SUPPLY CHAIN CONSIDERATIONS FOR ELECTRONIC GROCERY SHOPPING

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Dissertation for the degree of Doctor of Science in Technology to be presented with due permission for public examination and debate in Audiorium D at Helsinki University of Technology (Espoo, Finland) on the 24th of January, 2003 at 12 o'clock noon.

Abstract

The main hypothesis of the dissertation is that “e-grocery with home delivery can be more efficient than supermarket retailing handling a similar volume of sales”. The e-grocery business should be seen as an assembly industry producing shopping baskets. Only in this way can the new electronic channel work efficiently. The e-grocery business is usually seen as a supermarket copied into an electronic form; it is seen only as an opportunity to buy products. Instead, the starting point of operational design should be the real needs of a household and take into account the possibility of adding new services for the customers.

One of the conclusions of this research is that the operational costs of a distribution centre can be lower than those of a supermarket. Store-based order picking is less expensive than using a specialised distribution centre when turnover is less than one million euros. A turnover of more than 3 million euros means that a dedicated distribution centre appears to be more efficient than store-based picking. However, the distribution centre has to be purpose-built for shopping basket assembly with a reasonably stable workload. A combination of store-based picking and a specialised distribution centre has been introduced as an opportunity to create gradual low-risk growth in the e-grocery business.

It seems that efficient home delivery can be achieved even with a moderate market share. Unattended reception is very important for the overall cost structure of the supply chain and enable service models that give flexibility in route planning and optimisation. However, the investments that unattended reception requires should also be taken into account. The cost efficiency of a home delivery service model can be described by the average mileage driven per order, which directly correlates with the number of stops per hour.

New efficiency indicators are needed to measure the efficiency of the e-grocery business. Sales per distribution centre and sales per square kilometre are useful indicators when choosing home delivery service models and potential market areas. The most useful factor is sales per square kilometre. The critical sales volume appears to be 200,000 euros per square kilometre per annum. This sales volume can be achieved with 25 four-person households per square kilometre with 90 percent purchase loyalty.

E-grocery retailing is a very local business and store-based picking is a good alternative if fast roll-out with a low level of investment is required. A distribution centre-based operation is potentially much more efficient, but it is a slower approach and needs more investment. Whatever service model is chosen, it should first be made to work in a fairly compact geographical area and then copied to new areas.

Acknowledgements

This work has taken five years to complete, so the number of people who have helped me during this time is so large that there is no possibility of my mentioning everybody by name here. I feel very fortunate that I have had a chance to work with so many talented and inspiring people, especially during the three years of the ECOMLOG project, when the actual research work was carried out. Thank you all; it has been one of the greatest periods of my life.

I was brought up to value a high level of education. This is one of the reasons why I started this mission, which some people, knowing my corporate background, considered odd. I would like to thank my mother and late father for this. I just wish that he could have seen me finalise this work.

There are three professors at HUT who were not involved with this research, but who have otherwise helped me to reach this target. I would like to thank Eero Eloranta, Reijo “Shosta” Sulonen, and Markku “Murkku” Syrjänen; knowing them from my time as an undergraduate made it easy to come back to the University and start my postgraduate studies. Shosta helped me a great deal during my undergraduate studies and thanks to him I was able to concentrate on Information Technology and Industrial Management in my M.Sc. Murkku guided me back to the academic world and, for starters, gave me a course teaching artificial intelligence to very bright doctoral students. After that challenge everything else felt like a piece of cake. In our first postgraduate meeting Eero gave me a good reason not to quit by telling me that only ten per cent of the people coming back from the corporate world ever get their doctorates. I did not want to be part of the 90 per cent.

I started my postgraduate studies in order to update my knowledge and without a pre-selected research area. I am grateful to Professor Paul Lillrank for his endless stream of new ideas and continuous support. This research project was a by-product of Paul’s project idea of a high technology household maid service.

The working environment often has a much bigger influence on the results than people realise. I would like to thank Professor Kari Tanskanen and Docent Jan Holmström for their help and guidance during my dissertation process, and for the research environment they created. I thank my fellow researchers Vesa Kämäräinen and Mikko Punakivi and others in the ECOMLOG team for their support, ideas, criticism, and friendship. It has been a pleasure to work with you. I am grateful to the organisations that made this research project financially possible. TEKES, the National Technology Agency, took the main responsibility for the financing. I thank Pekka Aaltonen for his support and active role in the research project. The eight companies that participated in and sponsored the project (see Section 1.4) had an irreplaceable impact on the research results. I thank the representatives of these companies for their ideas and encouragement as well as for providing access to real data.

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Hannu Yrjölä

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1 Introduction

Grocery shopping has probably been the most traditional form of shopping in the everyday lives of normal families for hundreds of years. The start of grocery shopping can be regarded as the market, where consumers bought groceries directly from various producers. The first grocery retailers bought their merchandise directly from farmers and offered consumers a selection of the products they needed in their everyday lives. The grocery supply chain from the supplier to the household has developed over the years. The end of the supply chain, the point of sale, has changed from the market to the supermarket and the supply chain now has several levels instead of the single level of the market or the first retailing outlets. From the customer's point of view the point of sale has developed, but the original shopping process has not been changed. The customer still needs to go to the merchant to select the merchandise needed from the selection present at the merchandiser's place of business.

The possibility of electronic shopping created by the Internet has attracted many businesses to offer products to consumers online, changing the front end of their supply chain, the point of sale, from a shop to a website. In many cases this has been the only change in the whole supply chain, thus making the supply chain similar to the supply chain of catalogue sales. The change in the point of sale and home delivery of the products have only added costs, without any real savings in the whole supply chain. Customers have not been willing to pay any extra or only a fraction of the costs for the new services. No wonder most of these businesses have been unsuccessful. They have offered a more complicated consumer interface, with often more expensive fulfilment costs than those of their competitors. Hundreds of millions of dollars of marketing money have not helped to boost sales. Businesses such as BOO.COM, which offered clothes over the Internet, ran out of money after the investors had lost faith in the companies (Stockport et al, 2001).

Some e-commerce businesses have survived. Those are businesses that can offer consumers better value for the same price or the same value at a cheaper price than the competition. Better value can be a wider selection of products, as in the case of Amazon.com (Kurson, 2001). To be able to sell products more cheaply than a traditional store means that the structure of the business must be different. Amazon has been forced to develop its business model and particularly its logistics in order to be able to reach profitability.

For grocery retailing the question is: can the grocery supply chain be changed in such a way that it offers better value to consumers than a traditional supermarket but at the same price level? This means offering the picking and delivery of groceries to the household or another convenient location on the basis of the customer's order. Many analysts' reports state (Rosen & Howard, 2000) that grocery retailing is the most challenging form of business to convert to the e-channel.

The motivation for initiating this research work was to find out if there is a feasible way to change the structure of the grocery supply chain so as to create a completely new service which can be offered to consumers at a reasonable cost.

The key objective of the research was to estimate the cost of building and operating an electronic grocery shopping service that delivers the groceries all the way to the household. This included constructing the essential operational parts of the service and analysing their cost structure. Furthermore, the objective was to gain understanding on the cost drivers of the various operational parts and alternatives and identify suitable performance indicators for the new approach to grocery retailing.

1.1 The grocery business in Finland today

The purpose of this chapter is to give a short overview of the grocery market in Finland in order to show how concentrated and well protected it is. Furthermore, it will describe the current trend towards larger stores and fewer outlets. We argue that this development reduces the value that grocery retailers provide to consumers. From the consumer's point of view, this trend means that the structure of retailing will place more and more of the burden of work and transportation on consumers. On the other hand, the concentration of retail space in bigger shops increases the product range under one roof and offers greater opportunity to "one stop shopping" – enabling consumers to rationalise travel.

The total volume of the grocery business in Finland was 59 billion FIM (€10 billion) in 1998, excluding alcoholic beverages (A. C. Nielsen, 1999). Sales in kiosks and petrol stations represented 7 percent. The number of grocer's shops was 4026 and the number of specialist shops and market hall outlets totalled 650. The reduction in the number of stores, compared to the previous year, was 136. The amount of floor space, however, remained more or less constant. Co-operative stores represented 35.5 percent of total sales; the remaining 64.5 percent was from commercial stores.

The total floor space for grocery sales was approximately 1.7 million square metres in the year 2000 and it has grown gradually from 1.5 million in the year 1996 (A. C. Nielsen). Sales per square metre have been almost constant 34,000 FIM (€5,720) annually in the year 2000 and 33,000 FIM (€5,550) in the year 1996. The number of citizens per store was 1033 in 1996, growing to 1210 in the year 2000. The average amount of purchases was 10,000 FIM (€1,681) per capita in 1996 and grew to FIM 11,100 (€1,866) in the year 2000 (A. C. Nielsen).

Retailers measure their efficiency mainly with two indicators, sales per store square metre and sales per employee (Santasalo & Kontio, 1998). As a general trend, sales by area have remained at the same level. If inflation is taken into account, efficiency has decreased slightly. Efficiency in terms of sales per employee has soared. This is due to a dramatic reduction in staff. From 1990 to 1996 the staff of supermarkets and general grocery shops was reduced by 40 percent. At the same time the amount of stores was reduced from 6424 to 4670, which is 27 percent. Sales in these outlets increased by 3 percent in the same time period (Santasalo & Kontio, 1998).

The efficiency improvement in grocery retailing has been substantial but from the grocery supply chain point of view the improvement is, at least partly, sub-optimal. The decrease in the number of stores means that consumers need to travel longer distances to get to the store. On the other hand, the decrease in store personnel is due to the fact that there are fewer and larger outlets, with less service. This often means an increased rate of self-service and shopping time for the consumer (Salmela, 2002).

The trade is very concentrated and half of all purchases from suppliers are carried out through two dominant purchasing organisations: Kesko for its own stores and Inex Partners for the stores of the S-Group and Tradeka. The other half of grocery purchases are made from other wholesalers and directly from suppliers. A clear sign of the concentration of the grocery business is the fact that half of the total sales in 1998 were made by the 390 biggest grocery stores.

The market shares of the major grocery chains in Finland in 1998 were as follows (as a percentage of total grocery sales)

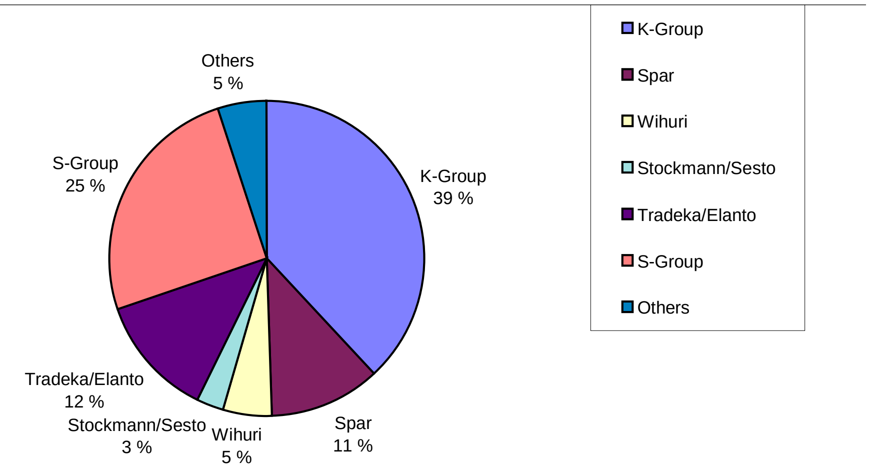

Figure 1.1 Market shares of grocery sales in Finland (A C Nielsen, 1999)

A more detailed description of the grocery retailing market in Finland and the grocery retailers can be found in Appendix 1 in Chapter 7.

The number of grocery stores in Finland has decreased since the year 1980 by more than half and the amount is still decreasing. Specialised small shops in cities have almost completely disappeared and retailing is concentrated in super- and hypermarkets built outside densely populated areas. The prevailing tendencies in Finnish grocery retailing are a growth in store size, a decrease in the number of stores, and concentration and chain formation (Federation of Finnish Commerce and Trade, 2000). The large retailing outlets are based on self-service and they are often not easily accessible to customers without a car. This means that to visit a large supermarket the consumer has to either travel with an expensive private car or spend a great deal of time using public transport. On the other hand, a positive side of the development has been the continuously falling prices.

In recent years, as a result of the rising standard of living, consumers have started to ask for better service. This has created the shop-in-shop concept in supermarkets but, more importantly, grocery retailing in petrol stations and kiosks has increased. They can even offer 24/7 opening hours and are often more conveniently located. These shops are primarily targeted for supplementary shopping and can hardly be a large-scale solution for consumers in search of better service at reasonable prices. At the same time the concentration of the population in Finland will require the building of 84,000 square metres of new store space in the years 1998-2002 (Federation of Finnish Commerce and Trade, 1998). Is there a way to create the services required by the consumers in a better way than just building bigger supermarkets?

1.2 The consumer process and cost structure of the grocery supply chain

This section analyses the cost structure and the shopping process from the consumer's point of view. The purpose is to show that increased efficiency in the retailer's operations generates inefficiency and extra cost to consumers.

More and more supermarkets are being built to enable people to park their cars nearby while shopping for heavy and bulky daily consumer products. According to studies carried out in Finland (Spåre & Pulkkinen, 1997) households visit shops on average 4.3 times a week, requiring, on average, 48 minutes on weekdays and 58 minutes at weekends per visit. 57% of the time is spent in cars and the rest in shops picking and paying for the goods. Altogether, we are looking at a total of some 450 million hours spent on this pick-up activity. On the basis of these facts it is clear that the downstream operations in the grocery goods logistics chain, from the shop to the household, are currently very expensive and inefficient from the viewpoint of the consumer (Raijas, 1994).

On the basis of these detailed studies of consumer behaviour in Finland (LTT, 1995), the collection task carried out by the consumer himself represents 20 percent of the value of grocery products at the shop check-out point. The total value of the grocery trade in Finland is approximately €10 billion annually. An annual figure of €2 billion is based on the previously-mentioned figure of 450 million hours spent shopping and travelling to and from shops. The hourly rate used here is only €3.25, which is the “leisure time” rate used by the Ministry of Transport for assessing road network investments (Ministry of Transport, 1999).

The valuation of personal time is a widely discussed subject. It seems that there are many different approaches to the way that valuations can be used. The Brookings Institution (Winston & Shirley, 1998) has calculated different values for personal travel time based on a willingness to pay a toll in return for saving time spent commuting. The valuation of time in this extensive study is dependent on the time of day and the length of the commute. The cheapest valuation of time in this study is as low as USD 1-2 for commutes of one mile or less during rush hour. The valuation goes up with the length of the commute, being USD 8-9 for commutes of 11 to 25 miles.

The Texas Transportation Institute takes a different approach to personal time valuation. When assessing the monetary losses due to congestion on the roads the valuation of personal time was USD 11.70 per hour (Lomax & Schrank, 1999). The value of a person’s time was derived from the perspective of the individual’s own value of their time. This valuation is double the minimum salary in the USA and only slightly less than the average net salary of “blue-collar” workers. Thus, it seems that when a person is asked how much he values his time, the valuation is higher than what he is in reality prepared to pay to save time.

