Closer Starfish: A research project investigating freight distribution cooperation opportunities in Sweden

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STARFISH

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Svensk sammanfattning

Horisontella samarbeten, där företag på samma nivå i försörjningskedjan samarbetar, är ett koncept som fått ökat fokus det senaste decenniet och som har undersökts i både Benelux och Storbritannien. I Sverige har horisontella samarbeten endast undersökts i mindre skala, och i avlägsna områden. Denna rapport bygger på en kvantitativ fältstudie som undersöker horisontella samarbeten på nätverksnivå. Sju företag; två detaljhandlare (Coop och Ica) och fem leverantörer (Findus, Arvid Nordquist, Löfbergs Lila, Cloetta och KåKå) har deltagit i studien och bidragit med godsflödes- och kostnadsdata. Analysen har testat olika samarbetskonstellationer av de deltagande företagen och studien visar, i linje med tidigare forskning, att företagen har möjlighet att minska sina transportkostnader. Samarbeten mellan en stor aktör och en eller flera mindre aktörer visar potential på kostnadsbesparingar mellan 1-10%. Samarbeten mellan de mindre aktörerna visar på en större relativ besparing, med potential från 20 % och uppåt. Dock finns det vissa osäkerheter i de mindre företagens data, vilket kräver ytterligare analys för att undersöka hur potentialen ska förverkligas.

Closer Starfish visar på stor potential för att minska kostnader genom korsvisa samarbeten mellan företag. Företagen har stora möjligheter att effektivisera sina transporter genom samarbete utanför sin försörjningskedja. För att ta vara på denna möjlighet är det nu viktigt att vidare studera koalitioner med korsvisa samarbeten och gå ner i detalj med intresserade företag för att undersöka hur man praktiskt ska realisera identifierad potential.

Om författarna

Andreas Holmberg är sedan 2013 anställd vid avdelningen för Förpackningslogistik på Lunds Tekniska Högskola, knuten till ReLog, Helsingborg. Andreas har en mastersexamen i Industriell Ekonomi med inriktning mot matematisk modellering och Supply Chain Management från Lunds Tekniska Högskola. Andreas har skrivit sitt examensarbete inom samdistribution för Coop och Ica och har sedan 2013 inriktad sig mot transportlogistik, samarbeten, transportreglering och supply chain design.

Dr. Henrik Sternberg är sedan 2012 postdoktor vid avdelningen för Förpackningslogistik på Lunds Tekniska Högskola, knuten till ReLog, Helsingborg. Henrik startade sin transportforskning 2006 på Chalmers Tekniska Högskola och blev 2011 Teknologie doktor där. Hans forskningsintressen är transportnätverk, transportreglering, informationsdelning och samarbeten inom transportlogistik och transportföretagens effektivitet ur försörjningskedjans perspektiv. Dr. Sternbergs forskning är publicerad i ledande internationella vetenskapliga tidskrifter, t.ex., Journal of Business Logistics, Computers in Industry och International Journal of Shipping and Transport Logistics. Han är även författare till Regeringens ITS-råd:s färdplan för ITS (Intelligenta Transport System) för godstransporter och har lång erfarenhet som konsult inom logistik och transportområdet åt bl.a. Volvo Trucks, Deutsche Post och AAK.

Jerker Sjögren är programansvarig för CLOSER, Lindholmen Science Park. CLOSER är den nationella svenska arenan för transporteffektivitet med fokus på innovation, forskning och utveckling på internationell nivå. Tidigare var Jerker Senior Advisor i näringslivsdepartementet och ansvarig för regeringens Logistikforum 2008-2011.

Executive summary

Horizontal cooperation, when companies on the same level in the supply chain cooperate, is a concept that has received increased focus during the last decade and has been examined in both the Benelux and the UK. In Sweden, the horizontal cooperation has only been examined on a smaller scale in remote areas. We have carried out a quantitative case study, examining horizontal cooperation at the network level. Seven companies--two retailers (Coop and ICA) and five suppliers (Findus, Arvid Nordquist, Löfbergs Lila, Cloetta, and KåKå) participated in the study and have contributed transportation and cost data. The analysis has tested various coalitions of the participating companies and the study shows, in line with previous research, that companies have the ability to reduce their transport costs. Cooperation between a large actor and one or more smaller companies shows a potential cost savings between 1 and 10%. Cooperations between the smaller actors indicate potential cost savings of more than 20%. However, there are uncertainties in the data concerning the smaller companies and therefore, further analysis is needed in order to investigate how these potentials are to be realized.

Closer Starfish shows that there is a large potential to reduce costs if companies combine horizontal and vertical cooperation. The companies have a great possibility to make their transports more efficient by cooperating outside of their own supply chain. In order to maximize the likelihood of this possibility it is important to further study in more depth coalitions with both horizontal and vertical cooperation in order to investigate how to realize the identified potential in practice.

About the authors

Andreas Holmberg has been employed by the Division of Packaging Logistics at Lund University, Faculty of Engineering since 2013. Andreas has a Master's degree in Industrial Engineering with a focus on mathematical modeling and Supply Chain Management from Lund University. Andreas did his master thesis investigating the effects of horizontal cooperation in logistics between Coop and Ica and has been focusing on transport logistics, cooperations, cabotage transports and supply chain design since 2013.

Dr. Henrik Sternberg's research interests are freight transport operations, international transport networks, cabotage traffic, supply chain information sharing and efficiency. His research has been published by a number of scientific supply chain management and logistics journals, e.g., Journal of Business Logistics, International Journal of Shipping and Logistics Management and Computers in Industry. Currently Dr. Sternberg is a postdoctoral researcher at Lund University, Faculty of Engineering. Henrik defended his doctoral thesis, "Waste in road transport operations – using information sharing to increase efficiency" in 2011 at Chalmers University of Technology. In 2012 Henrik authored the investigation, "The ITS Freight Roadmap of the Swedish Government's ITS Council" before pursuing an academic career. Dr. Sternberg was a consultant at Cambridge Technology Partners in Germany. In 2012 he won the International Cargo Handling Association's prize for his research.

Jerker Sjögren is currently the programme manager of CLOSER, Lindholmen Science Park. CLOSER is the Swedish arena for transport efficiency, focusing on innovation, research and development at an international level. Previously, Jerker Sjögren was senior advisor in the Swedish Ministry of Enterprise, Energy and Communications responsible for logistics issues and coordinator for the Swedish Logistics Forum.

Preface

This report presents the main findings from the project *Closer Starfish*, a project analyzing distribution networks in Sweden. The project is a collaboration between Lund University, Closer and Optilon.

Inspired by the British distribution cooperation project named *Starfish* by Andrew Palmer and Alan McKinnon, Jerker Sjögren at Closer (Lindholmen Science Park) initiated the project *Closer Starfish*. The purpose was to get an initial overview of the potential of engaging Swedish companies in logistics cooperation. The Swedish Transport Administration has been the main financial sponsor of the project, supported by Lund University.

