rationale behind this approach has been to reduce the cost be moving closer to markets. Consequently, to find the optimal hub network, which will provide the lowest total costs; it is necessary to first improve the outbound situation since this will offer the greatest cost savings and later examine the inbound challenges.

The work procedure of the distance optimisation has been done by grouping all short zip codes to area zones for each country. The guiding principle used was to identify the largest cities in each country and grouping the short zip codes after them. For instance in Italy, the short zip codes in the surrounding of M has been grouped to M area. The reason for this group of zip codes is the need of minimising the large amount of information in the data. It would have been possible to measure the distance to every short zip code for each country. However, since only *Microsoft Excel* and an on-line based distance calculator tool, *ViaMichelin,* have been used it would have involved huge amount of work effort and probably not provided any further information. Additionally to grouping the zip codes, consideration for the grouping has been taken to the pricing list from the logistics providers to deliver to each zip code. The pricing is different for the different short zip codes but is somehow arranged after codes located in the same region.

After the group of all short zip codes, distance calculation from each existing hub and from locations of potential new hubs to the new area zones were performed by the help of ViaMichelin. Later, it could be compared and decided where for an optimised distance point of view makes most sense to locate hubs. The requirement to open a new hub is at least C units and this information has been the foundation when deciding the number of hubs.

6.2.2 Market Division

The market division is primarily based on where the largest markets volumes are located today but also supported from the distance analysis. In order to get a clear understanding of how the new markets have been grouped, the dividing between the markets can be seen in *Figure 26*. The circles indicate a market which should be served from the same hub. Each market circle has been critically reviewed from a centre of gravity perspective. In other words, if the current existing hub within the circle is located in the centre of the volume or if the hub location should be modified to other position which is more optimised in terms of outbound distance. All of the five circles have been questioned in similar way and examined by measuring the number of kilometres. Thereafter, a total cost analysis has been made to secure that any modifications and supplements of the existing hub network not leads to costs increases but only cost reductions[131].

[131] Chapter of Analysis: Total Cost Analysis

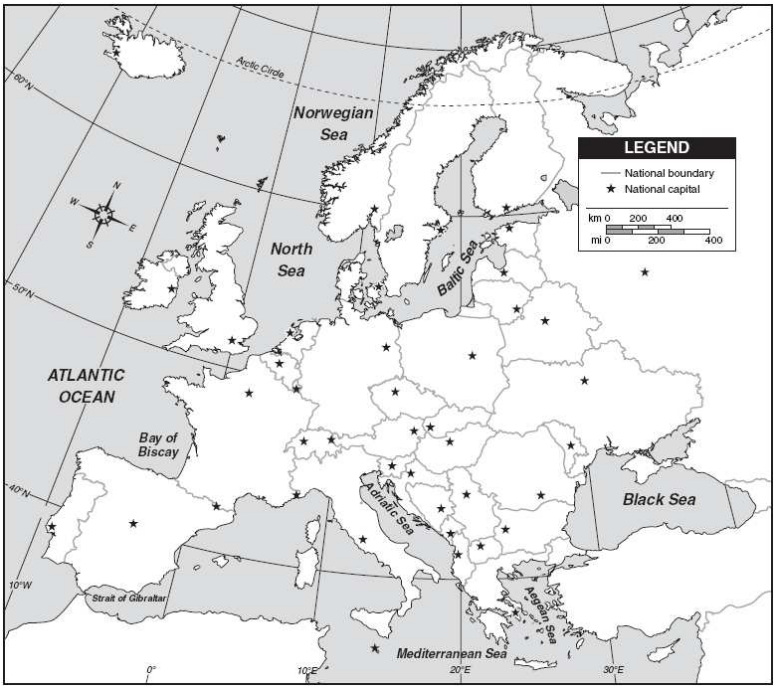


Figure 26: The new market dividing between the A hubs. (Modified)

6.2.2.1 A

Looking at the S and P market, they are today served from the upper A, which pure visually does not look to be the centre of gravity of the commission volumes. However, from an inbound point of view the hub location of today is perfectly placed[132]. As mentioned previously, the greatest savings are to be found on the outbound and therefore has each existing hub location been predominantly examined from a closeness-to-market perspective. The location of hub B has been compared to moving it to the direct surrounding of C. By this, the truck kilometre on the outbound would reduce with Z percent (Y truck kilometres) but the inbound truck kilometre would increase with Z percent (Y truck kilometres). Furthermore, additional cost on warehousing has to be considered with a movement[133].

6.2.2.2 B

The A market with suggested market split will be divided into two; South and North. The South part of A is served from hub C and the North part by hub D. With this new market dividing, the market volume will be significantly reduced for hub C. As can be seen in *Figure 26*, the hub is today serving a widely spread area of Europe; X (yellow dots). With the modification, however, hub D will only supply South and Middle of E. In terms of commission volume will this lead to a decrease with Z percent and in terms of units: C commissions. From an outbound perspective, the change in market group will give high truck kilometre savings. The outbound truck kilometre will be reduced with Z percent (Y truck kilometres). On the inbound truck kilometres however the change will be less dramatic; a decrease of Z percent (Y truck kilometres). These reductions of truck kilometres for the hub C must be seen together with F. The new hub and the new market split for hub C should in other words must be compared jointly with the old hub C since much of the old market for hub C been tranfered to D.

[132] Appendix C: Inbound Transports
[133] Chapter of Analysis: Total Cost Analysis

6.2.2.3 C

The A markets are not dramatically changed with the new market division. The B will supply more or less the same countries as today but with the modifications of delivering to the Northern parts of D which includes the large elevator market of E as well as stop transporting to the F. In terms of distance optimisation, the D are much better served from a hub in B. Thus, the new market division will mean for hub B that it delivers to following countries; X.

By changing the market for the B hub, it will lead to an outbound distance reduction of Z percent (Y truck kilometres). The inbound transports, however, increases with new market split with Z percent (Y truck kilometres). As can be seen, the total amount of truck kilometres increases for the B hub. The reason behind this is because the hub will now be responsible for a larger area than it is today. It is important to clarify that each hub should not be compared individually with before new market division and after new market division. The comparison must be done by summarising the transports for inbound and outbound for all the hubs before market division and after market division..

6.2.2.4 D

The A hub is moderately affected by the new market dividing. Today, the hub is delivering elevators to countries such as; B, C and D. With proposed market dividing they will continue to supply B and C but not D. From a distance point of view, these countries are better served from an E hub. Today, the hub in A has a commission volume of slightly less than C units and with the new market split they will handle around C units.

In terms of truck kilometre, both the in-and outbound distances are reduced by the new market division. The inbound truck kilometres are decreased with Z percent (Y truck kilometres) and the outbound with Z percent (Y truck kilometres).

6.2.2.5 E

The entire A market is with the new market dividing only served from one hub; an E hub. Today, hub A is mainly supplying this market with assistance from hub B. The C region constitutes of the largest area with the most widely spread markets compared with the D markets. In the longer future, it would make sense to investigate the possibility of using E hubs in this region in order to even more optimise the outbound transportations. However, then it is important to bear in mind the minimum number of commissions needed for open a new hub as well as potential increase of inbound transportation.

Furthermore, with an A hub the total outbound truck kilometres for this hub would be approximately Y kilometres. Adding them together with the new outbound kilometres for hub B would this lead to a reduction of total truck kilometres with Z percent (Y truck kilometres) compared with the existing outbound kilometres for hub B. Consequently, changing the existing division between today's hubs and an additional one hub in C would lead to large improvements on the outbound. Additionally, it is important for Company X to be present when the emerging markets take off in order to gain market shares. To be able for Company X to compete on these markets, they have to improve their distribution system and make it more competitive against others. An immediate solution is to further expand the existing hub network with D. Moreover, today Company X is offering a high service level in terms of being able to deliver on requested hour and in order to keep this it is important that the hubs are close to the markets. The high E is considered to be one of Company X's competitive strengths and therefore the new distribution network must also be able to provide this service successfully.

The exact location for an A hub is difficult to conclude. There are not large differences from a distance point of view to the main markets if the hub would be located in the border areas of B. However, in terms of economic and social aspects it is known there are differences between the countries. Therefore, the next section will describe the country comparison of these five countries. The comparison aims to provide a further knowledge basis for deciding upon which of the countries is to locate a new hub in.

6.2.3 Country Selection in A

Based on the distance optimisation, it is clear that the truck kilometres will be reduced with a hub in A. Then comes the question; where in A the hub should be located in order to best cover the A market. Due to some differences between the A countries and the small differences in distances optimisation, the judgement was made that a country evaluation would provide further knowledge for decision-making of which country in A is the most appropriate. When looking at the current and potential future market in A it can be seen that the largest volumes are in the Central A. Therefore, it makes sense to have an hub in the Middle of A.