The American Highway Users Alliance has carried out an extensive study on how to save money by investing in improvements in the road network (Hogarty, 2000). This study uses a simple approach to personal time valuation. The valuation is USD 6 per hour and based on an ongoing willingness-to-pay experiment in Virginia. The Dulles Greenway is a private toll road that connects Leesburg, Virginia and Dulles Airport. By paying USD 1.50 per trip people can save approximately 15 minutes of travelling time for the 14-mile trip. This implies that people are prepared to pay USD 0.10 per one minute saved, thus making the valuation of personal time USD 6 per hour.

These examples imply that the €3.25 valuation used in Finland is rather conservative. On the other hand, the average net salary level in Finland is much less than in the USA. Even if this is believed not to have a direct connection to the valuation of personal time, it is in truth most likely to have some influence. The exact value of the 450 million hours spent shopping annually is used only to motivate the research on alternatives, and not as a part of cost calculations when comparing the cost structures of different options.

In addition to time spent, consumers spend over half a billion euros on private car transportation when shopping. These costs are presently borne by consumers, who effectively cover the “last mile” of physical distribution in grocery shopping. The current structure of grocery shopping is outlined in Figure 1.2.

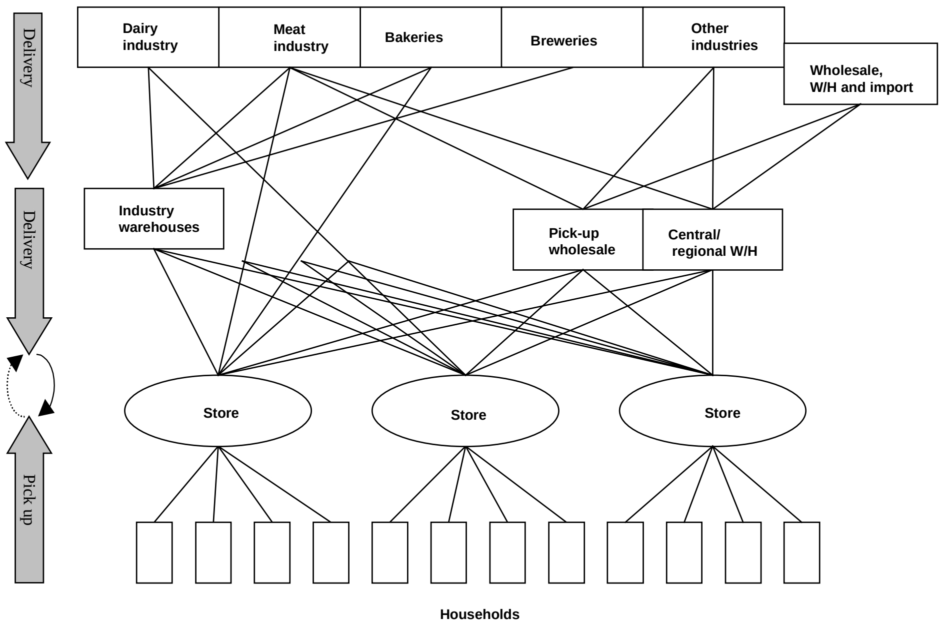

Figure 1.2 The current grocery distribution model

Current grocery retailing is based on the consumer picking the products and carrying out the “last mile” of transportation to the final destination, the household. An alternative to this structure is EGS, where the retailer (also called the ‘e-tailer’) assembles the shopping basket and delivers the groceries to the household on the basis of the customer’s order. Table 1.3 provides a comparison of modern supermarket internal cost structures in the USA and gives an estimate of what the cost structure for a high volume dedicated electronic grocery supply chain could be (Macht, 1996).

Streamline Versus Supermarkets: More Net Per Revenue Dollar

	TYPICAL SUPERMARKET*	STREAMLINE
Cost of Goods Sold	$0,75	$0,72
Operating Costs	$0,17	$0,13
Distribution	$0,04	$0,06
Corporate Overhead	$0,03	$0,03
Net Profit	$0,01	$0,06

*Figures compiled by Smart Store, a research-and-development initiative at Andersen Consulting.

Table 1.3 Modern supermarket vs. EGS (Macht, 1996)

The figures above were presented by Streamline, Inc. and are based on the assumption that the operation has sufficient sales volume to enable competitive buying power and sufficient customer density for efficient home delivery. On the basis of such profit and cost estimates companies such as General Electric, Intel, and SAP America invested millions of dollars in Streamline. There seem to be two key points that Streamline is making: 1. By taking a more active role in distribution the cost of goods sold could be lower. 2. The operating cost of a supermarket is 4 cents per dollar more than sorting and picking the goods at a distribution centre and delivering them to people’s homes (Yrjölä, 2001).

Even if Streamline failed commercially and had first to sell parts of the operation to its competitors and later, in November 2000, cease its operations altogether, this does not prove that the estimates presented were not plausible. The operation never reached the volume that the figures were intended for. A new player in the market needs to win market share at the same time as changing the value it offers (Holmström et al, 1999a) to customers. This is comparable to selling a new product to a new customer and, on the basis of marketing theories (e.g. Porter, 1980), is the most difficult form of business.

Traditional grocery chains have a better starting position when building an electronic channel. However, it requires extensive process re-engineering and will cannibalise part of the existing business.

1.3 The change in IT infrastructure that enables process re-engineering

This section will describe the changes in Information Technology that have created a new communication and information processing environment in society. This new environment will enable businesses to be based on direct and exact communication instead of estimates and prognoses.

It is very difficult to tell exactly when the information revolution that we are currently witnessing really started. There are many different opinions (e.g. Gray, 1999). In logistics the first large-scale change was seen in the ODETTE project in the early 1980s (MacLeod, 1999). ODETTE was a joint project of car manufacturers and aimed to standardise the Electronic Data Interchange (EDI) in their supply chain. Car manufacturers required that their suppliers receive orders and send all delivery information via EDI messages. This enabled the manufacturers to manage the whole supply chain instead of just their own inventory. This led to a drastic reduction of inventory levels and huge savings for the car manufacturers. Building these EDI links between companies was slow, difficult, and expensive. The typical cost of building a new link was in the order of €100,000. However, the end result was very profitable, even if it was more profitable for the car manufacturers than their suppliers. This was the first large-scale inter-company optimisation of supply chains that led to savings and better overall efficiency (Hammer, 1990). These kinds of EDI systems are still in use but require a large-scale operation with very few changes. Otherwise the cost will eat up the benefits.

The next type of inter-organisational development was the implementation of EXTRANET type systems (e.g. Ling & Yen, 2001). Companies opened their transaction processing system selectively to co-operating organisations. This enabled direct inter-company transaction processing and increased possibilities of developing more efficient control and management systems. The implementation of EXTRANETs is much faster and easier, but it still requires mutual agreement. Thus, it also needs a relatively stable environment in which the participating companies are not changing all the time. However, the technical cost of opening a new link is maybe a tenth of the cost of an EDI link. Therefore, EXTRANETs can be very efficient and profitable in much smaller-scale operations.

The Internet will soon cover more than 50 percent of the households of the western world and mobile connections are starting to increase rapidly (Ross, 2000; Gwin, 2000). This development looks very similar to the development in companies in the 1980s, when minicomputers changed the cost structure of computer systems. In most offices everybody was connected to the company's transaction processing system by means of a terminal. Even if paper documents did not disappear the control and management of operations was based on information in the transaction processing system, not documents. This, ideally, enabled everybody involved in any process to get all the information they needed for their task, when they needed it. This naturally happened only after the processes of the company were re-designed (Hammer, 1990). When the processes were streamlined, office departments were closed or restructured and the nature of office work was changed. Successful companies were able to improve their overall efficiency and to cut overhead costs at the same time (Benjamin & Wigand, 1995).

Now we can see this same development happening in the whole of society. The Internet is connecting all businesses, households, and individuals to the same transaction processing system. This will require the redesign of all the processes in society. Some processes that only include information are relatively easy to change and in these changes are likely to happen quickly. A good example of this is banking services. Most businesses and individuals in Finland use only electronic banking services (Nordea, 2001). Bank premises are only visited when the transaction needs negotiations or logistics, such as loan arrangement or collecting a new credit card. The change in processes is slower and more complicated when it involves logistics.

It has been said on many occasions that Business-to-Business (B2B) is the real money-maker in electronic commerce (e.g. Forrester Research, 2000, Rosen and Howard, 2000). Business-to-Consumer (B2C) is only the tip of the iceberg and will be of less importance. When we look at the re-engineering of processes that are logistics-intensive this approach can lead to not seeing the full potential of the new IT infrastructure to make the processes more efficient (Holmström et al, 1999a). Most supply chains can and must be seen as B2B2B2B2B2B2C. When this structure is streamlined it might well be that one or more B's will drop out. Some organisations will drop out from the logistical process but might still be important players in the information process. A company that has been in the wholesale business can continue to market and maintain a selection of products from a large number of manufacturers. But it is not so obvious any more that maintaining an inventory will add value. The new Information Technologies will enable the control and management of the logistics of the supply chain at a reasonable cost without the merchandise ever being seen. This is the reason why most processes can and will be re-engineered.

This re-engineering process can make all information-intensive processes in society at large more efficient (Benjamin & Wigand, 1995), in the same way that it was possible to increase efficiency using minicomputers in offices in the 1980s. But maybe an even more important aspect of the changes under way is the need to radically increase the efficiency of logistics. Is it possible to achieve the improvements needed for e-commerce to succeed?

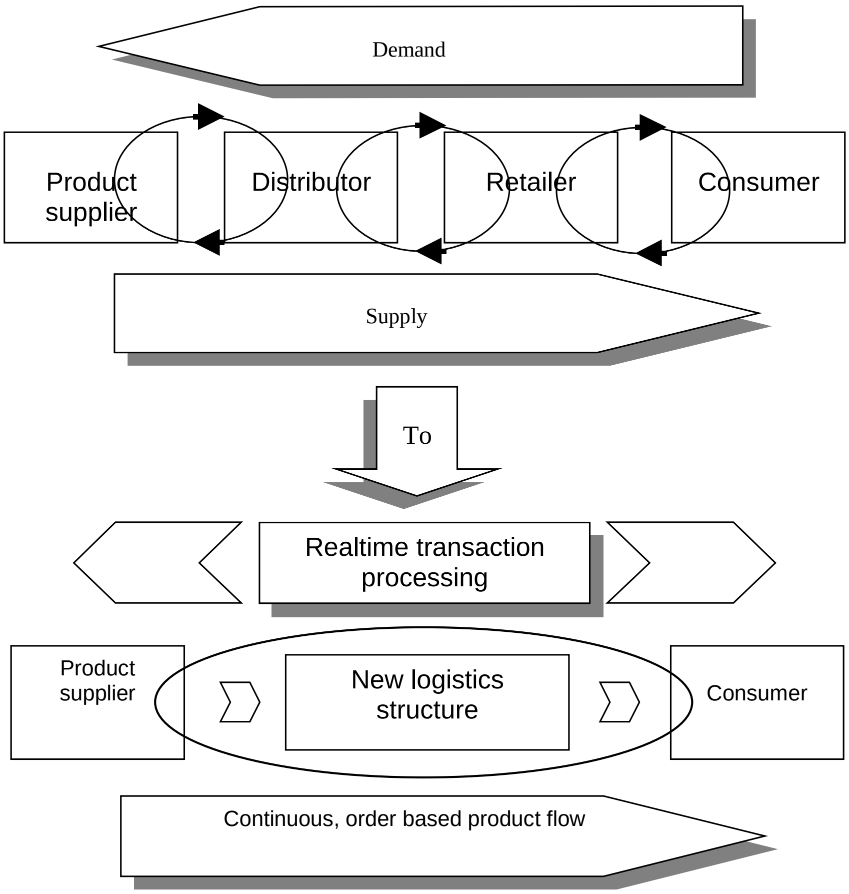

Figure 1.4 Changes in the structure of the grocery trade (Yrjölä, 2001)

Figure 1.4 illustrates the changes to the structure of grocery shopping as a process starting from the product supplier and ending at the consumer's location in today's ICT environment (Information and Communication Technology). In the upper structure the different levels of the supply chain trade with each other and the logistical processes are planned separately for each level. In the new environment product flow is based on consumer orders and the logistics can be designed and optimised for the whole supply chain as one process.

1.4 Research project background

The observations made in the early stages of electronic commerce suggested that trade and industry would be interested in getting answers to their questions concerning the possible changes that the new Information Technology infrastructure was likely to bring. The author suggested that a research project on electronic grocery shopping should be initiated at Helsinki University of Technology (HUT). The project was started with a pre-study in June 1998, financed by the HUT Industrial Management Department alone. The pre-study gave a significantly greater understanding of the research area and the problems that companies will face when starting to build new Internet-based trading channels.

On the basis of the pre-study we started to approach commercial companies in order to test their interest in participating in the research. The approach was very selective, because only companies with genuine commercial interest were wanted as participants. Earlier research projects in the same industry sector, such as ELITE (Tekes, 1999), had shown how important this aspect was. The companies have to be prepared to devote staff time to the project and only commercial interest will justify this.

First of all, we needed companies from the grocery supplier side. The pre-study showed that in terms of weight and volume close to fifty percent of groceries come from two product groups: brewery and dairy products. This is why we spent a great deal of time and effort on bringing suppliers from both groups into the project. The second clear need was to have one of the grocery chains involved, so as to bring in expertise concerning current retailing and insight into the feasibility of potential changes in processes. Thirdly, we believed that the new processes needed new types of telecommunication technology, at least in the long run. The major telecommunications operators were selected as prime targets. Fourthly, in order to be able to build any type of pilot operation, we needed a manufacturer of refrigeration equipment.

The autumn and winter of 1998 were used to approach trade and industry. The information and knowledge collected in the pre-study helped us to convince a sufficient number of prominent companies to participate and finance the project that the rest of the financing was able to be obtained from the Technology Agency of Finland. The project was officially started on 1st April 1999, but the major part of the project team of ten people was recruited during the summer of 1999. The team was fully staffed by September 1999, when the first conference papers were presented to an international academic audience.

The project was targeted for three years, with ten to twelve full-time researchers. This required a minimum of eight companies to participate and sponsor the project. The participating companies were:

Fazer, a major sweet manufacturer in Finland

Hansel, a wholesaler of office products, the former procurement organisation for state-owned companies and state organisations

Hollming, an industrial company with several fields of activity, its subsidiary company Norpe Ltd being a manufacturer of refrigeration equipment for grocery stores

Nokia, one of the world leaders in wireless technology

Panimoliitto, the union of Finnish breweries

S-Group, the second largest grocery chain in Finland

Sonera, a telecommunications and mobile telephone network operator

Unilever, a world-wide grocery supplier

Valio, the largest supplier of dairy products in Finland

Even if we were not in a position to select the participants, we were able to select the companies we approached in order to get them to participate. We tried to avoid getting direct competitors as participants, because we believed that it would be easier to share ideas and information within the project without a direct conflict of commercial interest being present. We were quite successful in this and the only slight exception was the union of breweries, representing most Finnish companies in the brewery industry. However, even if there were participants from competing breweries at most larger project meetings, they have a long tradition of co-operation with their competitors and this was never a problem.