Lund University has been responsible for data collection and analysis. Dr. Henrik Sternberg has been the project leader, working together with Andreas Holmberg (Lund University), Emma Tranarp (Optilon), Jerker Sjögren and the other members of the steering committee:

- Tomas Arvidsson	The Swedish Transport Administration
- Jan Bergstrand	The Swedish Transport Administration
- Anders Ekmark	The Swedish Transport Administration
- Stefan Back	The Transport Group (Swedish industry)
- Carl-Fredrik Bernmar	Coop
- Kjell Håkansson	Coop
- Peter Jordansson	SSAB
- Daniel Hellström	Lund University

Andreas, Henrik and Jerker would like to thank all the involved companies for their support of this project. In particular, we would like to thank Kjell Håkansson and Carl-Fredrik Bernmar (Coop) and Markus Gustafson (Ica) for their extensive contributions.

We would like to thank external experts Andrew Palmer (Herriot-Watt University) and Frans Cruijssen (ArgusI) for their valuable advice and support of the project. Finally, we would like to thank The Swedish Transport Administration for the funding of the project and LLamasoft for its software sponsorship.

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Andreas Holmberg   Henrik Sternberg   Jerker Sjögren

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Introduction to cooperation in distribution

*"Horizontal cooperation is about identifying and exploiting win-win situations among companies that are active at the same level of the supply chain in order to increase performance. These companies can be suppliers, retailers, customers, or LSPs" (*Cruijssen et al. (2007c)).

Many large companies have been working with customer and supplier relationships, but cooperation with companies outside their own supply chains, such as competitors combining horizontal and vertical cooperation, opens new opportunities to further improve efficiency and cut costs to stay competitive. Horizontal cooperation in Europe was boosted in 2008 when the European Intermodal Research Advisory Council (EIRAC), which is a group of more than 50 large industry players related to European Supply Chains, identified the critical issue to increase the capacity utilization of European freight transport systems. This led to the start of a European Union sponsored project called CO^3, Collaborative Concepts for Co-Modality (CO3-Project, 2013). The mission with the project is to increase the efficiency and bundling of European logistics flows through horizontal cooperation between European shippers. To achieve the mission a number of repeatable test cases will be created and a shipper who believes in horizontal cooperation can make use of the services of the CO^3 consortium to identify potential bundling partners and to set up test projects. One such example is the cooperation between JSP, transporting light weight products, and Hammerwerk, transporting heavy weight products, from The Czech Republic to Germany (Verstrepen and Jacobs, 2012). Both companies struggled to efficiently utilize their transports since JSP did not use the weight capacity and Hammerwerk did not use the volume capacity of the trucks. Through a CO3 test project they consolidated these freights and therefore utilized both the volume and the weight constraints of the trucks. Another CO3-project studied four companies, Mars, Wrigley, United Biscuit, and Saupiquet, which share a joint warehouse from where they collaboratively distribute (Guinouet et al., 2012). This cooperation has resulted in 30% relative cost savings for each company. In Sweden, Hageback and Segerstedt (2004) have investigated the potential of cooperation in sparsely populated areas and Frisk et al. (2010) investigated horizontal cooperation in the Swedish forest industry. The reported cost savings was around 15% with a 20% reduction of emissions from the trucks.

The Swedish research organisation TransportForsK AB (TFK) did a study in 2011 where they mapped the flows of goods and the volumes transported in Sweden for the three biggest actors in the grocery retail market – Ica, Coop and Dagab. Their aim was to investigate the prerequisites and opportunities to increase intermodal transport. The study showed that the three companies together have volumes sufficient for an increase in intermodal transport but if not all possible volumes were to be transferred, the potential would not be as high. Therefore, there is a need for cooperation in the industry to be able to use intermodal options to a higher degree. This project is now continuing in the ongoing project, SNAGO, also carried out by TFK.

A national project in the UK that investigated the potential for horizontal cooperation was conducted by Palmer and McKinnon (2011). The British retail organization IGD sponsored the project, with a purpose of identifying opportunities for both back-hauling and consolidation for retailers, wholesalers, and manufacturers. Reducing empty running by consolidation contributes to both reducing the environmental impact and cutting costs. The result gained a lot of attention in the UK with a total identified potential to reduce CO_2 emissions by 14.2% and costs by 17.6%! Horizontal cooperation is an area with great potential to increase efficiency. It is a relevant strategy for all types of companies: LSPs, manufacturers, and producers. The UK study (Palmer and McKinnon, 2011) included 27 companies from the FMCG sector and showed great potential for this specific sector. The result was a potential savings and is based on consolidation, backhauling, larger vehicles, and after hours deliveries. This report aims to continue and refine their research, while applying it to Swedish conditions. In the UK study Palmer and McKinnon used standard distance/weight costs in their network model. While that is a simpler way to calculate, it might also lower the accuracy of the result, since costs differ between different regions. In Sweden this is particularly true, where a large part of the trucks are leaving empty from Stockholm, resulting in significantly lower rates from Stockholm to South and West Sweden.

Seeking external cooperation with companies at the same level in the supply chain includes competitors or at least actors in the same market. One of the major obstacles is therefore to find suitable partners that can be trusted. A large hurdle, especially for small and medium sized companies, is to afford the research cost related to find potential partners and also to evaluate their competence and reliability (Cruijssen et al., 2007b). In a survey consisting of Belgian logistic service providers, 69% of the respondents considered difficulties in finding partners to be a critical issue for horizontal cooperation (Cruijssen and Salomon, 2004).

Purpose

Given the importance of CO2-reductions and the potential gains for the Swedish industry, the purpose of the Starfish project is to provide a first outline of the quantitative cooperation potential in the Swedish retail industry.

Cooperation from a legal point of view

The legal point of view concerning cooperation, and especially cooperation between competitors, has been investigated by the CO3-project. The following information is derived from a CO3-project report (2012).

There are some key components regarding the contracts that are recommended between the parties in the cooperation. There should be a contract, on different levels, for each relationship in the cooperation: one between the shippers, one between the shippers and the trustee and one between the shippers and the 3PL.

Cooperation between shippers can be a delicate situation in terms of competition law. Because of this, it is important that no sensitive information, such as price and volume information, is shared among the shippers. Instead, it should be distributed to the trustee, whose work it is to use the information in the interest of the shippers to advise on possible benefits. Other topics that need to be covered are which method to use for gain sharing, rules for exiting the cooperation and rules with respect to volume variation.

The following can be found in the CO3-report (2012).
From a transport law point of view it is important to know whether the contract between the shippers and the trustee qualifies as an agency agreement in general, or – as a consequence of the online activities carried out by the trustee – (also) as forwarding contract.
The cartel ban is included in article 101 paragraph 1 of the Treaty on the Functioning of the European Union.

Since horizontal collaboration in the supply chain generates efficiency gains, paragraph 3 of article 101 of the EU-Treaty is interesting. This provision contains an exemption on the cartel ban: "The provisions of paragraph 1 may be declared inapplicable in the case of:

- *any agreement of category of agreements between undertakings,*
- *decision or category of decisions by associations or undertakings,*
- *any concerted practice or category of concerted practices, which contributes to improving the production or distribution of goods or to promote technical or economic progress, while allowing consumers a fair share of the resulting benefit, and which does not:*
    - *a) impose on the undertakings concerted restrictions which are not indispensable to the attainment of these objectives;*
    - *b) afford such undertakings the possibility of elimination competition in respect of a substantial part of the products in question."*

In this respect it needs to be mentioned that the European Commission has published guidelines on the applicability of article 101 of the EU-Treaty to horizontal co-operation agreements in 2011 (2011C 11/01). These guidelines contain very useful and detailed information with respect to the do's and don'ts.