The centre of gravity in terms of volumes has been estimated to be in A after visual analysis and consultation with Company X employees and external experts[134]. The countries of interest in A are following; B, C, D, E and F. A table of the five countries together with seven evaluation criteria of individual weighting has been put together in
*Table **1***. Below text will describe each criterion more in detail followed by a discussion of the evaluation outcome. The weight of the criteria has been developed after the importance for Company X e.g. closeness to main market is more important than port connections[135].

Table 1: A location analysis. (*Baseline: 2007 plus outlook to 2013). (Modified)

	Weight					
Main market distance	*20*	*5*	*10*	*5*	*5*	*10*
Supplier base distance*	*20*	*8*	*9*	*8*	*6*	*9*
Infrastructure	*15*	*10*	*6*	*7*	*7*	*7*
Salary level	*15*	*3*	*6*	*6*	*7*	*8*
Economics aspects	*10*	*10*	*8*	*5*	*7*	*5*
Port connections	*10*	*8*	*1*	*8*	*10*	*8*
Cluster possibilities	*10*	*5*	*8*	*5*	*5*	*10*
Result		***625***	***640***	***605***	***610***	***765***
RECOMMENDATION						***BEST***

The main market in the A part of Europe for Company X is to be found in the capitals of the five countries. The largest single market is however in the B area. Therefore, the Middle point of the main markets will be somewhere in the between of C and D.

Today, the majority of the A European *supplier base* is located in area of B in C. There is also a supplier coming from the West part of A and in the forthcoming future suppliers are estimated to be situated in the far West of A. At the moment, Company X is working on increasing the number of suppliers in A as well as start source more from D.

The infrastructure in A consists of ten traffic corridors which are covering principally the main part of the A region (*Figure 28*). The figure shows how the infrastructural connections

[134] Else-Jack, D; Horstmann, U; Dr. Lawrence, P; Letosa, L; Omist,W; de la Puente, M.J; Tobajas, J.L; Volume, A; Weyandt, J, 16/01/08-28/02/08
[135] Ibid.

are divided in X. B has about 133,800 kilometres of paved roadways. C has about 424,000 kilometres of roadways. D has about 127,900 kilometres. E has about 43,000 kilometres of roadways. F has about 159,600 kilometres of roadways[136].

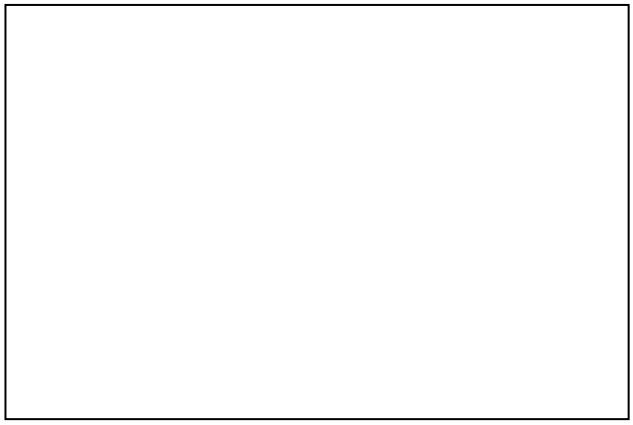


Figure 27: Illustrates the infrastructure in Europe. (Modified)

Source: Prof. Dr. Kummer, S, 2007

The low *salary level* along with the low tax rates and well educated labour force in B is well-known by foreign investors. B is therefore a popular investment country especially in the automotive industry. The *economic growth* of B in 2001 – 2007 has developed above expectations although the majority of Europe was experiencing a slowdown. Their unemployment however is still a critical part of B´s economy and was in 2007 estimated to 8.6 percent.

C´s market economy is well developed and is closely connected to other EU economies and then practically G´s. High standard of living, great labour flexibility and great labour participation of the aging population are further characteristics for C.

The economy of D is considered to be the strongest of the A European countries and grew with 6.5 percent of GDP in 2007. Today, D´s private sector is booming and consumer price inflation is among the lowest in EU; at 2.1 percent in 2007. However, D has another side. Their unemployment at almost 13 percent in 2007 is one of the highest in the EU and rising wages represent a risk to the stability of the consumer price.

E has a developed and high-income economy and is one of the most stable and well doing of the A European countries. Although, the balanced economic growth is threaten by the rising inflation from higher food and energy prices. The salary level in E is approximately 80 percent of the European Union average.

In F, the private sector stands for over 80 percent of GDP and foreign ownership of and investment in companies are widely spread around the country. The corporate taxes are low as well as the inflation, although it is starting to rise and get regulated. F has large budget deficit and the government will need to put additional reforms to ensure the long-term stability of the public finance. Furthermore, the government expected a slow GDP growth in 2007 and is likely to continue in 2008.

[136] The World Factbook, 2008

Port connections in the A are to be found along W as well as by U. Since Company X has given indications of the possibility to source more components from B in the forthcoming future, good port connections and maritime corridors to the seas are an advantage. D is the only country of these five which has real sea connections. F, B and C have connections to the W where shipments from the seas can be transhipped on the W.[137]

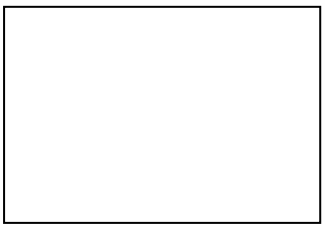
Cluster possibilities in terms of suppliers are most likely to occur in B than in the other five countries. Group of suppliers can give cluster advantages in many areas such as sharing knowledge and risks together as well as arranging common transportations. In the A part, there are one supplier in B and one in E. Moreover, the existing suppliers in A Europe will probably relocate some share of their production to the A part of F.

To summarise, B is the country in A which is most appropriate for locating a potential hub in, according to the country selection evaluation. However, this analysis must of course be complemented with a research of what kind of competitive facilities the different logistics providers are offering in each country. In other words, a decision for exact location of an A hub must be evaluated mutually with the logistics providers. The country location selection should therefore act as a guideline when choosing upon right hub location of the selected A countries.

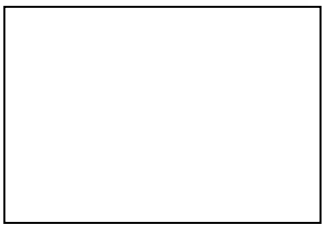
6.2.4 Proposals for New Optimised Hub-structure

With the distance optimisation analysis, the new market division and country location selection in A two proposals of new hub-structures can be concluded. The two proposals differ regarding which is the optimal hub location in A. In order to conclude which locations in A are most favourable, the two proposals will be evaluated from the perspectives of total truck kilometre as well as from a total costs aspect (inbound and outbound costs and storage costs)[138].

Proposal 1:



Proposal 2:



[137] The World Factbook, 2008

[138] Chapter of Analysis: Total Cost Analysis

6.3 Analysis of Future Challenges within the Transportation Market

This sub chapter will discuss which future market and costs challenges the new distribution network has to handle and withstand. The future challenges to be expected are primary a continuing market growth of the elevator business in Europe as well as a continuing increase of the costs involved in transportation. Firstly, the future market development in the different European countries will be discussed and estimated. Secondly, a discussion will be followed regarding which future costs increases are to be expected in the next five years. The outcome of these two analyses will first be used in a sensitivity analysis and later in a comparison analysis of the total cost to see what the consequences will be by keeping the existing distribution network or changing to a new one.

6.3.1 Future Market Development

As mentioned before, the market growth of the elevator business is much depended on the general economic development. Many indications have shown that the current economy in Europe will probably not continue to grow with the same rate compared to the last previous years, especially with the credit crunch in mind. The outcomes from the internal questionnaire show indications that they expect the market development for new installations can in some worst cases slightly decrease. Below table summarise the future expected market growth for new installation and replacement in Europe (*Table 2*).

Table 2: Expected growth between different countries in the next years.

	Estimated Market Growth
XX	*Z – Z% per year*
XX	*Z% per 3 years*
XX	*Z% per 3 years*
XX	*Z% per 3 years*
XX	*Z% per 3 years*
XX	*Z% per 3 years*
XX	*Z% per 3 years*
XX	*C elevators per 3 years*
XX	*Z% per 3 years*

Source: Appendix J: Questionnaire – Internal Experts.

The factor which influences the market growth for new installations is how developed the country is. The Western countries are all mature markets and show small signals of spectacular increases in the forthcoming years. Here, the modernisation business is expected to stand for the largest revenues. Therefore, the Western countries are not presumed to grow with more than Z – Z percent per year the next five years.