The project was named ‘Ecomlog’, standing for ‘e-commerce logistics’. The original idea of researching the electronic retailing of groceries had by now been expanded to cover more comprehensively all aspects of logistics in electronic commerce. The project was first organised into four sub-projects, as illustrated in Figure 1.5.

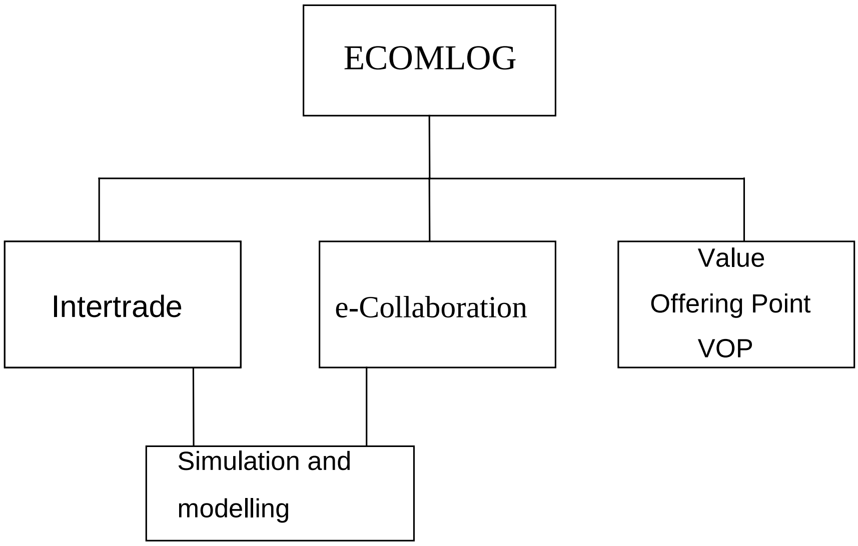

Figure 1.5 The organisation of Ecomlog

Intertrade: Physical distribution in electronic retailing

The retailing of groceries was organised as the first sub-project and called 'Intertrade', a name that was used for the project initiative in 1997. The first phase of the project involved researching the cost structure of the grocery supply chain, in other words testing the hypotheses of this dissertation. It was later decided that Intertrade would also cover the retailing logistics for electronic commerce in general merchandise. The results of the later phases of Intertrade and the results of the other sub-projects are not included in this dissertation.

Simulation and modelling: This part was first kept separate so as to serve both the Intertrade and e-Collaboration sub-projects with shared resources. It was later decided to merge this part with Intertrade.

e-Collaboration: Inter-company collaboration in the supply chain

Electronic communication between companies is very common today, and the Internet makes it possible to share information with an ever-increasing amount of business partners at a low cost. The e-Collaboration research project examines how electronic communication can be used for effective inter-company collaboration.

The objective of the e-Collaboration project is to find new ways for companies to work together to improve supply chain visibility and control. One of the focus areas is developing methods for linking category management information to logistics control. A tool for quantifying the benefits of information sharing has also been created.

VOP: Increasing customer value in electronic business models

In business-to-consumer e-commerce, the physical store is replaced by an electronic shopping environment. This changes, among other things, the rules of category management, the way products are displayed, and consumers' shopping behaviour. Understanding these changes is a prerequisite for creating viable electronic business models and is, therefore, one of the focus areas of the VOP research project.

The electronic environment and new technological advances such as wireless applications, however, also present a great opportunity to offer the consumer totally new services. The consumer does not, for example, have to order all regularly-used products every time, but can instead get them delivered through a replenishment service. One of the objectives of the VOP project is, consequently, to develop and test new consumer service models and to evaluate their effect on the customer relationship and the supply chain.

The VOP project also looks at added value and services in the business-to-business environment. The project develops tools for identifying new opportunities to serve customers better, as well as tools and principles that allow for cost-effective implementation.

2 Literature review

The purpose of this chapter is to give an overview of the development of supply chain theories and retail logistics. The theories closest linked to this dissertation and potential e-grocery supply chains will be discussed as a separate section 2.2 which will detail supply chain design issues as well as supply chain management issues. Finally, the literature on e-grocery and electronic commerce in general is reviewed and discussed in 2.3.

2.1 Supply Chain Management

This section is an overview of various aspects of supply chains and supply chain management. It discusses the development of supply chains, the related theory as well as the special features of retail logistics and its recent development. The purpose of the review is to provide the basis for the study of alternative supply chain solutions for electronic grocery shopping.

2.1.1 What is a Supply Chain and Supply Chain Management?

There are numerous definitions for a Supply Chain and Supply Chain Management. The definition often reflects the field from which the question is approached. For example, a manufacturing oriented view will emphasise different points than a marketing oriented view. A reasonable neutral definition for a Supply Chain has been presented by Ellram, 1991:

“A network of firms interacting to deliver a product or service to the end customer, linking flows from raw material supply to final delivery”

A similar type of definition for Supply Chain Management has been presented by Jones and Riley, 1985:

“The planning and control of total material flow from suppliers through manufacturing and distribution chain to the end users”

The recent definitions have placed more emphasis on the information flow, for example the definition by Hanfield and Nichols, 1999:

“It encompasses all activities associated with the flow and transformation of goods from raw materials stage, through the end user, as well as associated information flow. Material flow up and down the supply chain.”

The definitions of Supply Chain Management often overlap with those of modern definitions of logistics (Lambert, 2001). The key difference is perhaps that definitions of Supply Chain Management that do not come from a logistics background take a more holistic approach and the emphasis is on a network rather than on a single company. This single company approach can be seen, for example, in the definition of Logistics by Christopher, 1998:

“Logistics is the process of strategically managing the procurement, movement of storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channels in such a way that current and future profitability are maximised through the cost efficient fulfilment of orders.”

Towill (1997) has pointed out that it is not important whether the business process is called Supply Chain Management, Logistics, Production Management or Demand Chain. How we achieve our goals and continuously monitor our performance to maintain efficiency in the process is what is important, rather than the name that we give to these processes. The important aspect of these definitions are the network and the flow of information in addition to the flow of material.

2.1.2 The development of supply chains

This section discusses the development of supply chains on general level and the basic patterns for supply chain configuration. This forms the theoretical background for the development of e-grocery supply chain.

The most simple structure for a Supply Chain is perhaps a self-sufficient farm producing all the necessary means for living on-site. The demand forecasting, production management, inventory control and distribution are in the same closed system. This is the earliest stage in the history of the human race. The next step was the exchange of products between farms and farmers. The trading of products in markets enabled farms to specialise their production into goods or product groups where they were able to achieve a competitive edge.

When trading started to specialise more levels in the Supply Chain were needed. The wholesaler was able to buy the whole production of a certain product group from a farm and sell it to several retailers. The sub-contracting in industrial production added a new element to Supply Chains when production was distributed to several manufacturing sites. Today the Supply Chains are in fact reflections of the proliferation of more and more networks instead of being simple chains in a structure.

However, even the most complicated supply networks are based on a few basic patterns (Hoekstra et al, 1991). The level of complication is due to the number of elements in the network, not due to the complexity of the basic elements themselves. The patterns are described in Figure 2.1.

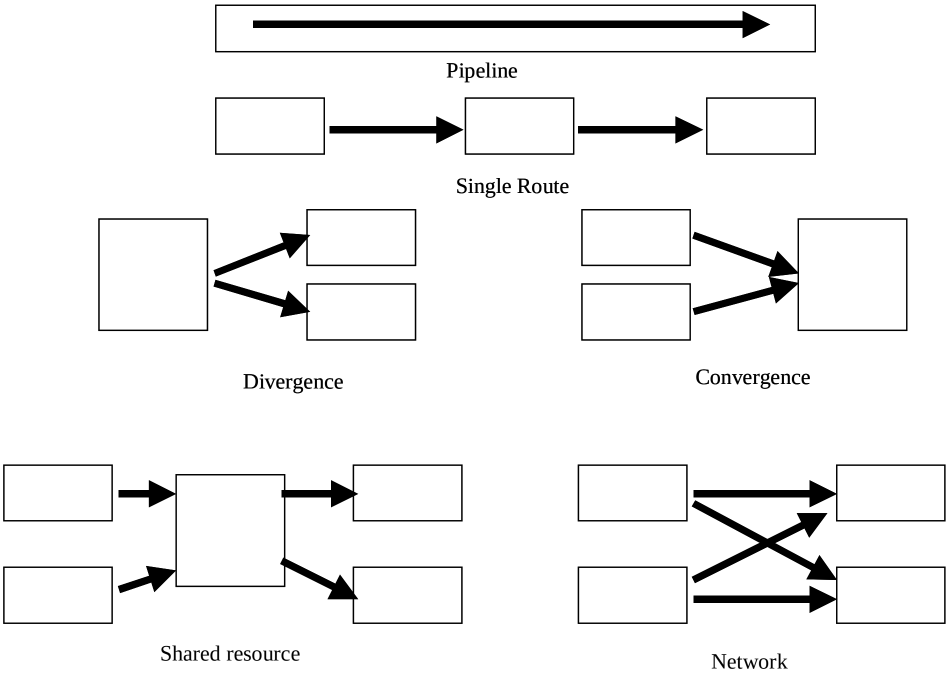

Figure 2.1 Basic patterns for Supply Chain configuration

The common elements for Supply Chain Management in literature review by Cooper et al, 1997 were:

-Supply Chain Management develops through several stages of intra- and inter-organisational integration and co-ordination, and in its broadest sense, it spans from the initial source to the ultimate consumer.

-Supply Chain Management involves potentially many independent organisations. Thus managing intra- and inter-organisational relationships is of essential importance

-Supply Chain Management includes the bi-directional flow of materials and services as well as information, and the associated managerial and operational activities

-Supply Chain Management seeks to fulfil the goals of providing high customer value with an appropriate use of resources, and building competitive chain advantages

Even if the tendency is to describe the Supply Chain as the whole chain from the ultimate origin to the ultimate destination, it has been suggested (Sharman, 1999) that company Supply Chains and Industry Supply Chains should be understood as different entities. Even if they have several goals in common (to minimise the cost of the Supply Chain, improve customer service focus and process orientations) they are different in nature. The differences are, for example, in information systems, the nature of co-operation and authority and so on.

However, the network character has been widely understood and it has had a major impact on management thinking. Christopher, 1998 points out that the key issues in the management of the network are responsiveness, reliability and relationships. Responsiveness means the trend from push to pull, from forecast driven Supply Chains to demand driven operations. However, it should be said that it is not possible to control the whole Supply Chain if it is understood in its widest sense. Controlling the vital key links of the network becomes important. Walker, 1998, describes this development as a tendency for companies to try to become a preferred link in a Supply Chain instead of a preferred supplier, which had previously been the aim of many companies.

The global nature of the entire supply chain raises the problem of global versus local control. Christopher, 1998 suggested “Global co-ordination, local management” as an approach for devising activities for global and local categories. The global activities include, for example, network structuring, information systems development and international transport modes and sourcing decisions. The local activities include customer service management, warehouse management with local delivery, as well as human resource management.

Finally, when taking the research approach to supply chains Harland, 1996, has suggested the division of Supply Chain research into four levels of complication as illustrated in Figure 2.2.

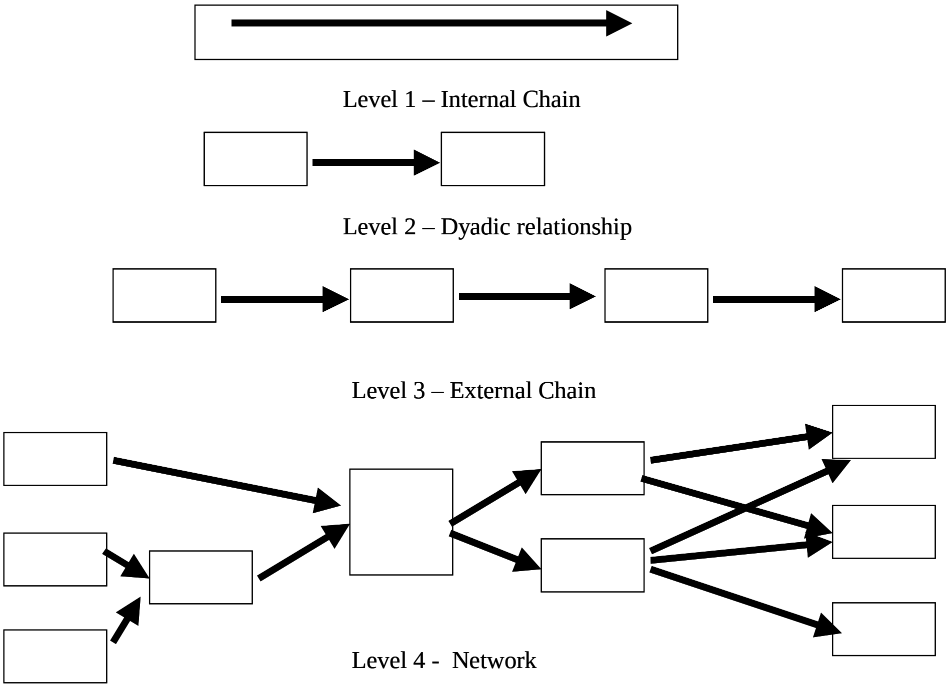

Figure 2.3 Four levels of research in Supply Chain Management

The levels describe Supply Chain integration and Supply Chain Management as the management of supply relations. This means that Supply Chain Management is not restricted to the management of the material flows. The management of information flows becomes more important as the complexity of the structure increases. The Grocery supply chains usually are not the most complex ones because most products are manufactured at single site.

However, the perishable nature of large part of the product range gives additional challenges to the information management.

2.1.3 The development of supply chain theories

This section will explain the most important concepts in supply chain management on general level. The section 2.1.6 will return to these themes with the focus on grocery retailing supply chain.

JIT and ICT

The most important enabler of supply chain development has been the development of Information and Communication Technology (ICT). Another way to describe this is to say that the most important contributor to supply chain thinking has been increased systems thinking (Metz, 1998).

Just-In-Time (JIT) management philosophy introduced the concept of fast response to end customer demand. Today it is the main driver for the development of supply chain management, with the help of information systems.

JIT was originally a manufacturing technique first implemented by Toyota and it has often been seen as a major reason for Japan's industrial success, especially in the 1970's and 1980's (Shoenberger, 1982; Lieberman et al, 1990). The definitions of JIT are very close to definitions of logistics and supply chain management: "JIT is a management philosophy which involves providing the right items of the right quality and quantity at the right place at the right time"(Muckhopadhyay, 1995). , It should be noted that JIT philosophy involves almost all the business processes and functions in a supply chain (Das et Hanfield, 1997).

JIT philosophy spread rapidly around the world and the car industry embraced the principles of JIT. The most potential benefits of JIT are (Wafa et Yasin, 1998):

Elimination of production and material waste
Improved communication both internally as well as externally
Lower purchasing costs
Reduced lead time
Decreased throughput time
Increased productivity
Improved production quality
Enhanced customer responsiveness

The essential idea of JIT philosophy is to keep minimal inventories. This lead to a need to improve communication, both internally as well as externally, in order to keep production running with decreased safety margins in the supply chain. To improve the internal communication companies implemented integrated information systems, enabling real time transaction processing systems. With the improvement of external communication a new concept, Electronic Data Interchange (EDI), was introduced. It was not surprising that the first large scale attempt to standardise the data communication between companies in the same supply chain was initiated by the car industry. The ODETTE project, discussed earlier in section 1.3, created standards for electronic messages between the car manufacturers and their suppliers (MacLeod, 1999).