Baseline of this research

While various forms of cooperation can reduce environmental emissions, not all types of cooperation have the potential to become economically profitable. In Closer Starfish, we have excluded non-profitable cooperations. This research has been performed on a network level, where, e.g., fill rates are not taken into consideration. The analysis has also been mainly quantitative, but some qualitative aspects from the work with Coop and Ica have been taken into consideration in the conclusions. The analysis is a balance optimization of flows from the participating companies and not an analysis on co-loading.

Methodology

In order to create new knowledge, it is important to start from existing knowledge. Closer Starfish is investigating a fairly new concept in logistics, meaning that the existing knowledge in the field is rather sparse. A literature review on collaboration, cooperation and cooperation in logistics, distribution and transport was carried out as a starting point. The literature review can be found in the thesis of Holmberg and Örne (2013).

The quantitative potential of cooperation between competitors has been proven in other geographical locations as Great Britain and the Netherlands. But qualitative problems have also emerged. Both suppliers and retailers (Hingley et al., 2011)have been proven reluctant to enter into a cooperation due to fear of losing business. Therefore, it is important that this kind of cooperation is proven to be quantitatively positive also in Sweden, because if there is no quantitative support for horizontal cooperation then there also is no need for qualitative studies. This report represents an initial estimation of the potential of cooperation on the Swedish market.

Project process

The project process is described below in Figure 1. A new company is contacted in the initial contact phase. Benefits, such as cost reduction and decreased environmental impact, in combination with successful cooperation projects were promoted to convince the company to join. Data collection is a crucial phase where all the relevant information is collected. The company receives an Excel template where the company can see which data is needed (the template is presented in Appendix). With the collected data the reference models can be built and verified with the companies. When the models have been finished after the companies' input, the horizontal analysis can start where the models are combined in one large model to investigate the potential benefits regarding cost and environmental impact, which is the result of the analysis.

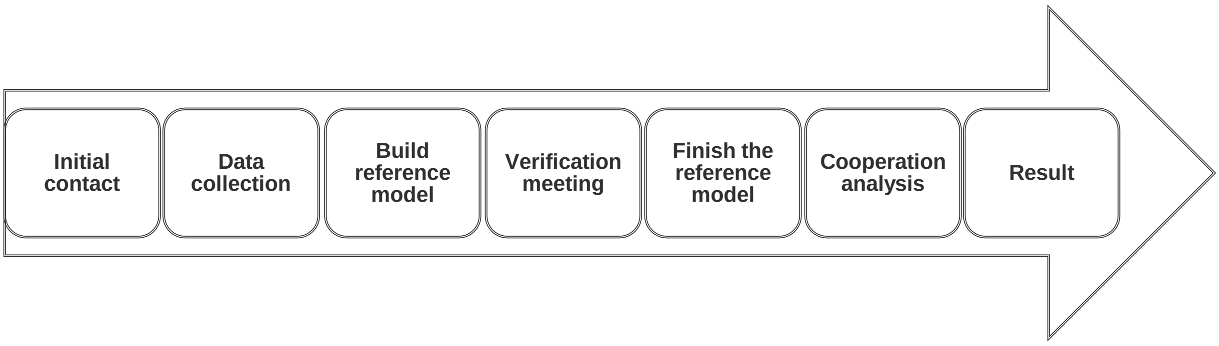

Figure 1 Illustration of the project process

Sampling of case companies

In December of 2012, a workshop organized by CLOSER was held where the Starfish idea was presented. In connection to this workshop, Coop and ICA expressed interest in participating in the project.

The Swedish grocery industry is highly dominated by a few large actors. ICA has around 50% of the market share, Coop 21%, Axfood (Willys and Hemköp) 15%, and Bergendahls (City Gross) 7%. Two smaller actors are Lidl, with a market share of 3%, and Netto, with a market share of 2% (Delfi, 2013). ICA and Coop account for 70% of the market share and have some imbalances in their transport flows. This indicates that they might have the potential for horizontal cooperation.

Thereafter, more companies were to be included in the study that could benefit from horizontal cooperation with Coop and ICA. Therefore, suppliers to the retailers were contacted and in January 2014 five more companies joined the study: Findus, Löfbergs Lila AB, Arvid Nordquist HAB, KåKå and Cloetta.

The first contact was made by e-mail, explaining the scope of the project. Thereafter, each company was contacted by phone to discuss any questions and further explain the level of involvement needed for the companies.

Supply chain design and Supply chain guru

Supply chain design transforms the “as-is” supply chain into an intentionally engineered “to-be” configuration, enabling a sustainable competitive advantage. The scientific field dates back to Geoffrion and Graves’ (1974) early work on distribution system design and has continually evolved since then (Olhager et al., 2013). In terms of optimization (cost minimization, profit maximization, etc.), the increasing computer power has fueled the development and ability to handle increasingly complex linear programming models.

Considering cooperation, multiple levels, i.e., manufacturing, warehousing and transportation can be considered. Previous researchers have mainly used custom made optimization models (Palmer and McKinnon, 2011). As supply chain optimization programs off-the-shelf are very expensive (approximately 1MSEK for 1 license), custom made software typically is a cheaper way to solve the problem at hand.

Off-the-shelf optimization programs have two major advantages. The first is scalability. Building a model representation of a company’s supply chain enables the researchers to extend the analysis and re-use models for more detailed regional analysis or for higher level analysis including location analysis. Modern supply chain design software is able to handle multiple companies and extensive scenario analysis. The second advantage is the performance of the model. Leading-edge linear programming solvers, such as the Supply Chain Guru (SCG), are built by scientists specializing in operations research[1], leading to high performance and the ability to upgrade the software with additional solving power.

Given the options above, the project team tested various types of software and decided on using Supply Chain Guru. SCG was made available through collaboration with Optilon and LLamasoft.

Data collection

This study includes 7 companies where Coop and ICA represent 95.7% of the total volume. The data collection process has therefore been different for Coop and ICA and Findus, Löfbergs, Arvid Nordquist, Cloetta and KåKå. Since the complexity of these companies’ logistical structure is much lower than the complexity of Coop and ICA it has been sufficient to manage the communication through e-mail and telephone for the scope of this study.

Every company included in the study has been provided with an Excel template, available in Appendix, where the necessary information is stated.

Swedish retail and fast moving consumer goods

The companies represented in this report are either retailers, Coop and Ica, or suppliers, Findus, Löfbergs, Arvid Nordquist, KåKå and Cloetta. While the retailers have different characteristics for inbound and outbound flows, inbound flows are often full pallets and output flows can either be mixed pallets, full pallets, or roll containers. All companies have in common that when transporting and storing, products have different requirements on temperature. The following groups have been identified together with the participating companies:

- Dry (food) — Transported between 0°C and + 20°C
- Dry (Non-food) — Transported above 0°C
- Fresh — Transported between 0°C and 10°C
- Fruit and vegetables — Transported around 8°C
- Frozen — Transported lower than - 25°C

[1] https://www.llamasoft.com/wp-content/uploads/DS-LLamasoft-SCG-Differentiators-US.pdf

Sites

There are some different types of sites represented in the logistical structure of the companies. Ica and Coop have several sites with different characteristics:

1. Central warehouses for slow moving goods.
2. Packaging & distribution warehouses where the products are packed for delivery to either the cross-docking warehouses or the stores.
3. Smaller cross-docking warehouses where the loads are divided for delivery to the stores.