The Eastern countries, on the other hand, are all countries which are more or less under development. They are expected to stand for the growing markets in the future. The last ten years the Eastern countries have made it easier for private and foreign investments to take place which has influenced the building industry positively. The estimated market growths for these countries are difficult to say on an annual basis since the growth rate could differ much depending on global and national economic situation for each year. Therefore, it should be noted that above numbers for the Eastern countries are in same cases high if they are

compounded over the next three to four years and especially given that possible impact of the credit crunch.

For analysis purpose, the future market development for the European countries has been divided into low and high market growth. For the Western countries, the high growth is assessed to be Z percent per year, which is Z percent on a five years period. With regards to the global economical situation and the character of the country markets, low growth is estimated to be Z percent increase on the next five years. For the Eastern countries, however, both low and high market growth have been assessed to show increases. On the high growth, the Eastern countries are each of them assumed to grow with Z percent per year, which is Z percent on five years time. Low growth is believed to increase with Z percent per year, which is Z percent on five years time.

These two scenarios of high and low growth development for both the Western and Eastern countries have been estimated through consultation with the internal employees at Company X.

6.3.2 Future Fuel Price Development

If there is something certain about the future in transportation market, it is that the prices in the nearest future indeed will go up. The difficulties are to estimate how much they will increase as well as what impact on the costs the potential changes of transport regulations can have. The European Commission is working hard to balance the two conflict situations of, first, the public demand on improved mobility and, second, the growing dissatisfaction of delays and insufficient quality on transport[139]. In order to achieve a sustainable development of transportation, the European Commission has introduced an outline plan for the infrastructure of the transports on a European level.

This section will describe how the future cost development has been worked out. In order to estimate what the future total costs increases for transportation are going to be, analyses have been done for identifying the different cost elements and how much each element are predictable to increase.

6.3.2.1 The Division of the Cost Elements in Road Transportation

It is difficult to distinguish the different cost elements which contribute to the total costs. Several countries measure different elements and group different costs together. Therefore, in order to come up with right amount for the costs elements several sources of information have been used. Furthermore, the cost shares have to be representative for all the European countries since the same price increase will be adapted for all the countries.

Figure 28 and*Figure **29*** are both showing the division of the total costs. Personnel and fuel costs are representing the largest shares and contribute therefore the largest impact of a potential increase. The left figure shows how the transportation costs are divided for Belgium whereas the right figure has posted the split for all the Western countries under EU and the Eastern countries separately.

[139] White Paper, 2007

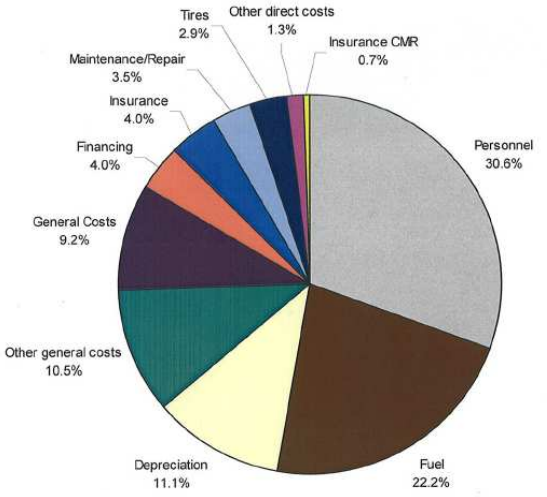


Figure 28: Illustrates cost elements of road transportation in Belgium.

Source: Institut Transport Routier et Logistique Belgique, 2007

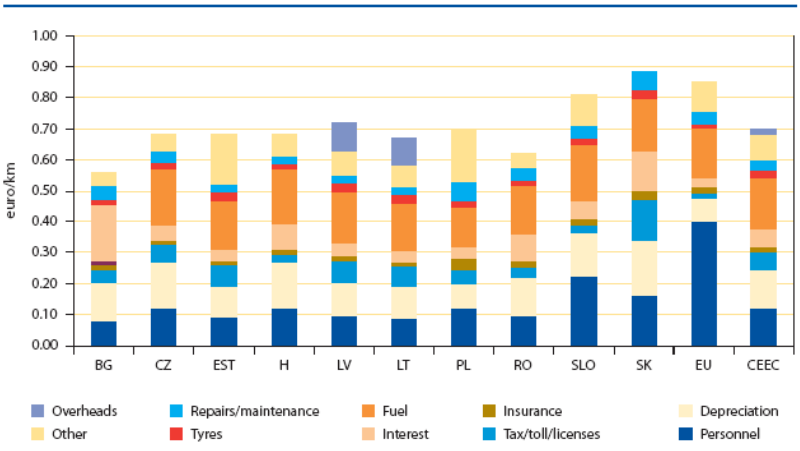


Figure 29: Cost per kilometre of international road haulage (1998). CEEC stands for The European Committee of Construction Economists.

Source: White Paper, 2007

It should be noted that *Figure 29* is based on data from 1998 and therefore the transport price are not up-to-date, but the split is still fairly valid. As the column indicates, the personnel costs stand for nearly 50 percent and the fuel costs stand for almost 20 percent in the EU. Many of the countries mentioned in the figure are now members of the EU so they are closing the gap of transportation costs. The fault in the figure is the small percentage the tax constitutes which should be a lot larger.

Since the calculation of the cost increase for the transportation will be put as a percentage increase on all the European transports, a general division needs to be done of how much each cost element represent. Based on the above *Figure 28* and*Figure* ***29***, it has been analysed and concluded that personnel costs, which means salaries for the truck drivers, stands for 40 percent, fuel costs for 25 percent, road tax for 10 percent, and others for 25 percent of the total transportation costs. Under others are all the costs grouped, which are assumed to follow a normal inflation increase development i.e. the costs such as interest, insurance, depreciation, maintenance, and tyres.

Table 3: Concluded split of different cost elements of the total transportation costs.

	Personnel	***Fuel price***	***Road Tax***	***Others***
General division for all European countries	*40%*	*25%*	*10%*	*25%*

6.3.3 The Development of Total Cost for Transports to 2013

The development of the costs for road transportations is difficult to predict, especially when estimations needs to be done for five years in advance. In order to get a proper evaluation of the new distribution network, it is necessary to make a forecast of what the future real costs are likely to be. In the cost calculation, today's transportation costs will be transformed with a future estimated cost percentage increase.

By knowing how much each cost element will increase together with how large share each cost element stands for, it is possible to calculate expected total cost over the next years. Therefore, this section analyse future cost increases. The discussion below is mainly based on the external experts' and the logistics providers' opinions and views on the costs development. Considerations have also been taken to what the consequences most likely will be of the European Commission's actions regarding changes in the transportation market.

The external experts and the logistics providers were asked to express their judgments on the future development of the different factors (*Table 4*). The table shows a summary of the findings from the questionnaires. In general, the external experts show more negative believes about the future developments whereas the logistics providers do not share the same strong cost growth thoughts.

Table 4: Based on external experts' and logistics providers' answers from the questionnaires[140].

	Fuel price (incl taxes) € per litre	***Salary level***	***Road tax***	***Regulation and directive***
External experts	*€X – X*	*+ Z – Z%*	*+ Z%*	*Targeted road pricing "Eurovignette"*
Logistics providers	*€X – X*	*+ Z – Z%*	-	*Less working hours*
	Worst case: > €X			

The fuel price: Both the experts and the logistics providers think the fuel price development will continue to increase. Today, the average fuel price is € 1.08 per litre which is based on the fuel prices from the following countries; Belgium, Spain, France, Germany and Slovakia A worst case scenario for the industry would be if the price hit over €X per litre, which might occur.[141]

The salary level: Z percent of the external experts and Z percent of the logistics providers, strongly agree that the salaries for truck drivers will increase within the nest five years. The majority anticipate a Z-percentage increase of the salary levels. Both groups believe this increase of salary in the short term will affect the transportation market in further lack of drivers, an increased demand for improved driver productivity, and better efficiency.

The road tax: Both external experts and logistics providers suggest that the strongest growth of road tax will take place in; *driven kilometre tax* and *point in time of day and level of crowd ness.* Additionally, the external experts claim that the road tax of *localisation* (the charges differs from where the roads are located due to differences in road maintenance, frequency of accidents) will grow as strong as the others whereas the logistics providers say that the tax

[140] Appendix I: External Questionnaires
[141] AA Roadwatch, 2008

connected to the vehicles' features will grow just as strong as the others. 75 percent of the external experts strongly agree that there will be an expansion of the road tax system in Europe and the other 25 percent agree. 100 percent of the logistics providers say that they agree regarding an expansion of today's road tax system. The expansion of the road tax system will take place in both countries which do not have a road tax system today and in countries where a road tax system already exists. Suggestion were made that a European harmonisation of the road tax system is to be adapted in the future. The logistics providers on the other hand believe that the expansion will only occur in countries where the road taxes do not exist today. One suggestion was that all the countries currently considered to be new entrants to the EU will enact a road tax system over the next five years.