In addition to potential benefits and savings Lambert and Stock (1993) have pointed out that there are potential problems when implementing JIT:
Larger number of smaller orders can lead to higher ordering costs
Delivery times can be less predictable and less flexible
Transportation costs can increase due to smaller average delivery size
Order handling and consolidation requirements increase

The car manufacturers began to experience some of these problems in the 1980's and started to solve them with the help of ICT. Even if JIT is very seldom mentioned in connection with grocery supply chains, the recent development of grocery logistics is not very far from the JIT philosophy. In fact, the Quick response strategy originally developed in the textile and clothing industry can be seen as an application of the JIT principle in retailing (Fernie, 1994).

Lean and agile logistics

As shown earlier, JIT philosophy is closely related to supply chain management concepts and it should be understood as a much wider concept than a pure manufacturing related technique (Vokurka et Davis, 1996; Womack et Jones, 1996). "A machine that changed the World" (Womack et al, 1990) was an introduction to "lean logistics". A group of MIT researchers conceptualised the model from the Japanese car industry. Lean logistics was followed by the concepts of "lean supply" and "lean production" (Katayama et Bennet, 1996; Karlsson et Åhlström, 1996). Lean supply describes the improvement in the supply chain and lean production covers the activities from product development to manufacturing, and from procurement to distribution. JIT survived as an essential part of lean production, which included following principles (Karlsson et Åhlström, 1996):

Elimination of waste
Continuous improvement
Zero defects
JIT
From push to pull
Decentralised responsibilities
Vertical information systems

The implementation of lean production requires major changes and development throughout the company. In the manufacturing process the changes start from product design and cover all activities up to the actual manufacturing. In logistics the changes are required both in inbound as well as on the outbound side (Sohal, 1996).

The next concept was based on the idea that trying to be as lean as possible was perhaps not the optimum. Katayama and Bennett (1996) had made an analysis of lean production in Japanese companies. They observed a major weakness in lean production: its inability to adjust to variations and, in particular, decrease of end product demand. The decrease in demand was a very common problem for Japanese industry in 1990's due to general recession in the economy. Thus, this weakness in lean production was noticed more often than before.

The "Agile" instead of "Lean" concept was introduced by Youssef, 1992 and it has been further developed for example by Christopher, 1998. In the "Agile" supply chain, production and logistics have been considered to be just the fine-tuning of "Lean" by some. Others consider it to be a completely new concept. This discussion is still alive in academic circles, especially in the United Kingdom. The lean paradigm emphasises cost and the agile paradigm emphasises availability. Christoffer and Towill suggest a combination of both paradigms in order to bring together best of both in the same supply chain: A lean (efficient) supply upstream combined with an agile (effective) supply downstream (Christoffer & Towill, 2000). Naylor et al suggest that agile manufacturing is best suited to satisfying a fluctuating demand and lean manufacturing requires a level schedule. They are also in the opinion that these paradigms should not be viewed in isolation. The use of either paradigm should be combined with a total supply chain strategy particularly considering market knowledge and positioning of the decoupling point (Naylor & al, 1999).

Demand Chain Management

Another approach to the supply chain is to look at the flow of material and information from the other side, the demand side. The fundamental idea behind this demand chain thinking is that demand information can be about more than just the demand volume. The nature of demand can include things like geographical location, seasonality, optimal delivery size and order size (Miles, 1994). The demand chain management concept emphasises that the primary control of the material flow should be customer demand. In other words instead of pushing the material to the supply chain based on demand estimates made at the supplier end, we should move to demand chain management based on the pull at the end customer side (Bruce, 1997; Hessney, 1998). Demand chain management thinking leads to a customer-centric design of the supply chain. In grocery supply chains there has been a strong tendency to start implementing demand chain management. However, the end customer has this far been seen as the store. In Electronic Grocery Shopping environment the demand chain management has to be based directly on the consumer demand.

Fisher (1997) claims that the nature of the demand correlates with the nature of the product and supply chains should be different for different product groups. A differentiation between functional and innovative products is emphasised. According to Fisher functional products have a predictable demand and the supply chain management should concentrate on efficiency. The innovative products have an unpredictable demand, but often a higher sales margin. For innovative products the supply chain management focus should be on responsiveness. Heikkilä (2000) has taken this even further and claims that within the same product or product group the supply chain management should take into account the different nature of customers and their demand behaviour.

Operational considerations for supply chain management

Sharman (1984) first introduced an important operational aspect for supply chain management, the concept of Order Penetration Point (OPP). OPP is the point in the supply chain where products are allocated to a specific customer order. OPP is also called Customer Order Decoupling Point in some literature (e.g. Olhager, 1994) and the positioning of OPP in the supply chain is often discussed in conjunction with the term postponement (Davis, 1993; vanHoek et al, 1998). There are three different types of postponement strategies. Postponement can be applied to form, time, and place. Form postponement means that companies delay production, assembly, or even planning and design until after customer has placed an order. This increases the ability to fine tune products to specific customer wishes. Time and place or logistics postponement means that the forward movement of goods is delayed to last possible place or moment in the chain of operations, and goods are kept in storage in the distribution chain

The positioning of the OPP has a crucial impact on the supply chain responsiveness and needed inventory levels. If the OPP is positioned near the end customer, the delivery time is shorter, but uncertainty and the risks for the manufacturer are higher. If the OPP is positioned far up-stream, the inventory risks are lower, but the service level to the customer is lower. The lowest risk to the supplier is to have the OPP in manufacturing, which eliminates the need for inventories. On the other hand, this might mean long delivery times and low service levels to the customers and the final decision is a trade-off between cost and service level compared to competition. The postponement is a way to increase the service level by tailoring the end product to the specific customer as late as possible in the supply chain. The inventories are held for standard products and the customer specific features are added very near the end customer. This decreases the number of different items in the inventory. At the same time it increases the service level compared to manufacture-to-order processes by decreasing the lead time. This can be seen as a combination of the best features of manufacture-to-order and ship-to-order. Figure 2.4 demonstrates the different positions in the OPP.

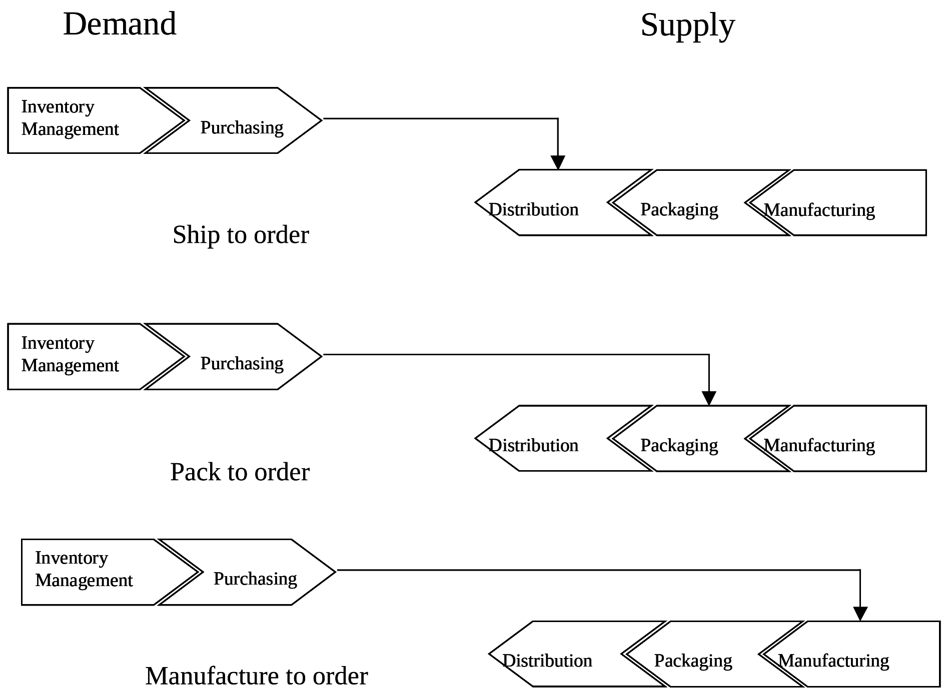

Figure 2.4 Examples of different positioning in the Order Penetration Point (Hoover et al, 2001)

OPP represents supplier oriented thinking. When the potentially different nature of demand is taken into account, we can additionally use the term Value Offering Point (VOP) (Hoover et al, 2001) to describe the nature of the offering that is made to fulfil the demand. Figure 2.5 gives examples of different service offerings and the positioning of the VOP. The first example, “offer to purchase”, is the same as the “ship to order” in the OPP positioning examples. In “offer to inventory management” the value has been added with inventory management, which eliminates the ordering function from the customer side. In the third example the assortment planning is moved to the supplier side. This means that the customer expects to have all the required items available, and additionally the assortment is updated continuously by the supplier to always cover the most suitable range of products. An example of the offer to planning model is an office product supplier who maintains an inventory at customer premises. The employees at the office can then take whatever paper and pencils they need without anybody needing to worry about when and what to order from the supplier.

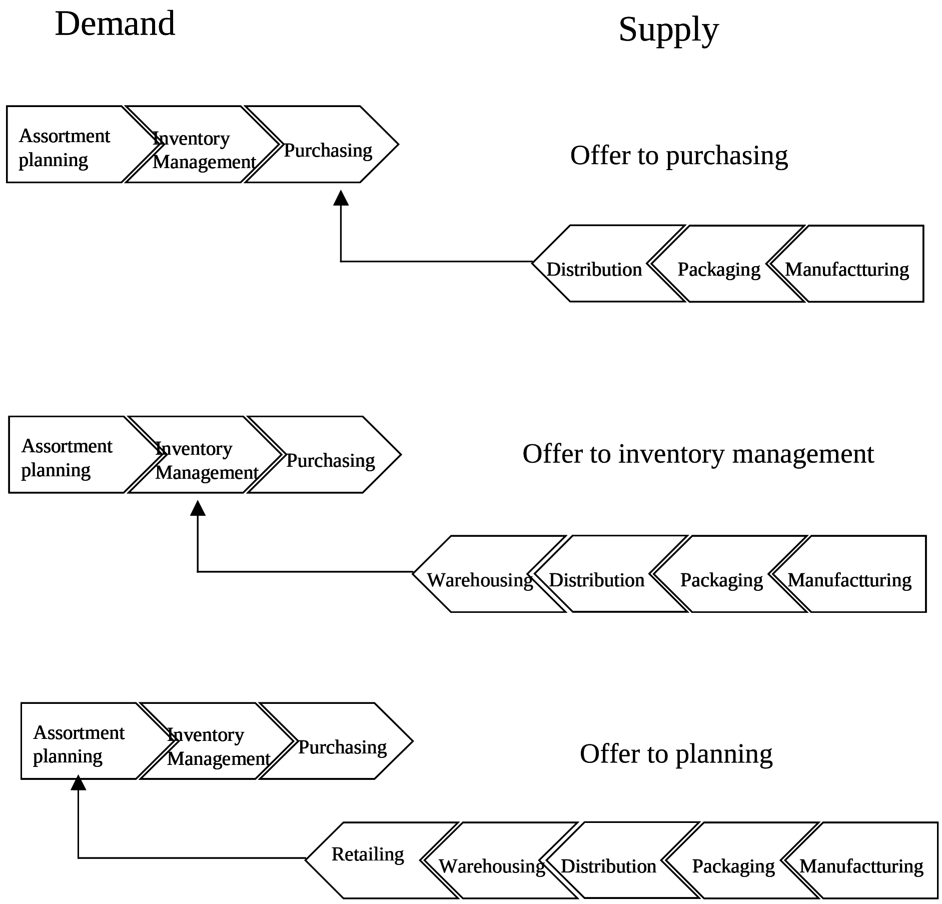

Figure 2.5 Examples of different positioning in the Value Offering Point (Holmström et al, 2000)

The VOP positioning becomes more and more important when companies are outsourcing their activities and concentrating on activities where they have a competitive edge. When transferring information between companies becomes easier and more automated, different pieces of the value offering can be performed by different companies. A third party logistics provider can, for example, be more efficient in inventory management than both the retailer and the supplier. Then the issue in supply and demand chain management shifts from performing functions to controlling value creation. Both OPP and VOP are important when designing the Electronic Grocery Shopping supply chain. There is more value that can be offered in the new environment than in the traditional supply chains where the consumer is taking care of the picking and the “last mile”. These will also give more options for the positioning of the OPP.

Towill (1997) has emphasised that companies no longer need to do everything themselves. In order to win and survive companies must be part of supply chain(s) with world-class performance. Competition is less and less between single companies. Goals and objectives for performance can be stretched across the supply chain where a network of companies are all concentrating in value creation in their specialised field of expertise.

2.1.4 Competitive advantage and the Supply Chain

This section will discuss how a supply chain can gain competitive advantage. It will further look at the potential for e-grocery supply chain to be more efficient than the traditional grocery supply chain.

Value creation can be seen to consist of two different concepts which give competitive advantage to companies: these are productivity advantage and value advantage (Christopher, 1998). If a company or a network of companies can achieve both at the same time the operation is likely to have a superior competitive edge. Productivity advantage can be achieved by being able to achieve the same results by using fewer resources than others. Resources can be raw material, the labour force or capital. Value encompasses notions such as customised products or services, responsiveness and reliability. Value advantage is often more difficult to achieve because it requires innovation in addition to resources.

To be able to achieve a competitive advantage of any sort a company needs to proactively decide what kind of advantage it wants to achieve and in which areas of operation it seeks to achieve them (Porter, 1985). If a company wants a competitive advantage in supply chain management, it has to make it its core competence. This means that it has to understand the requirements of the organisation and asses the current competence of the organisation correctly. Then it has to make development plans to achieve the competence required, and most importantly implement the plans (Prahalad and Hamel, 1990).

The key success factors for companies in today's highly competitive environment can be summed up by the acronym QSFV (Schonberger, 1996). It stands for Quality, Speed, Flexibility and Value. Miller (1992) named the following key competitive capabilities for companies in global manufacturing: price, flexibility, quality, delivery and service. All success factors named in both cases seem to have a direct link to supply chain management. This implies that to for a company to be able succeed in business, it has to be at least proficient in supply chain management.

Scharlacken et al (1997) have identified three types of economies to be achieved with the supply chain approach on a global level: economies of scale, economies of scope and economies of speed. Economies of scale in the supply chain convert into money in two ways, greater bargaining power and lower unit costs, both being based on sheer volume. Economies of scope means the benefit of being able to share resources across products, markets and businesses. Economies of speed means the ability to react quickly to changing customer requirements, and improved performance that is based on better sharing of control information. To be able to realise the benefits the network has to communicate openly and have common goals.

To show how the supply chain can be made to work for a competitive advantage, we will look at the PC-producer Dell as an example. PC-producers have traditionally worked through multi-level sales channels including distributors, wholesalers and retailers with standard product inventories. Dell-direct was a revolutionary change to this business model (Maglitta, 1997). Instead of manufacturing PCs and pushing them into the supply chain Dell started a pure pull mode assemble-to-order operation.