Interviews and on-site visits

The data collection has been done through meetings, telephone and e-mail contacts, and Excel templates. The process of contacts with the companies has generally followed 4 steps as seen in Figure 2. The first step after the company has joined the study is to fill in an Excel template. After the data has been processed and a first data model has been built up in SCG the second step is to contact the company with questions and verify that the data has been interpreted correctly. Step 3 is the verification of the final model before the analysis can be done. With the results from the analysis, step 4 is to present the findings for the companies and propose what needs to be done to verify the results and how to convert them into action.

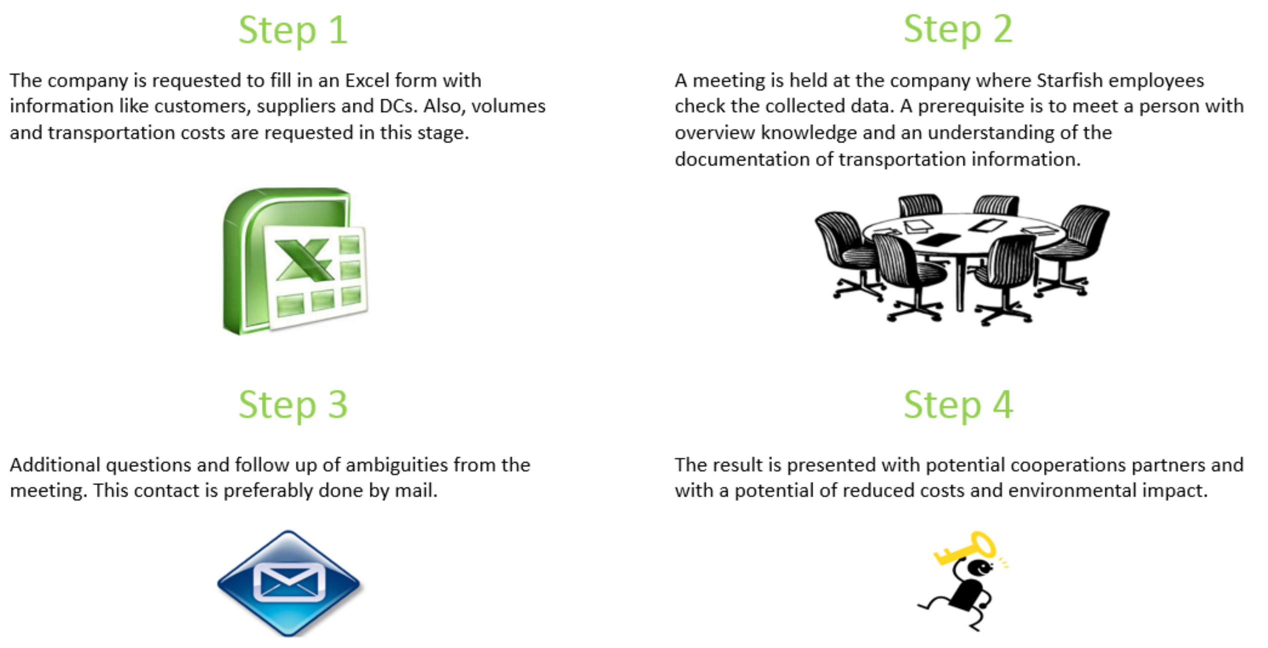

Figure 2 the 4 steps in the process of contacting the participating comapanies.

The interviewees in the project are presented in Table 1.

Table 1: Roles and company of the persons that have been interviewed.

Role	Company
Project Manager	Coop Logistics
Facility Manager	Coop Logistics
Transport Procurement Manager	Coop Logistics
Project Manager	ICA Sweden AB
Logistics Manager	Findus
Logistics Manager	Löfbergs Lila AB
Supply Chain Director	Arvid Nordquist HAB

Logistics Manager	KåKå
Business Development Manager	Optilon
Optimization Analyst	Optilon
Optimization Analyst	ArgusI (Netherlands)

Coop and ICA

A first meeting was held for each company in order for them to present the supply chain design and explain how their logistic solutions operate. In connection to these meetings, secondary data about the logistic structure was collected and the Excel template was sent out.

A first model in SCG was constructed based on the first data collected. Based on this model a second meeting was held to discuss problems encountered and to give the companies the opportunity to comment on the work and to point out errors.

Based on the data collected from the second meeting the model was corrected and developed further into a final model. This was again presented to the companies and the cost structure of the model has been verified against the real cost.

The complexity of transport cost is immense and simplifications have needed to be done, more closely presented in the analysis. To ensure that the modeling costs are as close to the reality as possible, this has been thoroughly discussed with each company.

Smaller companies

The smaller companies have in general a less complex transport structure and therefore all communication at this stage has been sorted out via e-mail and telephone.

Once the companies joined the project the Excel template was distributed and the companies provided data in the form of Excel, covering the necessary information. Based on this data a first model was constructed and questions were compiled and sent to the companies, including control questions regarding volumes and costs. This concluded the data collection.

Empirical data

Regions

The geography has been divided into 22 regions as presented in Table 1.

Table 1 Regions

Blekinge	Bohuslän	Dalarna
Gävle	Göteborg	Gotland
Halland	Jämtland	Jönköpings län
Kalmar län	Kronobergs län	Luleå
Närke	Östergötland	Skåne
Skaraborg	Södermanland	Stockholm
Sundsvall	Umeå	Uppland
Värmland		

Flows

The data modeling and analysis in this report is on a network level. Therefore, the demand and transport flows do not reach down to the product level. Instead, all products with the same demands on the transport and warehouse environment have been bundled together. In, for example, Coop and Ica stores you can find 5 different main categories of products:

1. Dry food products (e.g. cereals and rice)
2. Dry non-food products (e.g. toilet paper and scissors)
3. Fresh food products (e.g. juice and milk)
4. Fruits and vegetables
5. Fresh frozen products (e.g. frozen chicken and prepared meals).

In the modeling we have identified 3 flows into which the above 5 flows can be integrated and match the demands different flows have on temperature:

1. All goods that can be transported together in a truck without any control over temperature are bundled together into a group of dry products.
2. Goods that need to be transported in a chilled environment above 0°C are bundled together into a group of fresh products.
3. Goods needing transportation below 0°C are bundled together into a group of frozen products.

Coop and Ica are actors in the grocery market and keep products of all kinds in store. Arvid Nordquist, Löfbergs Lila and Cloetta only transport products to be considered as dry. KåKå has products in all categories--dry, fresh and frozen, and transport all of them in the same trucks. Dry products are transported in the same compartments as the fresh products and the frozen products have their own adjustable compartment. In the analysis in this report, their flow has been restricted to only represent fresh flows.

Data

In total, origin-destination data on 74,000 tons of freight was collected. Five companies have provided data for November 2012, the exceptions are Cloetta, January 2014, and KåKå, November 2013. Of the 7 companies there are 2 retailers, Coop and Ica, and 5 suppliers, Findus, Arvid Nordquist, Löfbergs Lila, KåKå and Cloetta.