The regulation: External experts do not expect any changes or new legislations regarding the truck drivers working hours. However, this is something the logistics providers can see coming more of in the future. They maintain that less working hours for the truck drivers will lead to an increase of transit times, further shortness of drivers, and higher costs. Furthermore, rules driven by safety concerns are issues both groups are expecting coming more of from the EU in the next five to ten years. The external experts claim that further targeted road pricing will be likely regulations coming from the EU as well as more taxes related to the environmental issues. Suggestions say that the directive of 99/62/EC (Eurovignette) will expand its penetration in Europe over the next five to ten years.

6.3.3.1 Summarised Future Challenges

The table below summarises the division on the cost elements in the road transportation and the general cost development for the future (*Table 5*). The four different cost elements have been given an individual percentage share of the total transportation costs. Furthermore, the four cost elements have been rated with three different cost increases. The three different percentage increases are based on the analysis of what the potential increase for each cost element will be in a five years time. The low and high cost increases lead to low and high cost impacts.

Table 5: Concluded expectations of the development for the cost elements.

	Personnel	***Fuel Price***	***Road Tax***	***Others***	***Total***
General Division for all European Countries	*40%*	*25%*	*10%*	*25%*	*100%*
Increases per Cost Element :					
Low	*+Z%*	*+Z%*	*+Z%*	*+Z%*	
High	*+Z%*	*+Z%*	*+Z%*	*+Z%*	
Calculated Transport Cost Impacts:					
Low	*Z%*	*Z%*	*Z%*	*Z%*	***Z%***
High	*Z%*	*Z%*	*Z%*	*Z%*	***Z%***

The shortage of truck drivers are already a large problem within the transportation business and will most likely continue in the future. The truck driver as an occupation in the Eastern countries has gotten more and more competition from other occupations. Therefore, the salary levels are valued to increase with at least Z – Z percent in the next five years. The business is not experiencing the same benefits of low cost drivers from East at the same extend anymore as they did in previous years.

Furthermore, the European Commission has expressed thoughts of further lowering the working times for truck drivers. The working time directive has been suggested to change from 10 – 12 hours to 8 hours per day. For the long journeys, this can mean that the logistics providers will have to use two drivers instead of one which of course leads to additional costs.

The fuel price has the recent month hit new records every time and with this in mind many are speculating if the future development will continue with the same rapid pace. Suggestions have been made that in five years time the fuel price will most probably hit €X per litre. From today's basis this means the fuel price will increase with approximately Z percent. If the fuel price reaches constantly new heights the search for alternatives fuels will become even more noticeable. The transportation companies will have to be more efficient by better optimising their transports. The logistics providers experience a constant pressure of the requirement to steady update their vehicle fleet to become more environmental friendly. The European Commission has directives that a certain amount of the fleet needs to of Euro 5 vehicles.

In order for the market economy to expend, it is necessary that the infrastructure is improved and further developed to cope with the constant strains any expansion would give rise to. The European Commission sees a road tax system as one way to finance future improvements. The commission has expressed thoughts of developing a harmonised charging system on a European level. A harmonised charging system would involve that regions and roads with heavily congestions problems or located in sensitive environments would implement a mandatory charging fee. The public sector must contribute to reach an improved transportation by better plan their journeys. However, this can only be done through economical incentive.

The low and high transport cost impact in *Table 5* will be used in the next sub-chapter of scenario analysis as low and high price development.

6.4 Sensitivity Analysis in terms of Scenarios

The numbers in the prior chapter make the base for the scenarios. From the middle range are a maximum and a minimum growth for both the transportation cost and the market growth. This gives four scenarios where one is a best and one is a worst (*Figure 30*). The percentages represent both the increase per year and the total change over a five year period.

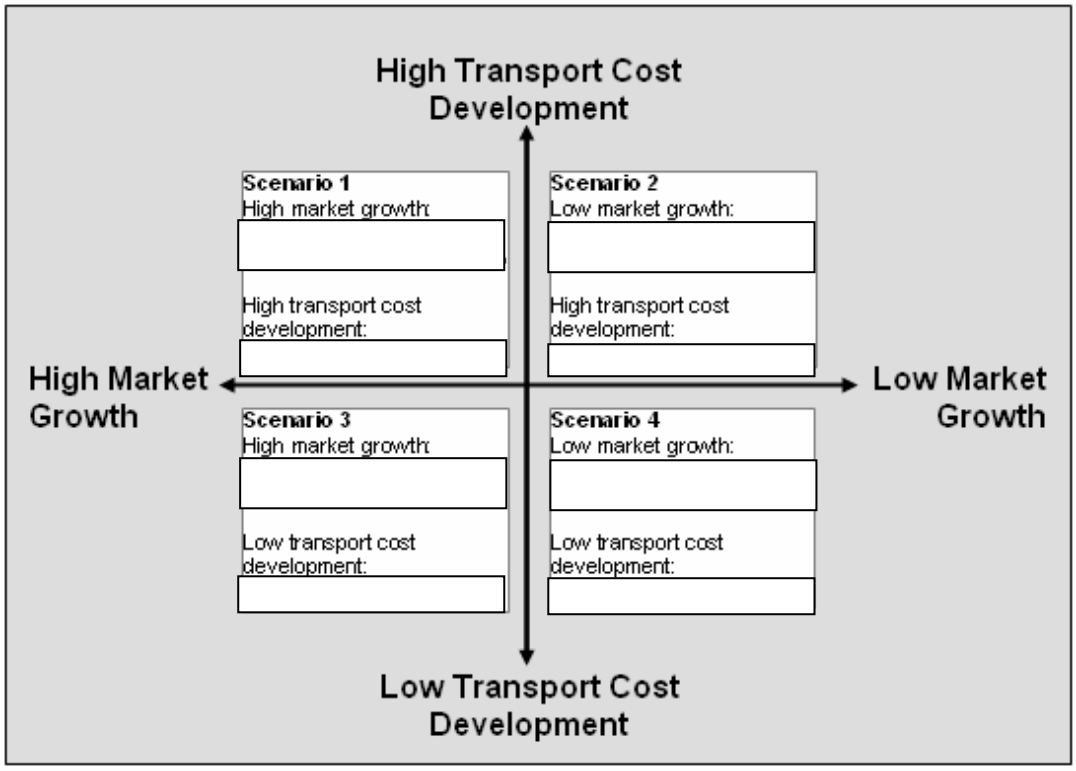


Figure 30: Illustrates four scenarios with different markets growth and transport cost increases.

The market growth in *Scenario 1* is expected to increase strongly in the Eastern part of Europe and more moderate in the Western parts. The transport prices will also grow heavily with impacts such as working hour directive and fuel price development. The scenario is supposed to be an extreme view of the future in order to analyse the maximum outcome and the costs it brings. When both the market growth and the cost development are high the result is expected to be an average of the outcomes from all the scenarios. This scenario is quite possible to occur but it requires that Company X A.

Scenario 2 is the *worst case* with a high price development but with a low market growth. This is most likely to occur since much indicates that Company X's market growth is going to stabilise, at least in the Western parts of Europe. The indications are based on the sales during 2007 and 2006 in comparison to each other.

Scenario 3 is the *best case* with high market growth and low costs. This is very unlikely to happen since the fuel costs have been increasing heavily the last year and the working hour directive for drivers and the road taxes may increase a great deal.

Scenario 4 is the extreme towards low. For the same reason as just mentioned this scenario is also quite unlikely to occur. The scenarios are thought to help Company X prepare for the future and also to be used as a sensitivity analysis of the new network. The different results

will show how the new network copes with both extreme and more modest changes. By changing the parameters from the scenarios, the result will tell if the system is sensitive or not. The non-sensitive is the better result since it will prove the system presumably decreases Company X's costs no matter what the future holds.

6.5 Total Cost Analysis

In this sub-chapter, the calculations will first be explained and later followed by an analysis of the result of the calculations.

6.5.1 Explanation of Calculations

When calculating the cost analysis, a grouping of the transportation system has been made into three separate areas (*Figure 31*). This is done in order to simplify an otherwise very complex logistics system. The grouping is based on the natural pass between the different services that are performed within the logistics system. The first area is the inbound transports, which represents the service carried out by the logistics providers between the suppliers to the hubs. The second area constitutes all costs related to the hub e.g. the costs for storage and handling goods. The third area is the outbound transportations handled by the LSP. For each of the three areas are calculations performed for both the existing situation and for the new proposed hub-structure.