End-customers were able to order and configure their PCs through Dell's web site. Dell assembled the PC and shipped it directly to the end-customer. By changing the whole supply chain Dell achieved many advantages simultaneously. Ordering the PC through a web site is in fact a form of self-service that gives a productivity advantage. However, if this had been the only change, it would not have worked unless prices had been lowered to such a level that the actual benefit of cheaper order handling would have been lost. The key to success was being able to achieve a value advantage at the same time by giving the customer better product information and more flexibility in end product configuration. The total change enabled lower inventories with reasonably short lead times. In particular, the value of the inventories can be kept much lower compared to the competition, because storing components is much cheaper than storing finished products. In addition, the lead times handsomely beat competitors' manufacture-to-order lead times. Dell's case shows that today's ITC infrastructure enables radical changes in the supply chain, which Michael Dell himself has termed: "Substitute inventory with information" (Magretta, 1998).

Electronic Grocery Shopping could have the same potential in supply chain excellence as Dell has achieved in the PC supply chain. This is because the e-grocery shopping basket can be seen as a customised product. However, the grocery supply chain is much more complicated, large part of the products are perishable and the customers have long shopping traditions. This means that gaining supply chain excellence will be much more difficult.

2.1.5 Demand Distortion in Supply Chains

This section will discuss demand distortion in supply chains as a general phenomenon. Section 2.2 will return to this issue with the focus on grocery supply chains.

One of the biggest problems in supply chains was discovered more than 40 years ago by Forrester (1961). Forrester made simulation experiments with supply chains and described how a small change in market demand can lead to a substantial change in demand for the manufacturer. In his reasonably simple model a 10 percent variation in demand caused a variation of over 50 percent for the manufacturer. Forrester suggested that the prime reasons for the demand amplification were long supply chains with time delays in information processing, long lead times and different control policies for orders and inventories. Forrester's experiments in industrial dynamics were based on the information feedback control theory and they revealed the problem, but the true nature and importance of the problem has perhaps still not been fully understood (Towill, 1997). In Forrester's simulations the improvement in the time delays in processing information had only a marginal effect on the amplification. The decrease in the number of tiers in the supply chain had a larger effect. However, the best improvement was achieved through modifications in the inventory policies.

The demand variation amplification phenomenon was called the Forrester-effect by Towill (1991). Lee et al (1997) have renamed the effect the Bullwhip-effect and have pointed out that distorted information in the supply chains creates the demand variation amplification. They claim that decisions made by people in the supply chain are logical taken into account the information available to them. The problem is that the available information is distorted.

Another effect also based on distorted information was discovered by Burbidge (1989). This effect, later named the Burbidge-effect by Towill, is caused by different control cycles in the supply chain. Different ordering and inventory control policies can lead to irregularities in order cycles through order batching. Furthermore, production in long series can also increase the amplification (Shonberger, 1996).

Lee et al (1997) have summarised the common reasons for demand amplification in supply chains and made the following four distinctions: demand forecast updating, order batching, price fluctuation and shortage gaming. Demand forecast updating is related to the original Forrester-effect. It is caused by the overreaction of the next tier in the supply chain to changes in the demand estimates by the preceding tier. The second is related to the Burbidge-effect. When there are several cyclic customers ordering in batches in addition to different inventory control policies, the demand is amplified towards the up-stream of the supply chain. The third reason is price fluctuation inflicted by the up-stream tiers of the supply chain. When the products are offered at a cheaper price than normal, the down-stream tiers tend to fill their inventories. In other words they are deliberately ordering more than what their own view of the end demand would suggest. The fourth reason is inflicted by the down-stream tiers and caused by gaming with orders.

When the supply is limited and lead times increase, the down-stream tiers try to increase their inventory to cover the increase in lead times. This is done by ordering more, including ordering from new suppliers. The suppliers have a tendency to divide the scarcity between the customers, trying to keep everybody reasonably happy. When the demand in a down-stream tier is fulfilled and the target inventories reached, the rest of the orders are then cancelled. However, this kind of interaction gives an unrealistic picture of the demand to the upstream tiers. The grocery supply chains have suffered from the demand distortion and most of recent development programs are targeted to decrease this phenomenon by improved sharing of information across the supply chain.

2.1.6 Retailing Logistics Development

In retailing logistics the demand management problems are the same as in supply chains in general. An additional challenge to supply chain management is perishable products, which might in the extreme case require a maximum time of just days to reach the supermarket checkout point after leaving the first tier supplier. There are two major tendencies in grocery retailing logistics: 1. Reduce the number of tiers in the supply chain (Cooper, 1990) and 2. Improve the demand forecasting with collaboration between the tiers (Buzzell, 1995; Stalk et al, 1992; Holmström et al, 2000).

Examples of a typical retailing supply chain structures are illustrated in figure 2.6. Based on a study in the United States, it took on average 104 days for a grocery dry product to reach the supermarket checkout point after leaving the first tier supplier. Even if there are usually several separate physical operations done to the product in the supply chain, most of the time the product is waiting for the next operation (Kurt Salomon Associates, 1993).

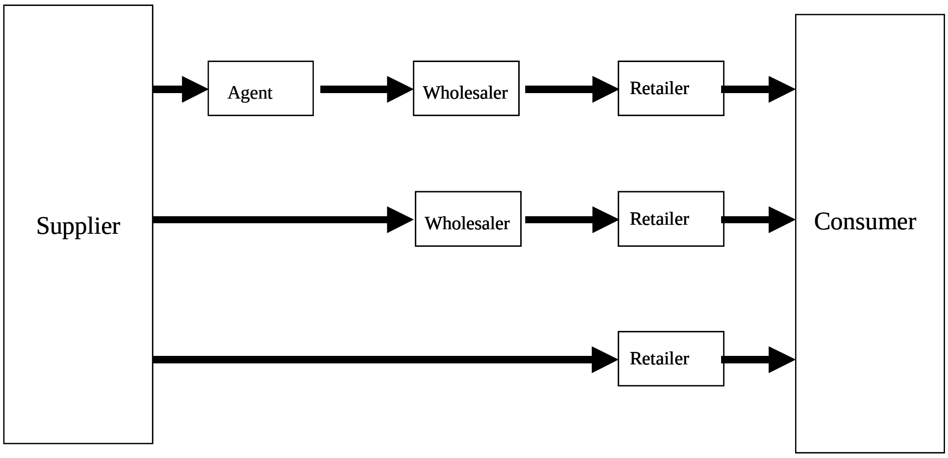

Figure 2.6 Examples of retailing supply chains (Bowersox et Closs, 1996)

Reducing the number of tiers in the supply chain decreases the number of physical operations done to the product, thus the elapsed time for the product to pass through the entire supply chain is decreased. Typical information processing in a retailing supply chain is illustrated in Figure 2.7. When the number of tiers is reduced, the possibilities for information distortion are reduced (Forrester, 1961; Lee et al, 1997).

Even if Forrester in his early experiments did not find the reduction of tiers to be absolutely the best way to decrease the demand amplification phenomenon, the positive effects of it have been emphasised by many later researchers (e.g. Lee et al, 1997; Levy, 1997).

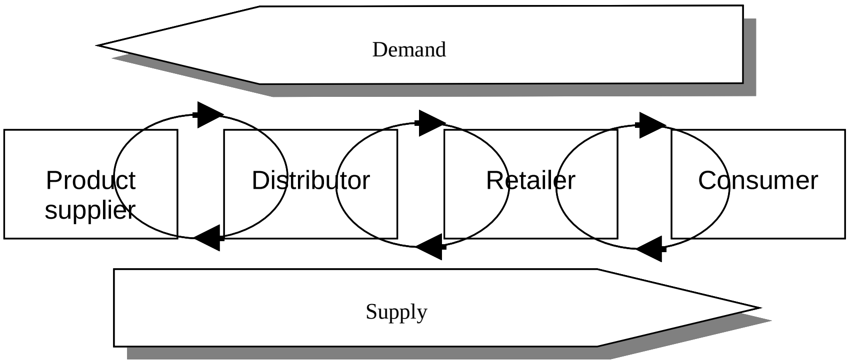

Figure 2.7 Information processing in a retailing supply chain (adapted from Kurt Salomon Associates, 1993).

Improvement in collaboration between the tiers in the supply chain is the other way to overcome the demand forecasting problem in the supply chain environment. Partnership in supply chain management has been introduced in recent literature (e.g. Ellram et Krause, 1994; Mitchell et al, 1992) and it requires an ongoing relationship between companies over an extended time period, where information, risks and rewards are mutually shared (Ellram et Krause, 1994). The development in information and telecommunications technology has helped this development in the form of new EDI-technology, which encourages companies into long term relationships (LaLonde et Cooper, 1989).

The development of physical retailing distribution systems has been fast in the last three decades. In the UK, for example, there have been four clearly different structural stages during this period: supplier control, centralisation, Just-in-Time and the relationship stage (Fernie et al, 2000). The development in Finland has been similar, but due to the size of the market the different stages have not been so clearly visible.

Supplier Control

The suppliers first had control over most of the logistics up to store level. In order to improve the service the supply chain operations were supported by a network of field warehouses. Sales representatives working for the supplier traded directly with the stores. Ordering and deliveries were made with large intervals, these being weekly or sometimes even longer periods. The stores kept a reasonably large stock in the backroom whilst smaller independent stores experienced difficulties reaching the minimum order size required by the larger suppliers. This created a new Cash and Carry wholesale format that serviced the small retailers (McKinnon, 1989).

Centralisation

The larger retailers started to demand better terms for larger orders, firstly in connection with orders to single stores. They quickly learned the benefits of consolidating purchasing volume and soon the battle over the control of the supply chain started. In the UK the leading retailers started building distribution centres in the late 1960s and early 1970s. Retailer-controlled distribution centres controlled some 65 percent of the grocery distribution business by 1990 (McKinnon, 1990). Regional Distribution Centres became the most important stock in the grocery supply chain and efficiency was improved considerably. The major benefits of centralisation were:

- The total amount of stock could be reduced
- Lead times were reduced from weeks to days
- Administrative work was reduced

There were four different reasons why the inventory levels could be reduced in centralised distribution: The square root law for safety stock allows a reduced inventory level for the same availability, the possibility of applying postponement, shorter lead times allow lower safety stock levels, better monitoring and management improve order size accuracy and reduce lost goods due to damage and pilferage. The disadvantages of centralisation were increased vulnerability to disturbances like industrial action or fire. Furthermore, centralisation required heavy capital investment and the transition was not always easy for the organisations concerned (McKinnon, 1990).

JIT and Quick Response

Centralisation moved to the next stage with the help of information technology. The most important element was firstly implementing EDI (Electronic Data Interchange) in the transmission of orders to the suppliers and secondly starting to use EPOS (Electronic Point of Sale) information in reporting store sales. The retailers were able to start applying Just-in-Time principles in their logistics operations and the improved flow of information enabled features such as composite distribution. Composite distribution is a system where goods can be transported and handled in several different temperatures throughout the whole transportation chain. The application of the JIT principles in retailing was called Quick response strategy (Fernie, 1994).

The improved flow of information was not good news for suppliers. There was pressure for even shorter lead times and smaller order sizes from the retailers. This lead to increased costs in the form of reduced vehicle load factors and a more complicated production process (Fernie et al, 2000). The relationship or partnership that currently exists is a result of this process. There was no opportunity to take any more cost out of the supply chain without improved collaboration between the suppliers and retailers.

Partnership

Partnership thinking has developed into new and different philosophies in retailing logistics. The Efficient Customer Response – concept (ECR) started in the United States has been widely adopted in the European grocery retailing business. ECR is a grocery retailing strategy with the purpose of creating more value to the grocery consumers, with close co-operation between suppliers and distributors. The ECR –concept's goal is to better understand consumer needs and to fulfil them more efficiently, and it is based on four main ideas (Rose, 1994):

-Efficient assortment
-Efficient replenishment
-Efficient promotions
-Efficient new product introductions

The basis of all of the above is category management, which is linked to product range, pricing, promotions and space management. Tesco, the UK based grocery chain, has successfully implemented the principles of ECR before the actual concept was launched. Tesco has built long-term partnerships with suppliers based on the adoption of new technology. Ordering is almost fully based on scanning in stores and 95 percent of orders are automated. The suppliers get all their orders as EDI messages and there is no telephone ordering. The most important achievement has been the reduction of inventory levels by one third (Hansson, 1996). In general the cost savings through adoption of ECR strategy have been estimated to be 2.3 to 2.4 percent of the total sales (Rose, 1994).

The Coca-Cola Retailing Research Group (1994) launched a similar strategy with the acronym SRC. It stands for Supplier-Retailer Collaboration. SRC is not as wide a concept as ECR, but the estimated savings are 1.5 – 2.5 percent of the sales with a complete and successful implementation. SRC is based on sharing information in the supply chain and also on defining policies and processes for decision making in order to achieve mutual benefits. The essential issues in SRC are operating standards, replenishment and administration. The operating standards are used to optimise the supply chain. The replenishment is made more efficient with accurate up-to-date sales information, as well as both short and long term demand estimates. The efficiency improvements in administration are achieved by elimination of duplication of work in organisations, with the help of improved information flow.

Cross-Docking and VMI

On the physical distribution side one of the most important innovations has been cross-docking. The success of Wal-Mart, a United States based retailer, is often said to be the cost structure benefit created by the efficient implementation of cross-docking in distribution (Stalk et al, 1992). In cross-docking the products delivered to a warehouse are sorted and reloaded and transported to the stores without ever staying in the inventory (Daugherty, 1994). In addition to an efficient distribution strategy, Wal-Mart implemented a new approach to inventory control together with Procter & Gamble. It gave the control of inventories to the supplier.

This new approach is called Vendor Managed Inventory (VMI). In a working VMI-arrangement the supplier is able to see the real demand with the help of Point Of Sale (POS) data, which is often called EPOS if transmitted electronically. Based on the actual sales information and inventory levels in the stores the vendor makes the replenishment decisions concerning the quantities, shipping and timing. This eliminates the ordering and purchase decision process and most importantly, the interpreting process from purchase order to demand estimates, thus reducing the distortion of demand information in the supply chain (Lee et al, 1997).

The benefits of VMI are a better utilisation of resources in production and transportation, and a reduction of inventory levels. The suppliers buffer stocks can be smaller due to the smoother demand signal. Additionally, the supplier has more freedom to co-ordinate the replenishment process proactively, instead of responding reactively to purchase orders. This will also help in reducing transportation costs (Waller et al, 1999).

CPFR

The examples discussed in this section show that there are, and have been, numerous approaches, strategies and concepts for improving the supply chain overall performance. They are based on long-term partnerships between the tiers of the supply chain. Most of the new concepts are based on modern information technology, such as electronic data interchange, automatic product identification and decision support systems. The systems do not need to be sophisticated to work, especially if the amount of SKU's is low (Waller et al, 1999). The main point is that all these different approaches aim to decrease the information distortion in the supply chain by improving co-operation and information sharing. The concepts discussed here are still in use and will still be further developed, but the industry has started to use a new term for this activity: CPFR (CPFR.org, 2002). This approach is explained in the following way on the organisation's web site:

"The Collaborative Planning, Forecasting and Replenishment Committee is a VICS (Voluntary Interindustry Commerce Standards Association) committee, made up of retailers, manufacturers, and solution providers. This group has developed a set of business processes that entities in a supply chain can use for collaboration on a number of buyer/seller functions, towards overall efficiency in the supply chain.