The following actions have been made with the data:

- The data has been converted into aggregated customers with one week average demand.
    - 98% of ICAs and Coops customers are alone in one postcode area.
    - Some companies have only provided data on this aggregated level.
    - The others have >80% of customers alone in one postcode area.
- Freight flows characterized as packages are neglected (<0.1%) from the total volume.
- In some cases it has not been possible to determine how many pallet equivalents a flow is; in these cases this data has not been included (0-4% of the total weight depending on company, less than 0.1% of the total volume).
- A part of the grocery inbound flow (fresh) for Coop is outsourced and has not been included in the analysis.

Ica and Coop have a complex transport structure due to their network size, which required an extensive data collection, validation and analysis, compared to the other participating companies. The data collected from Ica and Coop included inbound flow, flow between logistic sites (warehouse storages, packaging warehouses, distribution centers and train facilities) and distribution. The data regarding inbound does not include either import or flows where the supplier is responsible for the transportation.

Smaller Companies

The data received from the companies have been processed in the following manner:

- If quantities have not been stated in number of EUR, the quantities have been translated into EUR-equivalents and controlled with the company.
- Customers have been aggregated into 5-digit postcodes; the postcodes will be referred to as customers.
- Customers receiving less than 4 pallets during the period are removed since they do not significantly impact the result.
- The number of deliveries in the model corresponds to the average number of deliveries in reality.
- Each customer demand is aggregated for an average week in the sampling period.

Each company's transport network has been constructed in a data model in SCG. The data model consists of product types, sourcing policies (from which warehouse to source), transportation policies (which type of transportation is used), and which demand the customers/stores have during the week.

Distribution flows between regions

Table 2 presents the identified distribution flows of goods, where warehouses in the same region have been bundled together and customers in the same region have been bundled together.

The distribution flows concerning the region of Gotland have been excluded in the data below, due to inconclusive data received from the companies.

Table 2 Presenting the distribution flows between the regions

Source Region	Destination Region	Company	Nbr of Pallets
Dalarna	Dalarna	ICA	2 700
	Sundsvall	ICA	2 391
	Uppland	ICA	2 154
	Gävle	ICA	3 567
	Jämtland	ICA	508
	Luleå	ICA	60
	Närke	ICA	2 887
	Södermanland	ICA	438
	Umeå	ICA	762
	Värmland	ICA	42
Dalarna Total			15 508
Stockholm	Dalarna	Coop	486
		Arvid Nordquist	93
	Halland	Arvid Nordquist	54
	Skaraborg	Coop	639
	Stockholm	Coop	6 584
		ICA	16 466
		Arvid Nordquist	220
	Sundsvall	Coop	266
		Arvid Nordquist	4
	Uppland	Coop	1 877
		ICA	484

		Arvid Nordquist	693
	Bohuslän	Coop	623
		Arvid Nordquist	8
	Gävle	Coop	1 009
		Arvid Nordquist	2
	Göteborg	Coop	1 322
		Arvid Nordquist	167
	Jämtland	Coop	209
		Arvid Nordquist	5
	Jönköpings län	Coop	766
		Arvid Nordquist	48
	Kalmar län	Arvid Nordquist	2
	Kronobergs län	Arvid Nordquist	11
	Luleå	Arvid Nordquist	5
	Närke	Coop	557
		Arvid Nordquist	13
	Östergötland	Coop	565
		Arvid Nordquist	75
	Skåne	Arvid Nordquist	253
	Södermanland	Coop	1 302
		ICA	61
		Arvid Nordquist	55
	Umeå	Coop	764
		Arvid Nordquist	17
	Värmland	Coop	790
		Arvid Nordquist	18
Stockholm Total			36 512
Sundsvall	Sundsvall	Coop	692
	Jämtland	Coop	113
Sundsvall Total			806
Uppland	Dalarna	Coop	666
		ICA	466
	Skaraborg	Coop	825
	Stockholm	Coop	7 460
		ICA	5 100
	Sundsvall	ICA	174
	Uppland	Coop	2 591
		ICA	7 940
	Bohuslän	Coop	162
		ICA	533
	Gävle	Coop	173
		ICA	916
	Göteborg	Coop	735
	Jämtland	Coop	72

		ICA	100
	Luleå	ICA	234
	Närke	Coop	691
		ICA	1 278
	Östergötland	Coop	570
		ICA	810
	Södermanland	Coop	1 682
		ICA	3 158
	Umeå	Coop	100
		ICA	656
	Värmland	Coop	551
		ICA	366
Uppland Total			38 007
Skåne	Blekinge	ICA	1 623
		KåKå	16
	Dalarna	Cloetta	74
		Findus	2
	Halland	Cloetta	51
		Coop	176
		Findus	545
		ICA	1 773
		KåKå	19
	Skaraborg	Cloetta	33
		Findus	44
		ICA	295
	Stockholm	Cloetta	420
		Findus	314
		KåKå	238
	Sundsvall	Cloetta	5
		KåKå	2
	Uppland	Cloetta	374
		Findus	578
		KåKå	59
	Bohuslän	Cloetta	20
		Findus	15
		ICA	394
		KåKå	26
	Gävle	Cloetta	17
		Findus	7
	Göteborg	Cloetta	215
		Coop	108
		Findus	24
		ICA	999

		KåKå	118
	Jämtland	Findus	2
	Jönköpings län	Cloetta	36
		Findus	18
		ICA	1 249
		KåKå	56
	Kalmar län	Findus	4
		ICA	136
		KåKå	24
	Kronobergs län	Cloetta	31
		Findus	3
		ICA	945
		KåKå	34
	Luleå	Findus	5
		KåKå	18
	Närke	Cloetta	144
		Findus	7
	Östergötland	Cloetta	96
		Findus	13
		ICA	275
		KåKå	11
	Skåne	Cloetta	184
		Coop	3 799
		Findus	665
		ICA	17 923
		KåKå	366
	Södermanland	Cloetta	162
		Findus	11
		ICA	127
		KåKå	5
	Umeå	Cloetta	41
		Findus	16
	Värmland	Cloetta	19
		Findus	4
		ICA	123
Skåne Total			35 142
Bohuslän	Bohuslän	Coop	1 326
	Värmland	Coop	435
Bohuslän Total			1 761
Gävle	Gävle	Coop	1 411
	Värmland	Coop	10
Gävle Total			1 422
Göteborg	Halland	ICA	433
	Skaraborg	ICA	3 573

	Bohuslän	ICA	4 903
	Göteborg	Coop	2 184
		ICA	13 890
	Värmland	ICA	1 331
Göteborg Total			26 315
Jämtland	Sundsvall	Coop	20
		ICA	169
	Jämtland	Coop	635
		ICA	2 411
	Värmland	ICA	15
Jämtland Total			3 249
Kronobergs län	Blekinge	Coop	759
	Halland	Coop	187
	Jönköpings län	Coop	1 314
		ICA	1 287
	Kalmar län	Coop	701
		ICA	310
	Kronobergs län	Coop	649
		ICA	2 104
	Östergötland	Coop	168
		ICA	933
	Skåne	Coop	732
Kronobergs län Total			9 142
Luleå	Luleå	Coop	3 663
	Umeå	Coop	211
Luleå Total			3 874
Umeå	Luleå	ICA	3 226
	Umeå	Coop	2 742
		ICA	4 067
Umeå Total			10 035
Jönköpings län	Jönköpings län	ICA	2 342
	Östergötland	ICA	138
Jönköpings län Total			2 480
Kalmar län	Kalmar län	ICA	1 969
Kalmar län Total			1 969
Östergötland	Östergötland	ICA	2 203
	Södermanland	ICA	1 958
Östergötland Total			4 160
Närke	Dalarna	KåKå	54
	Skaraborg	KåKå	35
	Stockholm	KåKå	50
	Sundsvall	KåKå	13
	Uppland	KåKå	93
	Bohuslän	KåKå	3