The inbound and outbound transportation areas are comparable in the case that the same service is being provided; deliveries from one place to another. However, there is large difference in the value of the goods between the two. In the inbound deliveries, the goods being transported are components of an elevator and in the outbound, transportation of complete elevators take place. However, no consideration will be taken to the capital bound during transport due to too large difficulties in identifying what type of product has been transported from the received data.

When estimating the loading ratio, the differences in weight and volume of freight being forwarded in the inbound and outbound transports will be calculated differently. Thus, a further reason to keep the two transportations separated.

Figure 31: Illustrates the division of logistics costs.

The received data was arranged into inbound and outbound transactions. The inbound data included information about *number of commissions, supplier, ECH, planned ex-works date, ready to pick-up date, ECH-in date, type of material* and *product line*. Whereas the outbound data consisted of information about *number of commissions, country and short zip code, ECH, ECH-out date, site delivery date, split deliveries,* and *product line*. In order to extract the right information for the huge data volumes, pivot diagrams in Excel were drawn up and conducted into new data files. The inbound and outbound calculations are structured and follows the same counting procedure (*Figure 31* and*Figure **32***). With the *as-is* situation means that calculations are done from the basis of how the hub-network is looking today whereas the *new* situation means that calculations are performed on the new proposals of hub-structure. For each of these situations the costs are determined on two basis; *today* and *future*. By today means that the costs are calculated from how the commission volume and prices are today and by future means that the costs are pre-calculated in a five years time with a future estimated price increase and a future estimated market growth. Furthermore, when calculating the future

number of truck kilometre this is represented of the current truck kilometre multiplied with a market growth factor.

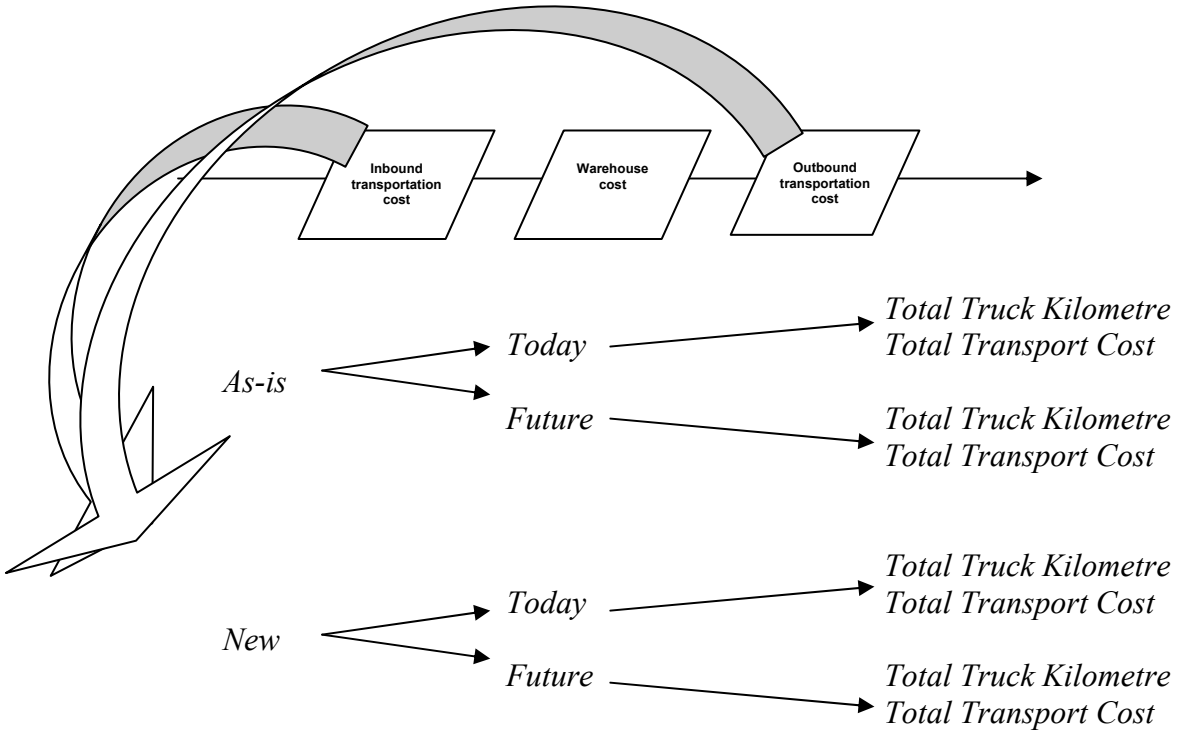


Figure 32: Illustrates the structure of the inbound and outbound calculations.

The inbound transportation costs are based on calculations of the number of delivered commission and the transport price from each supplier to each hub (*Equation 1 in Appendix E)*. The transport prices are supported from A with the agreed prices for Company X. Furthermore, in order to calculate what the new inbound transportation costs will be for deliveries to the new hub locations, the cost per kilometre has been calculated. The truck kilometres are calculated from the number of trucks going from each supplier multiplied with the distance between each supplier and hub (*Equation 3*). The information about number of trucks departing from each supplier to each hub has been estimated by D. This estimation is based on the number of commission from each supplier and with the knowledge of how many commissions in average that can be loaded in one truck, i.e. each supplier's loading ratio.

The outbound transportation costs are calculated in the same way as for the inbound; the outgoing number of commissions from each hub to each country zip code is multiplied with specific transport price per commission (*Equation 5*). The total truck kilometre per hub is determined by first a calculation of the total commission kilometre per hub and then a division of the average loading ratio per truck (*Equation 7*). The average loading ratio is estimated by analysing the loading ratio for all outbound deliveries for the representative month of April for three different countries; Spain, France and Germany (*Equation 9*).

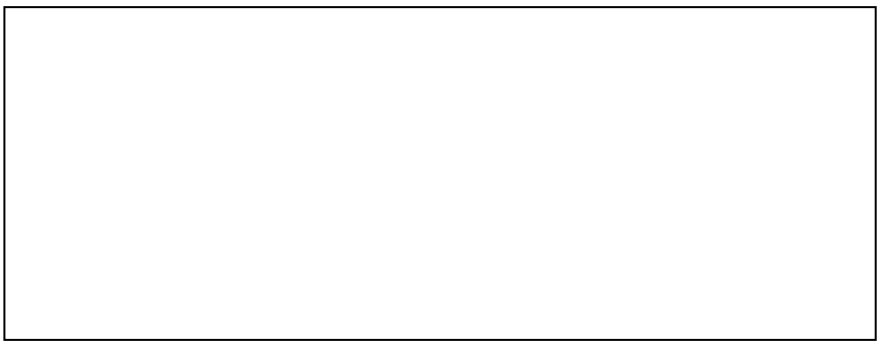
Neither the inbound nor the outbound transportations have been calculated in a tonne-kilometre system since the weight is varying a large amount between the different product lines and also with the number of stops an elevator has. For achieving a good comparing result between inbound and outbound, it was concluded that the truck kilometre was what should be the calculated factor.

The warehousing costs are based on the knowledge of following data; *annual inventory volume, handling charges, fix operation costs, staff salaries,* and *administration costs*. When calculating the warehouse costs, there are two parts of costs to consider; one is depending on A and the other one is depending on B (*Equation 11*). The first part constitute of C. The required amount of staff and storage space is estimated from the annual commission volume. The second part is a D. Company X has different agreements regarding the variable charge with their logistics providers. The future warehousing cost is calculated from today's cost multiplied with a price increase factor as well as a market growth factor (*Equation 12*).

6.5.2 As-is Situation

The results from the calculations are presented in *Table 6* and is divided into *As-is* and *New* hub-network. For both situations calculations are performed for costs and truck kilometres.

Table 6: Truck kilometres and costs per hub for *As-is* and *New* hub-network. (Modified)



The total costs for the current situation is €X million where the outbound has the largest share. The A hub is the prime hub in both volume and kilometre. By Z Europe, the inbound kilometre would increase with approximately Y million kilometres however the outbound would decrease with over Y million kilometres. The net impact would be a total decrease of nearly Y million kilometre and €X million. The outbound cost are with the proposal still a lot higher than the inbound which indicates that there are more to gain in being closer to the market. This however would be solved by having a virtual network with hubs always close to the market. The volumes and the cost split between the different hubs are with this proposal more even which makes the hubs more equal in size than previous. The storage cost would increase with the volume but also with an average salary increase of four percent per year.

The location of the B hub has been discussed in sub-chapters of inbound and outbound analysis and the calculations show a small advantage for the M location in total kilometre. However, the storage costs for the proposal are uncertain and in the table they are based on a Z percent increase of the X costs. This results in a total cost benefit for the B location even if the total kilometre is less for the M location. Even if the costs for having a hub in M is not an addition of Z percent, the difference in kilometres are too small and therefore the proposal is too sensitive towards changes in the storage cost. Thereof, a movement of the hub from B to M is not an option.