The mission of this committee is to create collaborative relationships between buyers and sellers through co-managed processes and shared information. By integrating demand and supply side processes CPFR will improve efficiencies, increase sales, reduce fixed assets and working capital, and reduce inventory for the entire supply chain while satisfying consumer needs."

2.2 Supply Chain Issues related to e-grocery

The previous section 2.1 discussed supply chain theories and literature starting with the basic concepts and ending up with retail logistics. This section will concentrate on issues that are closely related to e-grocery.

When we look at the supply chain from the producer to the household as an integrated process, it seems impossible to have an identical supply chain structure for all products and customer needs. The findings of Heikkilä (2000) suggest that there can be several supply chain structures, depending on the characteristics of the product or product group and the characteristics of the customer.

From the product perspective it is essential that the cost-to-serve is known for each product group for the whole supply chain for all feasible service level options, in order to make informed decisions on service offering and pricing. An organisation needs to take a process view rather than a functional view of supply chain planning. Thus, it should work across functional boundaries to integrate the business processes needed to create the supply chain. In this way an organisation can, in some cases, compress its lead times and raise quality and accuracy at all stages and, at the same time, improve service and lower costs (Braithwaite & Samakh, 1998). Tollington and Wachter have pointed out, that Activity Based Costing and Troughput Accounting are useful tools in Internet retail shopping environment to asses the cost-to-serve by product (Tollington & Wachter, 2001).

Basic warehouse management theories (e.g. Bowersox et al, 1986) suggest that the products in the warehouse should be classified according to volume or other criteria and each group should be managed and controlled accordingly. Fisher (1997) extends this classification from the warehouse to cover the whole supply chain. According to Fisher, products with a predictable demand should have an efficient supply chain focused on minimising physical cost. These "functional" stable demand products typically have a large volume and a low profit margin. In the grocery environment, good examples of this product category are milk and beverages.

The supply chain for products classified as "innovative" should be responsive. These high-margin, low-volume products typically display high product variety within each category and unpredictable demand. The margin of error in demand forecast, according to Fisher, is often up to 100 percent. Good examples of this kind of product in the grocery world are West Indian Chilli Sauce or insect repellent. Merely concentrating on the physical efficiency of the supply chain for these products will not increase overall profitability. This is due to the negative impact of other factors, such as lost sales, that can have a greater impact on overall profitability. The primary purpose of supply chain design for functional products is to meet predictable demand efficiently and at the lowest possible cost. For innovative products the design purpose is to respond quickly to unpredictable demand in order to minimise stock-outs, forced markdowns, and obsolete inventory.

There is another important issue to consider when designing the supply chain for an EGS, the positioning of the customer order decoupling point (CODP) or order penetration point (OPP). Both define the stage in the supply process where the product is linked to a specific customer order (Hoekstra et al, 1991; Van Hoek et al, 1998). The positive and negative effects of backwards and forward shifting generally are in Table 2.8 (Olhager, 1994).

	Backward	Forward
Positive effects	• Reduce reliance on forecasts • Reduce or eliminate inventories • Reduce the risk of obsolescence of inventories	• Reduce customer lead time • Process optimisation
Negative effects	• Longer delivery lead times • Reduced delivery reliability • Reduced process efficiency due to reduced possibilities for optimisation	• Rely more on forecasts • Higher risk of obsolescence • Reduce the product range • Increase products-in-process

Table 2.8 Reasons for and negative effects of a CODP shift

In the traditional grocery shop the CODP is normally in the store, when the customer walks into the store and personally picks up all the products he wishes to purchase. In the case of EGS it can be the moment when a picker selects and places a product into a picking tote. However, in the EGS environment the CODP can be shifted backwards and in some cases forward in the supply chain, providing a greater degree of freedom in supply chain design.

These general supply chain issues of cost-to-serve, product classification, and CODP form a further framework to help in constructing the elements of an electronic grocery shopping supply chain.

According to Fisher, demand chain structure depends on industry characteristics, implying that one structure is sufficient for any one industry. Heikkilä (2000) suggests, in a study concerning the cellular network industry, that this approach is too simple. Even within one single industry, several different chains might be needed to meet various customer needs and situations. Is this applicable to the supply chain structure of groceries delivered to households on the basis of household demand?

When considering the supply chain approach to the grocery business, it can be seen as an assembly industry producing shopping baskets. This leads to the need to look at general supply chain principles when trying to make the electronic channel work efficiently. Stalk (1988) emphasises the importance of reducing time delays in the flow of information and materials throughout the chain. Levy (1997) suggests that lead times are longer and inventory levels higher in longer supply chains than in shorter ones. Long supply chains lead to problems in forecasting accuracy. Furthermore, understanding customer needs is essential for designing the architecture of the chain.

The situation in the current multi-level grocery supply chain was illustrated earlier, in Figure 1.4. Genuine demand information is not transmitted to the upstream. The demand information is processed many times in the trading that takes place between different levels of the supply chain. When it reaches the supplier it does not describe the genuine demands of the consumers. It is originally based on the demands of stores, which are just an estimate of consumer demand, and are then affected by the phenomena created by distorted information flows.

If an electronic grocery shopping service is designed like an industrial supply chain, the principles and research work applied there should be utilised when trying to create the new service. Order processing, for example, is very often overemphasised. It is an important part of the process but it is not as important a part of the entire supply chain structure. Even if orders were placed, for example, by telephone and the transforming of the order to bits and bytes took place elsewhere in the ordering process, this would not have a significant impact on the total cost structure.

The common tendency has been to think that EGS is a supermarket copied into an electronic form. The digital copy of a supermarket can offer only the opportunity to buy products. When the value offering point, i.e. the point where the consumer receives the groceries (Holmström et al, 1999a), is shifted forward in the supply chain to the household, the starting point of operational design is the household's needs. This creates the possibility of offering completely new types of services, instead of just grocery delivery. An example of new value-adding services is the VMI (Vendor Managed Inventory) of groceries in the household (Småros & Holmström, 2000). A continuous flow of products, controlled by the e-grocer, would eliminate ordering. Therefore it is important to understand that EGS is not only a traditional shop in electronic form. It is a completely new supply chain structure that makes possible new approaches for building a demand-and-supply-based chain of grocery products from suppliers to the household.

2.3 Electronic commerce

The previous sections have discussed the theories and literature starting from general level and focusing on issues related to e-grocery in 2.2. This section will review the literature on electronic commerce and electronic grocery shopping.

Ravi Kalakota is one of the early authors in the field and has published several books concerning electronic commerce in general. Kalakota (1996) is a wide-ranging publication concerning mostly the technical background of trading over the Internet. According to Kalakota (1997), almost all retailers are re-evaluating every aspect of their operations, from customer service to advertising, merchandising to store design, and logistics to order fulfilment. On the other hand, the suppliers are reacting to pressure from retailers by trying to become more efficient producers of goods. They are assessing technology-based solutions to the problem of how to cut down the costs of labour, delivery, and production.

According to Macht (1996), consumer surveys in the United States have revealed that many people rate grocery shopping as only slightly less onerous than cleaning. An annual survey conducted in 1996 by the American Research Group revealed that home delivery was on the rise. The survey showed that in 1996 9% of the respondents were using home delivery services. This was a 30 percent increase on the previous year’s percentage of 6.9. Estimates at that time suggested that electronic grocery shopping might eventually capture 20 percent of the total US grocery market of more than USD 400 billion.

But ordering groceries for a week over the Web is much more complicated than ordering a pizza, a product that already has a long tradition of successful home delivery (Dagher, 1998). The pioneering companies are taking different approaches, not in order to differentiate themselves but because no one really knows which business model will work. According to Kate Delhagen, a senior analyst with Forrester Research in Cambridge, Massachusetts, who follows e-commerce: “Grocery shopping is a habit developed over a lifetime. People are unlikely to do a 180-degree turn overnight. This will probably be a slow-building business.”

The early academic journal articles have been very critical of electronic grocery shopping and the development of home delivery services. Laseter et al (2000) analyse the costs of home delivery in their “Last Mile to Nowhere”. The article criticises the companies offering free delivery and shows that there is not a massive economy of scale to be achieved, even in the largest cities of the US. However, the paper is limited to those service models which are currently available. This means attended delivery in a certain time window dictated by the customer. Unattended delivery and service models, where the service provider has more freedom in route planning, are not studied.

An even more critical view of home delivery, and especially of electronic grocery shopping, is presented by Ring and Tigert (2001). The article analyses the early pure play Internet grocers and shows the disadvantages they have. The two biggest disadvantages are named as price and the range of goods offered, based on the fact that research into store choice in food retailing shows that these constantly rank behind location as the second and third most important criteria. They predict that unless the pure play Internet grocers can close the price and range gap, the service will only attract 1-3 percent of households. There are some very valid points, such as the final conclusion: “The line between Internet retailers and “bricks and mortar” retailers is likely to disappear and what will be left are retailers that serve the customers however those customers want to be served, whether by store, by mail order, or by the Internet”. However, the article only analyses the operations and weaknesses of the pioneering companies. The problems of the early practitioners can possibly be solved. On the other hand, the paper considers the Internet merely as an ordering channel. The cost structure presented for an online grocer does not seem to be based on research; the order picking cost is quoted as USD 12 and home delivery cost USD 15-30, the technical costs as USD 1-2. On the basis of this USD 27-42 base cost per order, the article reasons that an Internet-based service will be too expensive to attract customers.

Rosen and Howard (2000) view the growth of e-commerce more positively. With a growing number of dual heads of household (two working members) and a resulting emphasis on expediency, electronic commerce seems to have the potential to help households utilise their scarce time resources better. However, even if they present an estimate with online food sales of USD 6.5 billion in 2002, they still have quite major reservations about online grocery retailing: “The online grocery sales model is intuitively questionable, nevertheless companies are making big bets online…online grocery sales look economically unattractive. Gross margins in the grocery trade are among the most slender of any retail sub-sector (around 24%)…..the delivery cost is large.” These statements are strong but are not supported by any research results.

The limited academic literature seems to be intuitively of the opinion that electronic grocery shopping is expensive, difficult, and unattractive to consumers, and that making a profit out of it is highly unlikely on a larger scale. But even if the pioneering companies have failed, is there really enough evidence to judge EGS as having failed altogether? Should EGS be analysed differently, as a supply chain from the product supplier to the household and not as an electronic copy of a supermarket? Fisher (1997) suggests that the most important factor when designing delivery chains is to understand the behaviour of demand. Have the early online grocers understood the behaviour and needs of a household and built the supply chain to serve it?

This chapter has presented the general theories of logistics and supply chain management, literature specially focused on retail logistics and finally, a review on still reasonably limited literature available on electronic commerce. The purpose of this literature review is to show how this research and its results are linked to the body of knowledge. Even if electronic commerce is a completely new way of conducting business, the basic theories of logistics and supply chain management will still be valid in the electronic environment.

3 The Early Models of Electronic Grocery Shopping

The purpose of this chapter is to describe different approaches to electronic grocery shopping from the supply chain point of view. The business models used and their features will be discussed and the businesses in Finland will be described in more detail so as to provide a background to the quantitative analyses in Chapter 5.

3.1 Channel model and intermediary model

From the customer's point of view, electronic grocery shopping can be the same even if the supply chain is different. The customer expects the groceries ordered electronically to be delivered to the household in the promised time frame. The way the logistical process is planned has no direct influence on the value of the service to the customer. The supply chain structure affects the cost structure of offering the service and in this way it has an indirect influence. There are two totally different business models that have been used to create an electronic grocery shopping service for consumers (Dagher, 1998; Heikkilä et al., 1998; Holmström et al., 1999; Kämäräinen, 2000).

The first alternative is to operate as an intermediary in the supply chain by picking groceries from a supermarket and delivering these to households. This has been illustrated in Figure 3.1. It can be seen as an additional service that has been built on top of a brick-and-mortar grocery retailing business. The intermediary business model will not change the logistics of the retailing business it is based on. This is how, for example, Peapod (www.peapod.com) in the USA started its operation and how Tesco (www.tesco.com) in the UK and Y-halli (www.yhalli.fi) in Finland today operate. It is the first and still the most common e-grocery business model in existence today.

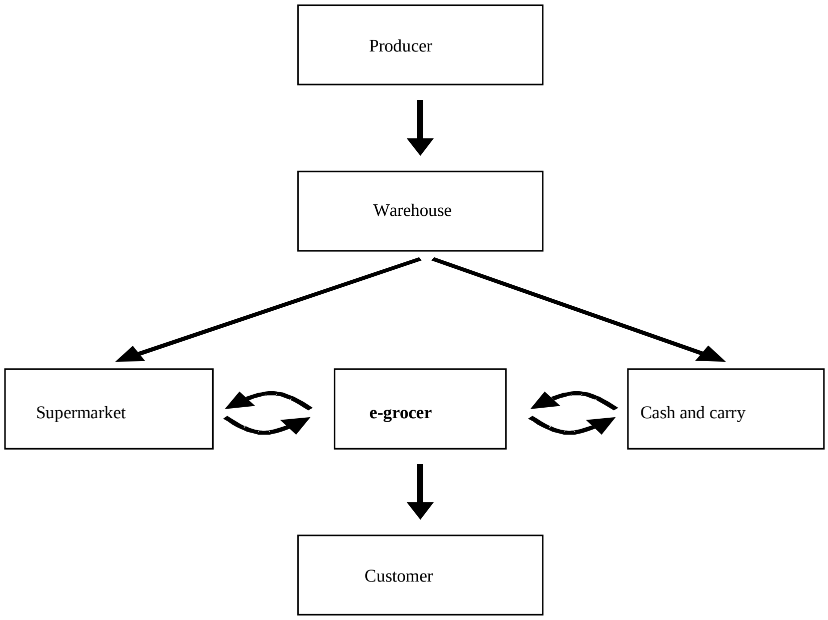

Figure 3.1 The e-grocer as an intermediary in the supply chain (Kämäräinen, 2000).

This model is based on the assumption that consumers do not need to change their behaviour. The customers do not need to plan ahead what they want to have delivered, but instead order when they notice a need for groceries. Therefore, they want their groceries immediately and demand quick home delivery. This requires a quick response from the e-grocer. The picking has to be done at short notice and home delivery needs to conform to tight time windows. This makes the service inefficient. This is not a problem if the customer is prepared to pay a price for the service that creates the possibility of profitable operation.

Occasional purchases and short response times cause capacity problems in picking and inefficiency in home delivery. It is very difficult to forecast customer demand and have the required picking capacity at hand only when needed. On the other hand, home delivery at short notice and with limited time windows leads to poor customer density and high costs (Punakivi & Saranen, 2001).

However, this concept is easy to implement when sales volumes are low and electronic grocery shopping is seen as a value-added service for the supermarkets. The early e-grocers have not been very cost-effective with this business model, but for example Tesco in the UK has been able to make this model profitable in reasonably short time. It is a fast way to increase sales volumes by moving quickly into new areas (Kämäräinen et al, 2001a). When sales volumes grow, more effective ways to operate can be considered.