	Gävle	KåKå	46
	Jämtland	KåKå	17
	Luleå	KåKå	6
	Närke	KåKå	75
	Östergötland	KåKå	76
	Södermanland	KåKå	63
	Umeå	KåKå	42
	Värmland	KåKå	43
Närke Total			628
	Halland	Löfbergs	36
	Skaraborg	Löfbergs	10
	Stockholm	Löfbergs	192
	Sundsvall	Löfbergs	16
	Uppland	Löfbergs	14
	Bohuslän	Löfbergs	44
	Gävle	Löfbergs	2
	Göteborg	Löfbergs	163
	Jämtland	Löfbergs	2
	Jönköpings län	Löfbergs	3
	Kalmar län	Löfbergs	3
	Kronobergs län	Löfbergs	1
	Luleå	Löfbergs	7
	Närke	Löfbergs	15
	Östergötland	Löfbergs	20
	Skåne	Löfbergs	73
	Södermanland	Löfbergs	109
	Umeå	Löfbergs	28
	Värmland	Löfbergs	18
Värmland Total			758
Grand Total			192 886

Inter-facility and inbound flows between regions

The data of inter-facility flows can be seen in

Table 3; this data is not complete and only inbound flows from Ica and Coop from Swedish suppliers have been included. No inbound flows for the other companies have been included at this stage, nor has information about import flows. Also, ex works inbound data to warehouses is inconclusive and has been estimated from outbound flows from the warehouses in order to make balance for in- and outbound flows for each warehouse.

Table 3 Presenting the inter facility flows between regions

Source Region	Destination Region	Company	Nbr of Pallets
Dalarna	Stockholm	Coop	328
	Uppland	ICA	88

	Jämtland	ICA	2 594
	Umeå	ICA	5 794
Dalarna Total			8 804
Stockholm	Dalarna	ICA	2 141
	Stockholm	Coop	6 094
		ICA	5 161
	Sundsvall	Coop	376
	Uppland	Coop	435
		ICA	6 680
	Luleå	Coop	1 720
	Jämtland	Coop	325
	Bohuslän	Coop	633
	Göteborg	Coop	465
		ICA	28
	Kronobergs län	Coop	68
	Skåne	Coop	3 574
	Gävle	Coop	17
	Umeå	Coop	1 041
Stockholm Total			28 759
Uppland	Dalarna	ICA	3 828
	Stockholm	Coop	2 871
		ICA	17 412
	Sundsvall	Coop	394
	Uppland	ICA	6 196
	Luleå	Coop	1 731
	Jämtland	Coop	312
	Bohuslän	Coop	423
	Göteborg	Coop	346
		ICA	4 790
	Kronobergs län	Coop	1 298
		ICA	674
	Skåne	Coop	1 819
		ICA	4 135
	Gävle	Coop	567
	Umeå	Coop	1 340
		ICA	1 760
	Jönköpings län	ICA	375
	Kalmar län	ICA	291
	Östergötland	ICA	507
Uppland Total			51 065
Skåne	Dalarna	ICA	11 888
	Stockholm	Coop	3 033
		ICA	1 201
	Uppland	Coop	1 653

		ICA	36 596
	Göteborg	Coop	1 258
		ICA	19 951
	Kronobergs län	Coop	1 555
		ICA	3 960
	Skåne	Coop	1 994
		ICA	4 210
	Umeå	ICA	248
	Jönköpings län	ICA	2 106
	Kalmar län	ICA	1 678
	Östergötland	ICA	4 076
Skåne Total			95 405
Göteborg	Dalarna	ICA	485
	Stockholm	Coop	1 976
	Uppland	Coop	109
		ICA	4 404
	Göteborg	ICA	115
	Skåne	Coop	49
		ICA	727
Göteborg Total			7 864
Värmland	Dalarna	ICA	205
	Stockholm	Coop	978
	Uppland	ICA	1 462
	Göteborg	ICA	19
Värmland Total			2 664
Jönköpings län	Stockholm	Coop	1 667
	Uppland	Coop	10
		ICA	232
	Skåne	Coop	123
Jönköpings län Total			2 032
Gävle	Dalarna	ICA	142
	Stockholm	Coop	365
		ICA	336
	Uppland	Coop	133
		ICA	798
Gävle Total			1 773
Närke	Dalarna	ICA	318
	Stockholm	Coop	562
		ICA	1 012
	Uppland	Coop	667
		ICA	665
	Göteborg	ICA	29
	Skåne	Coop	48
Närke Total			3 300

Södermanland	Dalarna	ICA	881
	Stockholm	Coop	582
	Uppland	Coop	35
		ICA	277
Södermanland Total			1 774
Skaraborg	Dalarna	ICA	188
	Stockholm	Coop	1 750
	Uppland	Coop	591
		ICA	362
	Skåne	Coop	225
Skaraborg Total			3 116
Jämtland	Uppland	Coop	4
Jämtland Total			4
Umeå	Dalarna	ICA	148
	Stockholm	Coop	83
		ICA	402
	Uppland	Coop	4
	Göteborg	ICA	14
Umeå Total			652
Östergötland	Dalarna	ICA	59
	Stockholm	Coop	67
		ICA	39
	Uppland	ICA	82
Östergötland Total			247
Halland	Dalarna	ICA	601
	Stockholm	Coop	971
		ICA	41
	Uppland	Coop	243
		ICA	3 680
	Göteborg	ICA	21
	Skåne	Coop	8
Halland Total			5 565
Kronobergs län	Stockholm	Coop	12
	Uppland	Coop	8
	Kronobergs län	Coop	1 344
	Skåne	ICA	83
Kronobergs län Total			1 447
Bohuslän	Dalarna	ICA	41
	Stockholm	Coop	38
		ICA	638
	Uppland	Coop	265
		ICA	130
	Skåne	ICA	65
Bohuslän Total			1 177

Kalmar län	Stockholm	Coop	2
		ICA	345
	Uppland	Coop	89
		ICA	266
Kalmar län Total			702
Blekinge	Stockholm	ICA	58
Blekinge Total			58
Grand Total			216 407

Balance in the city regions

In Sweden there are three big city regions, Skåne (Malmö, Helsingborg, etc.), Göteborg, and Mälardalen (Enköping, Västerås, Bro, Stockholm, etc.). The balances between respective regions are only based on the companies in the study and are displayed in Table 4, Table 5 and Table 6. These flows do not include all import flows (some are estimated by the software) and therefore these figures are to be seen as an indication of the imbalances in Swedish geography.

Table 4 Balance of flows between Skåne and Mälardalen

Skåne - Mälardalen

Direction	Nbr of Pallets
North	44 465
South	9 781

Table 5 Balance of flows between Skåne and Göteborg

Skåne - Göteborg

Direction	Nbr of Pallets
North	*22 673*
South	*776*

Table 6 Balance of flows between Göteborg and Mälardalen

Göteborg - Mälardalen

Direction	Nbr of Pallets
East	*6 489*
West	*7 852*

Costs

The companies have provided cost information about their transports and, where applicable, also handling costs. In the analysis a weighted average has been used in order to be able to fully compare the costs. The cost structure is an OD-matrix where the origins and destination are the defined regions. The costs in the OD-matrix are calculated average weighted costs.