6.5.3 Scenarios

The result from the scenarios is represented in *Figure 33*. The scenarios characterise the total change over a five year period and the saving represents an annual saving and in *Figure 33* is it the savings of year of 2013. The annual savings are between Y – Y million truck kilometre which is a cost saving from €X – €X million[142]. This indicates that the model is fairly insensitive towards the uncertainties given in the sensitivity analysis. The saving in percentage of the total costs is from Z – Z percent which also gives an indication in the insensitive direction. If the market growth is extremely high and the Eastern market is blooming, A may not be enough. This is the reason why the costs are increasing much more for scenario 1 and 3. However, cost increases are represented in all the scenarios since this is expected to occur in a longer term. The comparison of the current hub-network with increasing costs and the new hub-network with increasing costs is the important factor. The annual savings can also be seen as the annual loss if not implementing a new hub-network.

Figure 33: Result from the scenarios.

Scenario 1 gives a saving in over Y million kilometre, which is more than the kilometre savings from the 2007 situation, but the cost reduction is still €X million. This is Z percent cost savings. The A hub is starting to grow immensely and if the market grows as much as a Z percent in the B Europe, the dividing of the C market may be necessary. The virtual hub-network would still be the optimal solution but having D would be a first step.

Scenario 2 is the worst case scenario with low market growth and high costs but it is also much likely to happen and is therefore used as a lowest cost reduction scenario per year. In the worst case scenario will the profit from the proposal only give a difference of €X million compared to the €X million from scenario 1. This is still a very good number considering it is only a first change towards an eventual virtual network. The savings with adding an Eastern hub and edifying the markets are Y million kilometre but the costs savings are €X million. The savings are Z percent, which is the lowest saving among the scenarios but is still a very high lowest level.

[142] Appendix F: Total Cost Comparison

Scenario 3 was expected to be the best case scenario and the result is the anticipated. Since the high market is the transportations increasing but with almost Z percent. The price per kilometre is on the other hand low which means the total cost is not as high as scenario 1 as an example.

Scenario 4 is the extreme case of both low market growth and low transport costs. The total kilometre has increased with Z percent but the costs not much higher than the 2007 situation. The savings with the proposal compared to the current net-work are Y million kilometre and €X million. This is a Z percent saving which is well above the goal explained in the introduction chapter.

The savings in percentage is the highest for scenario 3 and 4 whereas the lowest is for scenario 1 and 2. The 2007 volume gives a savings percentage of Z percent and with having the transport costs increase with the lowest amount the savings on above is 10 percent. The lowest savings are in scenario 2 with only Z percent but this is still well according to the goal of Z percent described in the introduction chapter.

7. Final Proposal of New Optimised Hub-structure

This chapter will present and describe the final proposal of the new optimised hub-structure for Europe. The chapter will discuss what the new hub-structure would mean for Company X, how the existing hubs will be affected, and how the flows of in/outbound transportations will be transformed.

7.1 Additional Hub in A and Realigned European Coverage

After an extensive analysis, it has been concluded that the optimal hub-structure for Company X would be an additional hub in A and a realigned coverage of the European market (
*Figure **34***). The greatest advantage with the new network is that it is substantially better optimised to the customer markets than the present one. The overall transports can be reduced by between Y – Y million truck kilometres, depending on future scenario (*Figure 30* and*Figure **33***). In terms of costs, Company X would annually save between €X – €X million by a change of the network. A further benefit with new proposal, it does not require that any dramatically change will have to take place when adapting to the new system. From an environmental point of view, the new proposal renders a contribution to reduce the CO_2-emissions due to the reduction of driven truck kilometres. The new proposal constitutes of all the C existing hub locations with the D. The only changes that will need to take place are the new modifications of the hubs market coverage. By the D, Company X will be able to become more competitive and get an opportunity to win more business in A Europe. Today, Company X receives complains from many directions regarding their poor activities in supporting the Eastern European market.

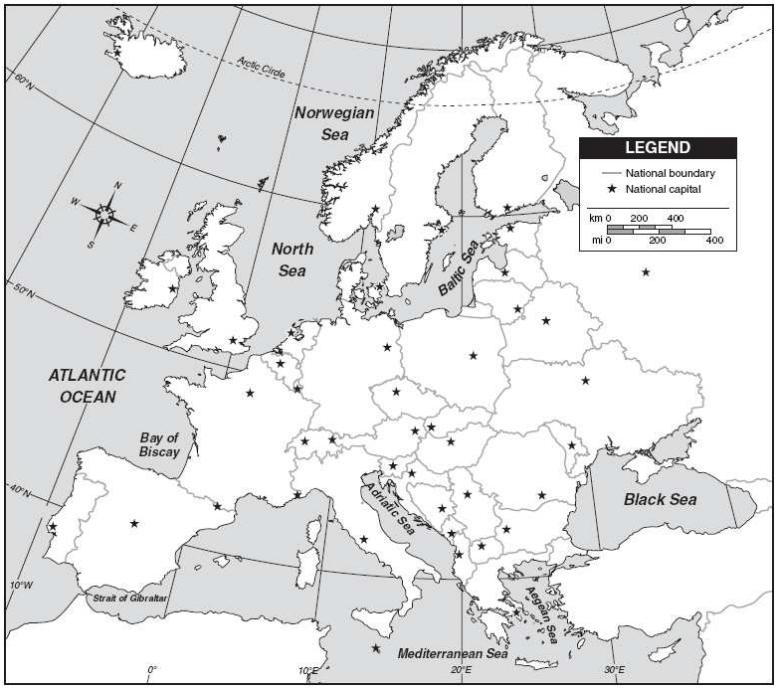


Figure 34: Proposal of new optimised European hub-structure. (Modified)

The new market coverage enables the hubs to better serve their markets. Before, hub A was supporting the whole G which resulted in large transportation costs. With the new coverage each hub is supplying the market closest from a distance point of view. Hub B now has to

serve more markets than previously and the hubs of A and D have to supply fewer markets than before. Thereof, the volume handled in each hub will be changed accordingly to *Table 7*.

Table 7: Indicates the change of volume. (Modified)

The hub in E will now stand for with the largest amount of elevators. In the present situation, hub A represented this with over C units annually. The volume share of the hubs will be more equal than previously which is a benefit when managing the information flow from the hubs. Today, the units are handled by m*erge-in-transit* activities. However, if Company X would allow the new distribution business to a forth-party logistics provider, even more value adding activities could be performed such as commissioning at hub. By this the logistics providers would go from a distribution role of consolidation to a *variant creation role* which would better support the Company X's wish of involving the logistics provider with more value adding activities.

With an additional hub in A the inbound transports will increase (*Figure 35).* This is always the situation when going from a centralised network to a more decentralised. It is possible to distinguish in both the two illustrations that the largest inbound flows are leaving from the clusters of suppliers in the areas of Z and M. Here, an alternative could be to use intermodal transportations from these areas to the five hubs[143]. The European Commission is working on improvement of the freight rail network across Europe[144]. Combine rail and road transports on the inbound would lead to a further reduction of the CO_2-emissions.

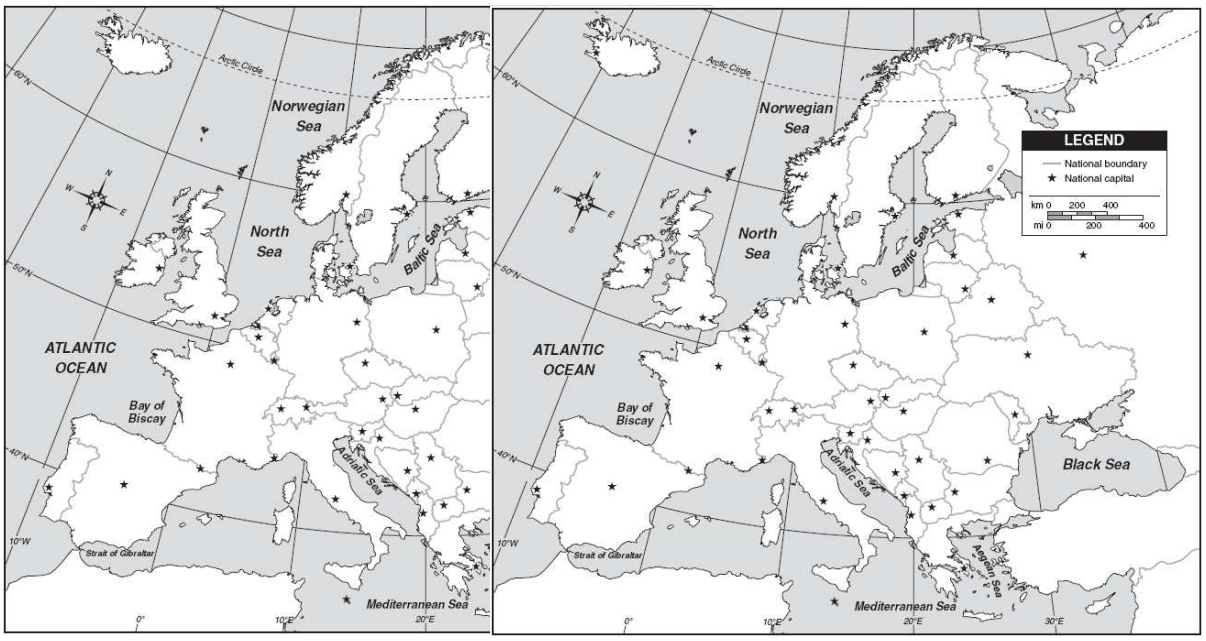


Figure 35: Comparison of inbound transports; *As-is* versus *New*. (Modified)