When sales volumes are sufficiently large, the supply chain from the supplier to the consumer can be completely rebuilt. In this business model, the e-grocer purchases items straight from the producers or importers to a local distribution centre. In this outlet, also called a fulfilment centre, inventory- and order-based items are combined into customer shopping baskets that are delivered directly to consumers, as illustrated in Figure 3.2. This is how, for example, Streamline (www.streamline.com) and Webvan (www.webvan.com) in the USA and Matomera (www.matomera.se) in Sweden operated.

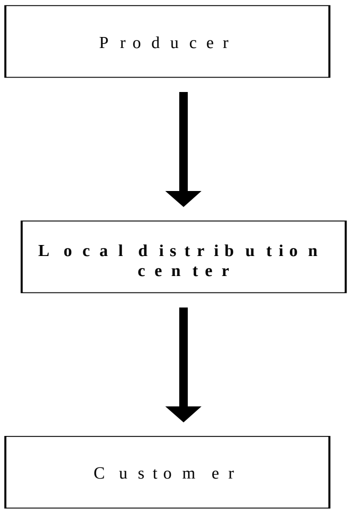

Figure 3.2 An e-grocer using a distribution centre in the supply chain (Kämäräinen, 2000).

In this model, picking and packing are more efficient than when operating from a conventional store, because picking speed increases when the operations are purpose-built to serve customer order-based picking (Kämäräinen et al, 2001a). However, investment costs are higher with this model. For example, Webvan's highly automated distribution centres cost between $25 million and $35 million apiece (Cuglielmo, 2000). Competitors in the USA who use less automation have costs of between $4 million and $6 million per distribution centre. However, it is possible to build a local distribution centre without automation for less cost than a supermarket with a similar sales volume, as Matomera did in Sweden.

Those e-grocers that are actively increasing their market share, such as Tesco in the UK and Safeway in the USA (Weir, 2001), use the intermediary model. This service concept has worked well as a value-added service for supermarkets. However, an increased amount of e-grocery customers will motivate retailers to look for more efficient solutions. When an increasing number of customers require better services and lower prices, picking from distribution centres rather than from supermarkets becomes more attractive. In addition, more flexible ways of receiving the goods at the consumer end are needed so as to lower delivery costs.

3.2 Current business models in Finland

Electronic grocery shopping in Finland has started with very moderate investments and it is totally under the control of the established grocery chains. All business models are based on the intermediary model, even if there is only one true intermediary operator. The other operations are based on individual supermarkets offering e-grocery as an additional service built on top of the traditional supply chain. The value offered to consumers can be described as “an offer to purchase home delivered”. The ordering process has been moved to the Internet by copying the supermarket into an electronic form.

There are four electronic grocery shopping services commercially available in the metropolitan area of Helsinki: Y-halli, Ruokavarasto, Eurospar, and Ruokanet. The first three are operated by the supermarket as additional services at additional cost. Groceries are ordered through a website, picked in the shop by its staff, and delivered to the home. Transportation is carried out by a third party parcel service or a van owned by the shop or a combination of these. The consumer pays a service charge for the picking and delivery of groceries. The prices of the groceries are exactly the same as in the shop and checking out happens in the same way as if the consumer visited the shop himself. The only difference is that the in-store shopping activities are carried out by shop staff. From the retailer's point of view, the creation of the service does not offer any savings in comparison to traditional do-it-yourself shopping. All aspects of the service create extra cost.

The fourth of the early e-grocers, Ruokanet, differs from the others. It is independently operated and not owned by a grocery chain. It operates in close co-operation with the K-Group and the picking is carried out in a pick-up wholesale warehouse targeted for business-to-business grocery sales. The merchandise is for the most part in wholesale packages and individual consumers are not allowed to shop there. Small restaurants and kiosks fetch their groceries from these outlets to avoid the delivery charges for small orders and larger businesses occasionally use it for urgent needs. Companies can shop there for coffee and biscuits for their internal use. Ruokanet can be seen as a dedicated e-grocer without a fully dedicated logistics solution. However, it eliminates half a step in the supply chain when not using the store for picking orders. The prices of groceries in the wholesale warehouse are often slightly cheaper than in a supermarket, but hardly as cheap as the purchase price from the supplier.

We made a limited price comparison for these four early e-grocers with ten items that are at the top of the list of the most frequently purchased groceries.

The price comparison is presented in Table 3.3 and the details, with references to the websites, can be found in Appendix 2.

	Ruokavarasto	Y-Halli	Eurospar	Ruokanet
Price of shopping basket	124.52	131.86	122.91	151.72
Index	100	105.89	98.71	115.06
Index with home delivery	108.03	113.93	110.75	127.87

Table 3.3 Limited shopping basket comparison of early e-grocers

Even if the amount of items used in the comparison is not sufficient to compare the first three accurately, this limited test proved to be useful. The price levels of the three supermarket-based e-grocers are very close to each other and when one quarter of the picking and home delivery charges is added the prices are almost identical. The limited shopping basket was assumed to be one quarter of a full shopping basket, and thus a quarter of the service charges was used to indicate the price level when home delivered. The prices of Ruokanet were clearly higher than those of the competition. This gives a strong indication that operations based on supermarkets do not require the same profitability from e-grocery sales as from in-store sales. In other words, they see electronic business as incremental sales and do not allocate same proportion of store costs to it. Tesco in the UK has reached profitability in the electronic business, even if they have allocated all store related costs evenly to all products (Business Week, 2001).

3.3 Cost considerations

An electronic grocery business can be started at a very low investment level as an additional service to customers organised by a traditional brick-and-mortar grocery shop. However, there are very few benefits and no economies of scale to be achieved by this operational model. There are additional costs to those of traditional shopkeeping but very little in the way of savings or additional revenue. It can be argued that theft and damaged goods in the shop can be reduced in this model, but it is not likely to have a substantial effect on the overall cost structure.

In an e-grocery operation based on picking in a traditional supermarket the movement of goods in the shop is as follows (Kämäräinen, 2000):

<>Reception of goods at the back of the shop. The quantity and quality are checked and goods are left to wait for shelf set-up.

<>Placing on to shelves, where the wholesale packaging is broken up into consumer packages and the goods are put on display on the shelf to attract consumers. This is done partly when the store is closed.

<>Picking is carried out either by the shop staff or by the intermediary operating the e-grocery. Normally the pickers are professionals familiar with the shop and the products and picking is faster than when carried out by the consumer or an average staff member. The picking speed is dependent on the time of the day. It is much slower when the shop is full of consumers.

<>Checkout is performed in two different ways. In the less advanced operations the goods are brought to the cash register and scanned one by one and then packed for delivery. In more advanced operations the goods are scanned as they are picked. This requires a portable barcode reader with a memory or a wireless connection to the computer system.

In practice it is not always this simple. The picking can be done early in the morning or late in the evening, when the shop is closed, so as to speed up the process. The shop might not have the full range of fresh products available at that time and the partially picked shopping baskets have to be stored. Additional picking is needed before delivery to the home in order to complete the orders. On the other hand, frozen products have to be kept at the correct temperature while stored to wait for delivery, which will separate them from the rest of the order. All this needs continuous checking and monitoring and all this will add to the cost.

The major cost items that can be allocated to electronic grocery shopping when picking is carried out in a traditional shop have been analysed by Kämäräinen (2000). They are as follows:

Type of cost	Amount as percentage of sales
Space	2.4%
Placing on shelves	3.8%
Picking	10.6%
Checkout	2.6%
Broken and stolen	1.7%
TOTAL	21.1%

There are no fixed rules as to how to allocate the cost to different types of sales. Part of the business can be seen as marginal and only the marginal costs borne by that part of the business are allocated to it. Using this kind of allocation, a small volume e-grocery can even be seen as profitable if the cost of the goods sold and of picking and home delivery are the only costs allocated to it, particularly when the e-grocery can charge the customer a service charge that covers at least the cost of transportation to the household. This way of thinking must assume that all Internet sales are additional to existing business and this is the reason why the sales margin of the existing business has to bear all the other costs.

The cheapest home delivery cost quoted in Finland for groceries is 22 FIM (€3.7) per order (Kyyrö, 2000). This is based on using the shop's own staff's idle time for deliveries, backed up by the occasional use of a third party service as a backup. This implies that only the marginal cost elements in home delivery are considered as costs in the calculation. Making the calculation this way, an order worth €50 will have a marginal cost of €5.3 if only the picking cost is taken into account. The carrying out of home delivery by a member of staff increases the cost by €3.7, making the total marginal cost for the order €9. The customer pays FIM 40 (€6.7) as a service charge, making the additional net cost for the order €2.3. This represents 4.6 percent of the value of the order, which can still be regarded as profitable business, especially if it is new business taken from the competition.

Tesco covers 90% of the households in the UK with its service, which is claimed to be profitable (CIES, 2000). The average order is 100 pounds and the delivery charge 5 pounds per order. If online sales are considered as a marginal addition to sales and no fixed costs are allocated to this part of the business, the contribution of the business can easily be positive. This does not necessarily mean that it is a profitable business in the long run, because it will eventually cannibalise part of the profitable pick-it-yourself supermarket sales. Furthermore, when the portion of the on-line business grows, the need to allocate more costs to it grows. Otherwise the traditional business becomes unprofitable in the calculations.

Established grocery chains normally start their e-grocery operation by opening a website for the placing of orders and using existing shops for picking the orders, as Tesco and Sainsbury's have done in the UK. This is a low-risk and low-investment approach that will offer consumers an added value alternative. However, in most cases delivery is attended, meaning that the consumer has to stay at home to receive the goods. This will lower the value of the service in many cases. The limited added value, together with the high cost of production, will slow down the growth of the e-grocery business from both the demand and supply sides. The grocer does not see the service as very profitable and the consumer does not really get the added value that it would potentially be possible to create using the new infrastructure.

Safeway, one of the largest supermarket chains in the USA, has made a slightly bigger investment to enter the e-grocery market. It made a substantial investment in a pure play e-grocer called Groceryworks (Weiss, 2001), which was running out of money and in danger of becoming insolvent. Groceryworks is a new dedicated channel for electronic business, with its own supply chain working in parallel with the traditional channel based on supermarkets. This gives the new channel the full benefit of existing purchasing power and supplier relations. The dedicated supply chain also helps streamline the new channel's cost structure on its own terms, disregarding the limitations and restrictions caused by the supermarkets open to the public. Ahold has used a similar approach and acquired Peapod (Prior, 2001) to act as a separate e-grocery channel in the US market.

The most expensive and the highest-risk approach is trying to beat the existing grocery chains in their home field with a new business model. There are no surviving large-scale independent operations. Webvan, Streamline, and Shoplink all had to close down their operations and most of the others ended up in alliances with existing grocery chains. Time will tell if it is possible to break through the existing competition by starting a new service from scratch. Even the one billion dollars invested in Webvan (Alsop, 2001) were not enough to build a business able to survive in its own right. The task is not easy because it means both winning market share and educating consumers in a new type of shopping at the same time.

3.4 Summary: The grocery retailers have a strategic problem

Consumers are starting to demand an easy and time-saving way to have their groceries available for everyday use. The demand for electronic grocery shopping is not going to be evenly distributed. Families with children and with both parents working are believed to be the prime targets for the new services. The direct costs to consumers for shopping are increasing as a result of the continuously increasing size of stores and some people will start calculating these costs.

The number of families in the Helsinki metropolitan area in Finland that discovered this new way of grocery shopping doubled last year (Helsingin Sanomat, 2001). Approximately five thousand families are now users of e-groceries. This is still a very moderate market but it can replace one large supermarket completely, with high customer loyalty. There are dozens of suburbs in the Helsinki metropolitan area without a single local grocer's shop and the number of shops is still decreasing rapidly (Salmela, 2002). If the development continues, the market for EGS can soon be substantial.

Trying to create a completely new supply chain from suppliers to households looks to be too much to achieve in one go. Creating superior purchasing power and all the phases of supply chain logistics and marketing the services to consumers (winning them from the competition) and, at the same time, teaching the consumers to change their habits, seems to be too much. The grocery market in Finland is much more concentrated than, for example, in the USA. This makes it far more difficult to penetrate the market as a new player. Making electronic grocery shopping an additional interface to an existing store seems to solve the consumer problem. The cost, however, does not make it a viable solution from the retailer's point of view other than as a starting phase. Are we in a complete deadlock situation or is there a way to create the services that an increasing number of consumers are demanding, at an acceptable cost to all parties involved?

This is an enormous area for research and it is essential that the research is carried out while the demand is still limited. This way the research can help the practitioners to assess better the opportunities and risks of the new services, before making large investments. In smaller markets, such as in Finland, there are hardly enough risk takers and risk capital simply to start creating the new services by means of a trial and error method. It will require a lot of money and effort to create the new services and, once ready, they will cannibalise part of the existing business. The dominant players in the grocery market cannot be blamed for being careful and having a cautious attitude towards developments.

If electronic grocery shopping is a service that will take a reasonable market share in the future and nobody develops the services, problems will arise when demand starts growing. The density of Internet users is growing, and the consumers are getting one year older every year, meaning that a large proportion of the buyers of groceries will be replaced in the next ten years. The new buyers have been raised with personal computers and the technology will not be a barrier when they are facing the time pressures of a young family with children. Is there going to be a revolution and will completely new players take this market? Are some of the old players facing the destiny of the dinosaurs? Are the new services feasible, how should they be built, what are the risks, and what are the low-risk approaches? Having answers to these questions, among others, will lower the risk of starting to build the new services as an evolutionary process. The research can find at least partial answers to these questions and piloting the new services with limited investments will possibly give even more reliable information.

4 Hypotheses

The previous chapters have shown that grocery retailing in Finland is very concentrated. Trade is carried out through fewer and larger outlets in order to be able to offer lower product prices. However, in this development consumers creating more and more of the total value of the supply chain when it is seen as a complete chain from suppliers to households. Consumers are creating value in two ways: picking the groceries in supermarkets and transporting them to the final destination. The IT infrastructure has developed rapidly and it could enable the re-engineering of the grocery supply chain up to the household.

Bringing into use a new ordering process using the Internet can solve the consumer's problem by reducing the need to visit the supermarket. But using the supermarket as the picking place for orders is not a cost-efficient solution for the retailer in the long run. Building the supply chain from scratch as a new player in the market seems to necessitate winning too many battles simultaneously. The demand for the new services is growing but in order to answer this demand the established grocery retailers would need at least partly to cannibalise their existing business. With both risk capital and the willingness to take risks limited, one way to break the deadlock is to acquire more information through research to act as a basis on which development decisions can be taken.

To be able to start solving this problem, one has to understand the cost structure of all elements in the new supply chain. This includes home delivery with different service models and reception methods. Goods handling and order assembly at the local distribution centre is an essential element in the new structure. The flow of goods from the suppliers to the distribution centre and the implications for supplier costs structure must be understood in order to ensure that the potential savings in downstream operations are not reflected as additional costs in upstream operations.