Analysis

The analysis is based on data modeling in the Supply Chain Guru software. The transport networks of each company have been modeled in the software and verified with the collected costs from each company. The transport networks have then been combined in 29 different scenarios, with different combinations of companies. In these scenarios the cost structure has been based on an OD-matrix consisting of costs between different regions; these costs are the same for all companies in order to be able to fully compare the results.

The identified potentials have been derived from a comparison between the companies' cost and average costs with and without cooperation. The software chooses the most cost efficient use of the available network, so the more companies included in a scenario the more opportunities for the software to use to find a more efficient solution.

The reason why the full potential shown is not realistic is that all costs affected by the analysis are not included. It only shows that the transport cost will decrease, but how that affects handling, time, and facility costs is yet to be examined.

Transportation cost

All the studied companies have different transport cost structures, i.e., they have various contractual agreements and ways of calculating transport costs. If the cost for each company were to be used in the combined model, potential savings would appear based on the cost structure instead of the network structure and the flows. Therefore, the cost used in the analysis is a weighted average from the submitted costs, giving all the warehouses the same cost per mile. This results in eventual potential not being based on one of the companies' cost, but instead on the match of infrastructure and/or flows. The data from Arvid Nordquist have some insecurities that have not been investigated fully. This leads to their baseline model not being verified and this has resulted in cooperation potentials involving them to be higher than plausible. This relate from that the distribution costs are based on the insecure data from Arvid Nordquist.

Scenario analysis

The analysis consists of several scenario analyses that combine different settings of companies. In Table 7 the result with weighted cost is displayed, while the result with the collected cost from each company is displayed in Table 8. It is important to clarify that the fill rate has not been considered in the analysis and this has a great impact on the effect on the environmental impact, but also on the costs. The only consideration of fill rates in the analysis is that the inter facility costs used are based on actual costs from Coop and Ica, and these are significantly lower than distribution cost, thanks to higher fill rates in reality.

Table 7 Scenarios with weighted costs

Nbr	*Company 1*	*Company 2*	*Company 3*	*Company 4*	*Cost*	*CO2*
1	Ica	Coop			-8.1%	-3.5%
2	Ica	*Arvid Nordquist*	Löfbergs Lila	*Cloetta*	-8.2%	1.7%
3	Ica	*Arvid Nordquist*	Löfbergs Lila		-6.3%	1.6%
4	Ica	*Arvid Nordquist*	*Cloetta*		-7.6%	1.8%
5	Ica	Löfbergs Lila	*Cloetta*		-2.1%	0.1%
6	Ica	*Arvid Nordquist*			-5.6%	1.7%
7	Ica	Löfbergs Lila			-0.8%	0.1%
8	Ica	*Cloetta*			-0.5%	0.1%
9	Coop	*Arvid Nordquist*	Löfbergs Lila	*Cloetta*	-13.1%	-11.7%
10	Coop	*Arvid Nordquist*	Löfbergs Lila		-9%	-0,7%
11	Coop	*Arvid Nordquist*	*Cloetta*		-11.9%	0.6%
12	Coop	Löfbergs Lila	*Cloetta*		-3.5%	-0.7%

13	Coop	Löfbergs Lila		-1.5%	-0.3%
14	Coop	*Cloetta*		-0.4%	-2.2%
15	*Arvid Nordquist*	Löfbergs Lila	*Cloetta*	*-49.4%*	*N/A*
16	*Arvid Nordquist*	Löfbergs Lila		-29.1%	*N/A*
17	*Arvid Nordquist*	*Cloetta*		*-48.8%*	*N/A*
18	Löfbergs Lila	*Cloetta*		-19.5%	*N/A*
19	Ica	Findus		-1.3%	0.1%
20	Coop	Findus		-0.6%	-1.9%
21	Ica	KåKå		-3.7%	0.2%
22	Coop	KåKå		-5.4%	-0.7%
23	Coop	Löfbergs	KåKå	-6.0%	-1.6%
24	Ica	*Arvid Nordquist*	KåKå	-9.2%	-8.6%
25	KåKå	Löfbergs Lila		0%	0%
26	Coop	Findus	KåKå	-4.8%	-1.5%
27	Ica	Findus	KåKå	-4.9%	0.2%
28	Coop	Findus	*Arvid Nordquist*	-7.3%	-1.3%
29	Ica	Findus	Löfbergs Lila	-2.1%	0.0%

In Table 8 the scenario results when using each company's collected cost instead of a weighted average; this results in a generally higher potential. When doing an analysis on a network level it is important to make some simplifications and in this case the costs have been applied between regions, in the OD-matrix. This leads to some inconsistencies in specific costs and if an analysis is made as in Table 8, the software will use these inconsistencies and this results in higher potentials. Also, the comparison between different scenarios is easier when using the same cost in all scenarios since the prerequisites are the same.

Table 8 Scenarios with each company's collected cost

Number	*Company 1*	*Company 2*	*Company 3*	*Company 4*	*Cost*
1	Ica	Coop			-8.8%
3	Ica	*Arvid Nordquist*	Löfbergs Lila		-4.7%
10	Coop	*Arvid Nordquist*	Löfbergs Lila		-5.5%
13	Coop	Löfbergs Lila			-0.7%
26	Coop	Findus	KåKå		-7.0%

Co2-emmissions

When performing an optimization at network level the focus is not on what assets are used. In the model a difference has been made between trailers, trucks and train transports. The companies in general do not have any information on their total CO_2 impact and therefore it is not possible to verify that the CO_2 emissions from the model are in line with real-life. However, the relative difference should give a reliable indication of how a cooperation will affect emissions.

The effects of cooperation from the scenario analyses on CO_2 emissions vary greatly depending on which coalition is investigated. In some cases, cooperation will theoretically result in increasing CO_2 emissions. This is mainly due to the usage of cheaper, more distant warehouses.

If the analysis would be done on a lower level, taking into account co-loading, with potentially better fill-rates, and more efficient utilization of the network, the CO2 emissions from the scenarios would be slightly lower.

Concluding recommendations

Conclusions

According to the analysis, there are potential efficiency gains of all cooperations. The small suppliers display the greatest relative potential for cost savings by cooperation. In line with existing theory, the more participants a coalition has, the greater the potential savings (Frisk et al., 2010).

Retail goods has a lower density in the last distribution step, i.e., the delivery to the store. Hence, splitting and consolidating freight as close to the final destination as possible enables higher fill rates. For Coop and Ica the average distances of the distribution from the warehouses are lower than for the other companies. Having a larger number of warehouses at their disposal, they are able to put larger flows in inter facility flows which are easier to plan and to operate at a high fill rate. Higher fill rate means lower transportation cost. The smaller companies on the other hand rely on the infrastructure of logistics service providers.

Joint distribution in a region means that companies can take advantage of each others' distribution systems. The flow analysis confirms intuition that companies operating warehouses or serving customers in the same geographical region have the potential to combine their flows.