[143] Chapter of Theory: Intermodal
[144] White Paper, 2007

The inbound transports increase with approximately Y – Y million truck kilometres, depending of the growth of the different markets in Europe in the next five years[145]. Since, the new hub-structure is optimised from the perspective of outbound transportations a next step for Company X would be to optimise the inbound transports[146].

Regarding the outbound transports, they are positively affected by the additional hub and the realigned market coverage (*Figure 36*). The outbound transports decrease with approximately Y – Y million truck kilometres, depending on future market growth in Europe[147]. Predominately, it is the outbound deliveries from hub A which are changed and now divided to leave from hub B instead.

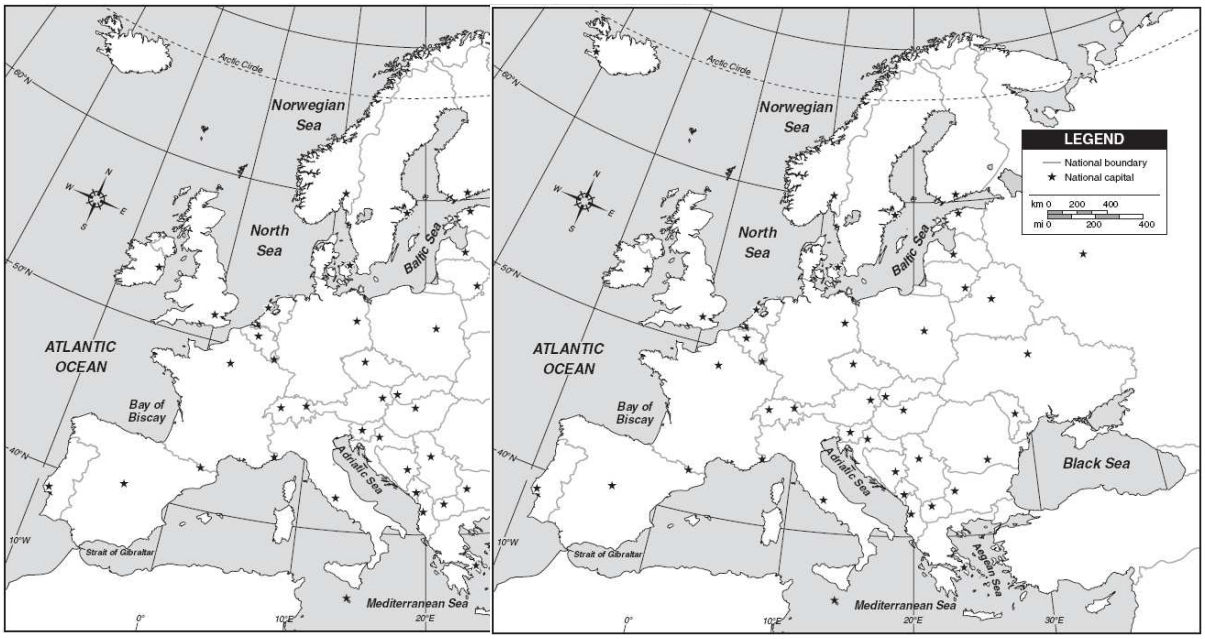


Figure 36: Comparison of outbound transports; *As-is* versus *New*. (Modified)

With the new proposal of hub-structure, Company X will be more focusing on the downstream, the customer, of the supply chain than previously. By doing so, they will be better inline with the new directions within supply chain management[148]. Adapting to a new network enables Company X to be more competitive with their supply chain. However, in order to really compete with other chains they need to modify their traditional management and become even more adjusted to *lateral management (Figure 13)*.

The new hub-structure can act as a foundation for Company X to in the future adapt a *virtual or hybrid logistics network*[149]. When adapting to the new network, it is a great possibility for Company X to change from today's three logistics providers to use only one logistics provider with pan-European coverage. Company X provides the logistics provider with the information of where their markets are located and then let the logistics provider itself optimise the transports through its network. However, at the moment, this is a too dramatic distribution solution for Company X to completely let themselves in the hands of the logistics provider without influencing which hubs they are using. Therefore, as a first step towards a virtual

[145] Appendix G: Scenarios
[146] Chapter of Conclusions and Recommendations
[147] Appendix G: Scenarios
[148] Chapter of Development and Trends: Supply Chain Management
[149] Chapter of Development and Trends: Distribution Network Design

network, Company X should agree with the fourth-party provider to use the new network and with decided floating forwarding hubs. They would still have control of the A hubs but would be able to share together with the logistics provider the benefits of using forwarding hubs. Today, Company X is only aware of that the logistics providers are using forwarding hubs to optimise the loading ratio but they do not share the profits with them. The logistics providers would manage the virtual network through the different service level of the product. Some products could be transported directly from supplier to site and some are going through the hubs. However, first Company X needs to investigate the use of *differentiated service levels* on their components[150].

Company X is currently working to improve their supply chain management through the development of A for all the partners in the supply chain; *S project*. It enables event visibility and real-time connectivity in the supply chain. It is necessary to have a well-developed information system if Company X would like to fully adapt a virtual network in the future.

[150] Chapter of Conclusions and Recommendations

8. Conclusions and Recommendations

The aim of this chapter is to present the conclusions and the recommendations of the thesis. The conclusions are based on the outcome from the analysis with help from both theories, external and internal experts. The recommendations include future projects to consider.

8.1 Conclusions

The purpose of the thesis was to analyse Company X's present and future logistic flows within Europe, their present and future supplier and customer bases, the future developments within the European transportation market and from that propose a new optimised European hub-structure.

8.1.1 Inbound

From the mapping of the logistic flows, it was identified that the total distance of the outbound deliveries is almost double of the inbound deliveries. As such it can be mathematically concluded that moving closer to the customer would give a positive result for both total distance and total costs. Therefore, it is accepted to increase inbound transportation distance (approx +Z% inbound versus -Z% outbound) to enable the capture of considerably greater outbound efficiencies. For inbound transports, clusters of suppliers were identified surrounding A of the A hubs. Company X is however not using this advantage (i.e. of consolidating loads/using milk-runs) since almost all inbounds transports from suppliers deliver directly to each hub. This can be compared with one of Company X's main competitors, who group all suppliers in close proximity to a single hub serving all outbound destinations thereby more or less negating inbound costs.

8.1.2 Outbound

The outbound flows are largest in A and B, which are a reflection of Company X's main markets. The current structure, C serving the D European markets, enforces extended delivery distance and therefore costs. Through analysing delivery data it was identified that there is an imbalance in the centres of gravity of the hubs, leading to an opportunity to minimise outbound delivery distance and costs.

8.1.3 Improved Hub-structure

In an attempt to improve the hub-network, a number of network proposals were tested based on distance optimisation and centre of gravity analysis, three of which initially seemed of interest:

- Relocation of the A hub from B to C
- Addition of an D hub
- Realigned geographic coverage of hubs

On balance it was discovered that maintaining hubs in B continue to create benefit for Company X owing to higher C costs (distance costs reduced but out weighted by higher infrastructure costs). The addition of an hub, tested positively and D was chosen since it had the best score in a weighted diagram where closeness to market, salary level, infrastructure and port connections among others were the criteria evaluated.

In total with the the addition of an E hub and a new realignment of market coverage of the hubs, the total annual savings are as follows:

- *Y million truck kilometre*
- *€X million (Z%)*

8.1.4 Future Challenges

The challenges Company X is facing are an even stronger growth of the A market, increasing transportation costs in terms of fuel costs, salary inflation (including stronger working hour directives) and escalating national road taxes. The current hub-network is not well adapted to the future changes and all these factors together will therefore likely lead to large cost increases for Company X. In an attempt to try to identify the future changes, a sensitivity analysis was conducted using four scenarios. The uncertainties given in the scenarios were projected market growth and estimated transportation price development.