The number of companies included in a cooperation can vary; in this analysis we have only investigated scenarios with up to 4 companies, due to the compatibility of the flows among the companies. The results show that cooperation with more than 2 companies have a higher potential than between only 2 companies, but they show no significant difference between cooperations with 3 or 4 companies. The feasibility of a coalition decreases as the number of participants increases.

Another finding from the study is the importance of demand characteristics. Some of the companies had slight differences in the temperatures of their transports and the monitoring of transport temperatures. Another sample difference was the demands on working conditions of the truck drivers. For actual coalitions, these factors need to be considered.

Theoretical matching models (Cruijssen et al., 2007a, Palmer and McKinnon, 2011) have presented improvements in the range of 15-50%, using flat costs over the entire network. Using similar data, our model is able to produce similar results, but such results have limited implications for practice. Hence our analysis is based on actual cost data and presents more realistic indications of the potential coalitions. The analysis results confirm the positive potential of cooperation, yet for a complete, feasible cooperation, the analysis needs to go one abstraction level lower and address the actual setups in the cooperations to present exact potential, something that was not feasible within the frame of this small study.

Recommendations

Important note*: The recommendations are built on both the quantitative analysis and the knowledge about the companies gathered over the past year. While previous research has provided recommendations mainly based on theoretical matching (e.g., Palmer and McKinnon, 2011), our ambition has been to combine the theoretical matching and implicit knowledge about the networks of the involved companies.*

- *Arvid Nordquist*, due to being situated in central Sweden, shows a relatively large savings potential by being highly compatible with all the other involved companies. *Löfbergs*, situated in Karlstad, displays similar characteristics.
- *Coop* already has a rather well-balanced network. Based on the analysis, Coop potential savings would stem from involving other actors' goods in their network, achieving economy of scale.
- *Findus* would benefit from co-loading their frozen flows; the first cooperation option to consider would be KåKå.

- *Ica*, due to its size, has very small relative benefits from cooperation. In order for Ica to identify savings, local co-distribution might be interesting, considering overcapacity in the newly built Helsingborg warehouse.
- *KåKå*, being a very small supplier, can benefit from cooperation with virtually any partner.

For the involved companies, ex works flows were not considered. *Cloetta* was an exception, involving ex works flows for the sake of analyzing freight balances.

Future investigation

This study has focused on the quantitative aspects of horizontal cooperation and the potential cost savings that can be achieved. The analysis shows several interesting results that strongly indicate the positive potential of horizontal cooperation in the fast moving consumer goods industry, but many more aspects need to be investigated. As previously outlined, fill rates were not included in the study and thus the effects on the environmental impact are not fully investigated, representing an important step for future investigation.

When companies sourcing from the same region combine their networks, the number of stores supported from a warehouse increases. This also results in a change in the backhauling where many of the companies have mentioned that they are or have the ambition to combine distribution tours with inbound transports. This aspect has not been investigated in this project.

The current analysis is on a network level; when the matching of companies is done the analysis would benefit economic accuracy by going into more depth in the analysis. In that case more detailed information of cost structure, capacities at warehouses, available assets and time constraints can be considered. To a large extent the detailed data was made available to the project, but was not used due to the short project duration. Also, the analysis has not included matching companies on a product level, i.e., finding combinations between companies shipping light, volume demanding products with heavy, low volume products in order to achieve efficiency for both weight and volume constraints in the trucks.

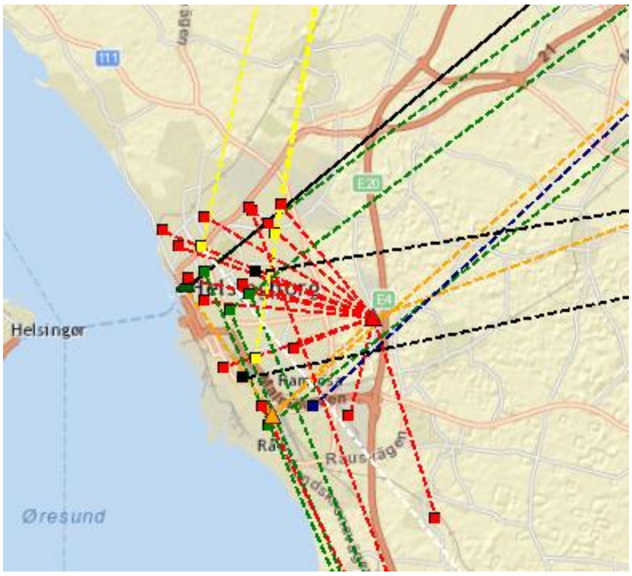

Figure 3 Inbound flows for all retailers in the city of Helsingborg

A natural continuation of these results is to investigate the results on a lower level, e.g., by restricting the analysis to an urban region, e.g., Helsingborg. Freight transport stands for up to 40% of emissions in urban regions and therefore it is quite interesting to investigate eventual potential to reduce CO_2 emissions by logistics cooperations. Also, when modeling a smaller geographical area it is possible to combine a network analysis with simulations and transport optimization. In Figure 3 all retailers and their inbound flow in the city of Helsingborg can be seen. Today the retailers are distributing without any collaboration with each other. In addition, suppliers located in the surrounding areas often need to deliver to the retailers' warehouses even though the distance to the stores is significantly shorter. Overall horizontal cooperation offers benefits, but analyzing supply of an urban area from a national network perspective, to our best knowledge, offers the most promising feasibility and significant short-term efficiency improvement.

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Appendix

In the tables below, the different data that has been requested from the companies by an Excel-template are presented.

Information about the suppliers

Name of the supplier	City	Zip Code	Delivery warehouse 1	Delivery warehouse 2	Delivery warehouse 3	Type of goods
	If more locations than one, use several rows		To which warehouse/terminal does the supplier normally deliver			What type of sku does the supplier normally distribute (EUR, wagon, etc.)

Information about customers

Customer Name	City	Zip Code	Sourcing warehouse 1	Sourcing warehouse 2	Sourcing warehouse 3
			From which warehouse does the store receive goods		

Information about sites and facilities

Name of the terminal/warehouse	City	Zip Code	Product	Warehouse capacity
			If it only handles a certain type of goods (Frozen, dry, etc.)	Number of pallets the warehouse can contain

Information about distribution flows

Trip	Date	Origin (Terminal/ Warehouse)	Type of Transportation	Type of goods 1	Type of goods 2 (SKU)	Number of Skus	Volume (M3)	Weight (Kg)	Distance (Km)	Price (SEK)	Number of stops	Destination
The unique number for a specific number of stores that are distributed on the same trip			Which type of truck and/or trailer	Frozen, dry, Noon-food, etc.	EUR/W aggon/E tc.					The cost of the specific transportation		Name of customer

Information about the inbound flow

Supplier	City	Zip Code	Destination	Type of Transportation	Type of goods (SKU)	Number of Skus	Volume (M3)	Weight (Kg)	Distance (Km)	Price	Date
Supplier 1			Terminal/Warehouse /Store	Which type of truck and/or trailer	EUR/Wagon/ Etc.					The cost of the specific transportation	

Information about flows between sites/facilities

Date	Origin (Terminal/Warehouse)	Type of Transportation	Type of goods (SKU)	Number of Skus	Volume (M3)	Weight (Kg)	Distance (Km)	Price (SEK)	Destination
		Which type of truck and/or trailer	EUR/Waggon/Etc.					The cost of the specific transportation	