For each scenario, the new hub network is providing following annual savings:

- *Scenario 1: Y million truck kilometre* *€X million (Z%)*
- *Scenario 2: Y million truck kilometre* *€X million (Z%)*
- *Scenario 3: Y million truck kilometre* *€X million (Z%)*
- *Scenario 4: Y million truck kilometre* *€X million (Z%)*

8.1.5 Efficiency Gains

Irrespective of which scenario is chosen, the new hub-structure continues to deliver significant efficiency gains. It can therefore be concluded that the new hub-structure is not overly sensitive. The costs savings between Z – Z percent should be compared with the goal set in the beginning of the thesis of Z – Z percent.

The natural clustering of inbound suppliers can be used for milk-runs or pre-consolidations in the nearest hub which would improve the loading ratio and therefore also lead to further cost saving potential. Furthermore, the reduction of kilometres would generate a decrease of CO_2-emissions. In order to further decrease the emissions, train as a transport mode is an option. It is difficult to predict the reduction however it is significant comparing to the road mode. By the use of train, it would demand other processes within Company X since the lead time most likely will increase.

8.1.6 Transport Market Trends

The trends are moving towards virtual hub-networks run by a single logistics provider, known as fourth-party logistics providers. By adding a B hub, the the opportunity to ask for proposals of a fourth-party arrangement is given. Irrespective, this will mean considerable internal change within Company X not only in terms of understanding the implications of a single supplier strategy but also a fundamental realignment of internal processes. This will require considerable care to ensure successful implementation of any proposed solution, despite the obvious cost improvements.

8.2 Recommendations

Company X should consider realigning the geographic coverage of the hubs and include the addition of a hub in A to maximise long term cost benefits. To achieve maximal returns Company X should ensure a benefit sharing concept with a fourth-party logistics supplier with regards to additional efficiencies. In order to achieve the calculated savings, the negotiation of prices and terms are playing key roles and this task is fully in the hands of the internal experts of Company X.

For further optimisations, the inbound transportations are the next to be considered. Milk-runs and pre-consolidations are proposals to be evaluated since the suppliers are located close to A out of A hubs. Continuing with inbound optimisation, the packaging needs to be improved in order to maximise loading efficiencies. Whilst potentially adding costs for increased packaging standards, the total costs should decrease due to achievement of higher loading ratios and reduction of claims.

Furthermore, Company X should consider if the logistics providers are capable of providing further value-adding activities. For standardised products with longer lead times, Company X ought to think of "making-to-stock" as an option to decrease overall delivery time which is a winning concept within the elevator business. This could be a major consideration if Company X increases sourcing parts from A which would increase overall lead times.

In order to achieve as much profit from the value-adding activities, the needed service level for each product line should be investigated. In the current situation, every product line is having the same service level which probably is an unnecessary demand. As a comparison, a major competitor offers their internal clients a price reduction if the clients are willing to adjust their required delivery time in line with optimal route planning. In the evaluation of the service levels, the s-curve is a tool that could be used by Company X to align the needs of correct service level to each product line and it is associated delivery needs. M is an example of a product line in need of varying service levels. Since the packages often are highly differentiated from the other product lines, the distribution through a Company X specified network is most of the time logistically unnecessary. It should therefore be considered a virtual hub-network to be taken into use as soon as possible.

The proposed hub-structure is valid for the next five years. After these five years, Company X has probably changed their processes and is possibly more prepared to adapt to a virtual hub network for deliveries of the elevators.

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9.5 Interviews

9.5.1 Internal employees at Company X (Modified)

Head of Material
Leader Mechanics
Global Purchasing Manager General
Operation Area Manager
System Process Manager
President of the Management
Vice President, Project Management & Supply Chain Process
Head of Corporate Purchasing

9.5.2 External

Dr. Laurence, Peter, PhD, MSc, FIEF, FIOM, and Principal of Scb Consulting – Solving International Supply Chain Europe

Appendix

A. Description of Elevator

B. Market

C. Inbound Transports

D. Outbound Transports

E. Equations

Inbound

$$Total\ Transport\ \ Cost_{Today} = \sum_{i=1}^{k}(\sum_{s=1}^{t}(\sum_{u=1}^{v} Number\ \ of\ \ Commission\ s \times Transport\ \ Price_{per\ Commis\ sion}))$$

$k =$ *Number of hubs*

$t =$ *Number of suppliers*

$v =$ *Number of product lines*

Equation 1

$$Total\,TransportCost_{Future} = Total\,TransportCost_{Today} \times Price\,IncreaseFactor \times Market\,growthFactor$$

Equation 2

$$Total\ \ Truck\ \ Kilometre_{\ Today} = \sum_{i=1}^{k}(\sum_{s=1}^{t} Number\ \ of\ Trucks\ \times Distance_{\ Supplier\ \ to\ hub})$$

$k =$ *Number of hubs*

$t =$ *Number of suppliers*

Equation 3

$$Total\ Truck\ Kilometre_{Future} = Total\ Truck\ Kilometre_{Today} \times Market\ Growth\ Factor$$

Equation 4

Outbound

$$Total\ Transport\ Cost_{Today} = \sum_{i=1}^{k}(\sum_{s=1}^{t}(\sum_{u=1}^{v} Number\ of\ Commissions \times Transport\ Price_{per\ Commission}))$$

$k =$ *Number of hubs*

$t =$ *Number of country zip codes*

$v =$ *Number of product lines*

Equation 5

$$Total\,Transport\,Cost_{Future} = Total\,Transport\,Cost_{Today} \times Price\ Increase\,Factor \times Market\,Growth\,Factor$$

Equation 6

$$Total\ Truck\ Kilometre_{Today} = \sum_{i=1}^{k}(\sum_{s=1}^{t} Commission\ Kilometre / Average\ Loading\ Ratio$$

$k = Number\ of\ hubs$

$t = Number\ of\ country\ zip\ codes$

Equation 7

$$Commission\ Kilometre = Number\ of\ Commissions \times Distance_{Hub\ to\ country\ zip\ code}$$

Equation 8

$$Average\ Loading\ Ratio_{April} = (\sum_{i=1}^{k} Number\ of\ Commissions / Truck) / k = 1.71$$

$k = Spain, France\ and\ Germany$

Equation 9

$$Total\ Truck\ Kilometre_{Future} = Total\ Truck\ Kilometre_{Today} \times Market\ Growth\ Factor$$

Equation 10

Warehouse

$$Total\ Warehouse\ Cost_{Today} = \sum_{i=1}^{k}(\sum_{s=1}^{t}(Number\ of\ Commissions \times Hub\ Fee_{per\ Commission}) + (Number\ of\ days\ stored \times Storage\ Fee_{per\ Day\ and\ Commission}))$$

$k = Number\ of\ hubs$

$t = Number\ of\ product\ line$

Equation 11

$$Total\ Warehouse Cost_{Future} = Total\ Warehouse\ Cost_{Today} \times Price\ Increase\ Factor \times Market\ Growth\ Factor$$

Equation 12

F. Total Cost Comparison

G. Scenarios

H. List of Participants

External Experts

The external experts were a group of seven people with different business titles (e.g. PhD, Regional Manager Transportation, and World-Wide Head of Purchasing Logistics) from varying industries (e.g. large logistics companies, consulting companies, and international manufacturing companies).

Internal Experts

The internal experts consisted of ten people from Company X. These people came from various departments and all had large knowledge about the logistics processes.

I. Summary of External Experts & Logistics Providers Questionnaires

J. Summary of Internal Experts Questionnaire

K. Essen List

Table I: Projects submitted by the Member States and the European Parliament from being examined by the European Commission for including in the list of "special" projects so called the Essen list. (Source: White Paper, p. 113)

Project			Length (km)	Type	Completion date	Remaining investment (million EUR)
1	IT	Milan–Bologna and Verona–Naples	830	Mixed high-speed line	2007	13 994
3	F	Montpellier–Nîmes	50	Mixed high-speed and freight line	2012	790
15	EU	Galileo	–	European satellite navigation system	2008	3 250
16	E/F	High-capacity Pyrenees crossing	180	Rail freight line	2020	5 000
17	D/A	Stuttgart–Munich–Salzburg–Vienna	713	Mixed high-speed and freight line	2012	9 501
18	D	Vilshofen–Straubing	70	Improving the navigability of the Danube	—	700
19	E/P	Interoperability of the Iberian high-speed rail network	7 800	New and upgraded high-speed lines	—	29 600
20	D/DK	Fehmarn fixed link	50	Rail and road bridge/tunnel	2013	3 650
				Total		**66 485**