We formulated the following two research questions on the basis of the understanding we had developed of the supply chain management of grocery retailing, warehouse management, and physical distribution, and their financial parameters:

Research question 1: What is the operational costs structure of a local distribution centre for EGS?

Research question 2: What is the cost structure of home delivery in EGS?

Based on our pre-understanding electronic grocery shopping service as its most simple application consists of two elements that replace the store of the conventional grocery supply chain. The local distribution centre, where the shopping baskets are picked based on customer orders replaces the consumer picking process done in a conventional store. The home delivery in the new service has to be arranged by the service provider to replace the home delivery done by the consumer in the conventional retailing. The cost of the new elements in the new supply chain will replace the operational costs of the supermarket. Four working hypotheses have been formed based on these research questions.

Hypothesis 1: The operational costs of a local distribution centre with high business volumes are lower than the operational costs of a supermarket

Hypothesis 2: The home delivery costs can be substantially lowered by unattended reception

Hypothesis 3: The home delivery cost is a function of geographical customer density

Hypothesis 4: The operational costs of the first tier suppliers will not increase due to the change from supermarkets to local distribution centres with home delivery

Finally, the research results from the research questions and knowledge gained when testing the four working hypotheses are combined and used to test the main hypothesis of this dissertation:

Main Hypothesis: e-grocery with home delivery can be more efficient than supermarket retailing handling a similar volume of sales.

The research questions one and two can be divided to several more detailed questions. The details and the structure of all research questions are explained in appendix 5. The objective of the research is to test the hypothesis in order to gain new knowledge and direction for further research (Popper, 1968) on electronic grocery shopping. The purpose is not to try to prove the hypotheses right in a positivistic deduction and present the results as an “eternal” truth. The subject is understood to be far too complicated for this kind of methodological approach. The methodology section explains how the research project was conducted and what research methods were used for the different research questions.

4.1 Operational cost structure of a local distribution centre

In a traditional supermarket groceries are normally received in wholesale packages and put on shelves for consumers to pick. After picking, the goods are checked out at the cashier’s desk. In Europe the consumer usually does the packing himself, while in the USA there are staff who pack and help to take the groceries to customers’ cars.

Running a supermarket seems to be very simple and having the consumers taking care of the picking free of charge does not seem to leave very much room for improvements in efficiency. However, there are many hidden costs not visible to normal consumers, such as goods becoming perished, broken, or stolen. Also, in a supermarket, extra room and guidance is needed for non-professional pickers to be able to do the picking. The research question related to the operational cost structure of a distribution centre for an e-grocery is: what are the costs of receiving the groceries, keeping inventory as needed, and assembling the ordered shopping baskets ready for delivery, in comparison to running a supermarket with the same volume of business? The customer's time and travel costs are not included in the comparison.

Based on the pre-understanding of the area of this research question the first working hypothesis was formed as:

Hypothesis 1: The operational costs of a local distribution centre with high business volumes are lower than the operational costs of a supermarket

4.2 Efficient home delivery and its cost drivers

The consumer takes care of home delivery in the supermarket environment. In the case of e-grocery, home delivery is organised by the grocer, with a visible cost which is eventually paid for by the consumer in a profitable e-grocery business. The cost of distribution is dependent more on time than distance (e.g. Sartjärvi, 1992) and the time needed for a single delivery is dependent on customer density. Does the additional cost of home delivery make e-grocery too expensive for consumers?

To be able to understand the factors affecting the costs we formulated the following research question: is it possible to achieve an acceptable cost level for home delivery with a moderate market share, at least in urban and suburban areas? The cost of home delivery is heavily dependent on the service model used and the market share. The home delivery of groceries seems to be closely analogous to rubbish collection, where high collection density is essential for efficient operation. The market share needed for profitable operation for grocery home delivery is expected to be lower than with rubbish collection as a result of the higher value of the service to the customer.

Based on pre-understanding on the home delivery cost structure two additional working hypotheses were formed:

Hypothesis 2: The home delivery costs can be substantially lowered by unattended reception

Hypothesis 3: The home delivery cost is a function of geographical customer density

4.3 Main Hypothesis: e-grocery with home delivery can be more efficient than supermarket retailing handling a similar volume of sales

The four working hypotheses were formed in order to make it easier to present the results. The main hypothesis is far too wide to come up with simple evidence. The working hypotheses help focusing the research to the relevant areas of the e-grocery supply chain cost structure.

Today's grocery supply chain has developed a great deal in recent years and efficiency from the supplier to the store has improved constantly. One of the latest efficiency improvements has been the development of supplier-wholesaler-store co-operation by improving the amount and quality of information transfer between the organisations. This development is often called Efficient Customer Response (ECR) (Kurt Salmon, 1993; Bowersox et al, 1999) and it includes several ways to make the supply chain more responsive to fluctuation in consumer demand. Very good results have been achieved by handing responsibility for inventory levels to vendors. In many cases it has been possible to lower inventory levels and improve service level at the same time (Waller et al, 1999).

All this work that has been performed to make the supply chain more efficient has been done on the basis of the store being the “end customer”. There has been no attempt to improve the whole supply chain up to the household. On the contrary, driving distances to supermarkets have grown and the average size of supermarkets has also grown, leading to more time and mileage spent on grocery shopping by the consumer (LTT, 1995). Is the overall efficiency of this kind of supply chain real? Or has the increase in efficiency in the activities up to the point of the supermarket led to more inefficient “last mile” work, performed and paid for by the consumer?

Supply chain development can in some cases lead to zero sum play. The increased efficiency of some parts of the chain will add costs representing the same amount to other parts of the chain. A good example of this is a powerful buyer requiring its supplier to cut delivery time so as to be able to lower inventory levels. If nothing else is done to improve the overall process, this is likely to lead to the inventories just moving from the buyer to the supplier. The overall cost in the supply chain will not change (e.g. Whitley & Cox, 1989).

To be able to cover the whole supply chain, an additional question needs to be answered: if the downstream supermarkets are replaced with local distribution centres with home delivery, will the cost in the middle and the upstream of the supply chain change and, if so, how? To gain new knowledge on this area the fourth working hypothesis was formed:

Hypothesis 4: The operational costs of the first tier suppliers will not increase due to the change from supermarkets to local distribution centres with home delivery

There will be changes to the operation as a result of the fact that in e-grocery a local distribution centre is not a commercial entity in the supply chain. The role of a local distribution centre is to assemble the shopping baskets ordered by the consumers as efficiently as possible and nothing else. In the traditional supply chain the supermarket is the actual trading party for the consumer. In addition to logistical operations, the supermarket tries to merchandise products and make the consumer buy more than initially intended.

In the e-grocery supply chain, the products are sold to the consumer directly and inventories are only held if it is logistically sound. In the traditional supply chain the products are sold many times. Each level of the supply chain sells the products to the next level and finally they end up in a store. The store then sells the products to consumers, but there is no guarantee that the consumers are willing to buy exactly the products that are on offer.

This dissertation will not try to quantify exactly the changes in costs in the upstream. It will try to find evidence that there are sufficient positive effects to offset the potential negative effects of the change.

The consumer time spent on shopping can be valued in many ways. If the average salary of industrial workers is used (approximately €10 per hour) (Statistics Finland, 2001), the cost of the time used for shopping would be € 4.5 billion. That would be 45 percent of the value of the groceries bought. It seems obvious that any type of ordering, picking, and home delivery system can be cheaper than this. But what if the consumer costs are not taken into consideration at all? Is the supermarket-based supply chain cost structure superior to a supply chain that is optimised up to the final destination, the household? Our main hypothesis is that it is not.

Based on the pre-understanding we have proposed a minimum amount of changes to the grocery supply chain to make it an electronic grocery shopping service. The store level has to be replaced by a dedicated picking facility and a home delivery service has to be added. The ordering processes for products that already today are transported directly to the stores from the suppliers are likely to require changes even if the transportation routes and routines can be left as they are today. Most likely there are changes that in an electronic grocery shopping environment could reduce the logistical costs from suppliers to the stores for products that in the store based supply chain have inventories on regional or national level or both. This could be researched and taken into account in the cost structure, but it would require a reconstruction of the whole supply chain of groceries on national level to give valid results. On the other hand, the potential savings could be so small that they would not be clearly visible in the scale the major cost elements are compared. Thus, the testing of the hypothesis is decided to be limited to the minimum changes in the supply chain.

The change from store based supply chain to local distribution centre based supply chain has impact on suppliers that deliver directly to the stores today. When testing the hypothesis the changes in cost structure could be estimated and taken into account in the comparisons. However, based on the interviews of the logistics experts of these suppliers revealed that quantifying the changes in cost structure would require some real data from a working new structure. The form of the hypothesis does not require accurate figures on the changes in the cost structure of the supplier operations for testing it. If it can be shown with sufficient reliability, that the costs of these suppliers will not increase, the way the hypothesis is formulated allows this potential change to be discarded in the calculations.

5 Methodology

To examine the main hypothesis, the grocery supply chain must be approached from different angles and the primary research questions answered. The main hypothesis is that using today's infrastructure, groceries can be delivered to the household at the same cost or even more cheaply than what it costs to have them on display at a supermarket and for consumers to take care of the last mile themselves. To cover the whole supply chain, we need to analyse the structure replacing the work carried out in today's supermarket, the local distribution centre. The additional cost of delivering the goods to the household has to be modelled in order to find out the financial parameters of physical distribution. Furthermore, we have to look at the upstream operations in the supply chain to analyse how the modifications made to the downstream affect the costs of the suppliers and of distribution. By combining the analyses of all three areas and testing of the working hypotheses, the main hypothesis can be tested.

5.1 Research philosophy and methodological options

"Engineering sciences, agricultural and forestry sciences, medical sciences, and practical social sciences are often mentioned as examples of applied science. Falling between basic science and technology, they produce new knowledge which is intended to be useful for the specific purpose of increasing the effectiveness of some human activity. The produced knowledge functions as a tool. Hence, the value of the results of such applied sciences can be evaluated *both* in terms of epistemic and practical utilities" (Niiniluoto, 1992a). In other words, the results can be valued based on the amount of new knowledge and based on the practical usefulness of this new knowledge.

Logistics belongs to engineering sciences and the quote above describes the basic philosophical approach of the research work, which this dissertation is based on. The purpose of the research is to find new knowledge with practical relevance. In applied research this often means that besides the epistemic utilities relevant to basic science, simplicity or manageability are appropriate aims in the research work (Resher, 1990; Niiniluoto, 1992b). The products of applied research should be assessed for the amount of new information they produce and for the correctness and veracity of this new information. This means that approximations and simplifications can be made to make calculations easier or practically possible, sometimes even at the expense of the validity of the results (Niiniluoto, 1984).

Furthermore, in applied science the truth of a theory does not automatically guarantee pragmatic success, only potential success. Even if it could be shown that changing the supply chain of groceries reaching people's homes would save money, be better for the environment and have other positive implications, there is no guarantee that this will be done in practice. It is possible that a cognitive process in applied science will not be cashed out in practice (Niiniluoto, 1992a). In other words the research creates new knowledge of how to do something in a better way. However, this increased knowledge will not be used in practice and the value of the research is just the new knowledge.

There is an ongoing argument between the positivistic and hermeneutical approach in research. Hermeneutics was originally a methodology for explaining the bible, but it has been later adopted by other non-theological sciences. It means methodology to describe, explain or interpret something unclear and vague. The hermeneutics often emphasises the "pre-understanding" of the research subject, that is based on everyday life experience (Gadamer, 1960).

The majority of the logistics research focuses on quantitative methods (Flynn et al, 1990; Mentzner et Kahn, 1993). These include statistical testing of survey data, simulations and model building. Qualitative methods have not been widely accepted in logistics, operations and materials management research, especially in the United States (Mentzner et Kahn, 1993). However, the emphasis in research is shifting towards more empirically grounded and qualitative methods to improve the relevance of business research (Flynn et al, 1990). The empirical methods can be qualitative or quantitative, or a mixture of both.

How should a new business area with no real empirical data nor established operational traditions be researched? Ellram, 1996 has made a synthesis of Yin, 1994, Crabtree and Miller, 1992, Strauss and Corbin, 1990, Marshall and Rossman, 1989 as well as Miles and Huberman, 1994. The synthesis classifies the research methods according to key research objectives and questions. The Objectives are divided into four categories: Exploration, Explanation, Description and Prediction. Explanation and description could be research objectives for established businesses, but the applicability to electronic grocery shopping research does not seem good, at least in the years 1997 to 2000. The objective of the research in this dissertation is not to make predictions, but to test the potential pragmatic success of a new business opportunity. Thus, the objective in this classification is exploration.

New information can be created by making a hypothesis, that can be proved to be false and by testing it (Popper, 1968). The philosophical approach of the research of this dissertation is not to make exact calculations for commercial companies for the profitability of electronic grocery shopping. By making a general hypothesis on the profitability and testing it, the knowledge of the new business model is believed to increase. This knowledge will further guide the research activities and possibly identify new research areas. This approach is believed to produce more new knowledge with practical applications than an attempt to prove the hypothesis to be correct in a positivistic way.

In exploration the appropriate methodologies are divided in Figure 5.1 based on the nature of the research questions (Ellram. 1996):

Question	Examples of appropriate Methodologies
how, why	Qualitative · Experiment · Case study · Participant observation
how often, how much, how many, who, what, where	Quantitative · Survey · Secondary data analysis

Figure 5.1 Examples of appropriate methods in exploration

The applicability of the survey method and statistical analyses on electronic grocery shopping was seen to be poor. The potential answers to survey questions would come from persons in conventional retailing business, who are not necessarily well informed about the new possibilities. They might have a natural resistance towards changes and interest in the subject might vary considerably from individual to individual. The survey method in these kind of circumstances will not produce results with a high degree of validity (e.g. Bogart, 1972; Galtung, 1970). The use of the survey method at the initial stages of electronic grocery shopping was discarded. The secondary data analysis was impossible due to a lack of statistics and other sources of information. Thus, the quantitative methods as primary tools were found to be inappropriate.

The Constructive approach was assessed to be the most suitable as an overall approach. In constructive research process the following steps can be identified (Kasanen et al, 1993):

1.Find a practically relevant problem with research potential
2. Obtain a general and comprehensive understanding of the topic
3. Innovate (construct) a solution idea
4. Demonstrate that the solution works

5. Show the theoretical connections and the research contribution of the solution concept
6. Examine the scope of applicability of the solution

The order of the phases might vary from case to case but the core element of this method is the innovation. A successful constructive research project has to produce a new solution to the problem in question, otherwise there is no point in going on with the research (Kasanen et al, 1993).

Even though the research of Forrester (1961) in industrial dynamics is best known for the work on the demand distortion phenomenon in supply chains, his writing can partly be seen as guidance for selecting a methodological approach in management science. According to Forrester, building computer models of industrial and economic situations creates a controlled laboratory environment. In this environment one can quickly learn at a low cost answers that would seldom be obtainable from trials on real organisations. The use of models should primarily be done in order to enhance the understanding of the inherent characteristics of the system, not to predict specific events in the future. Even though Forrester is primarily referring to dynamic simulation as the basic tool for modelling, the methodological approach appears to be applicable for other modelling techniques.

Forrester points out that many people discount the potential utility of models due to a lack of adequate data on which to base a model. They believe that the first step must be the extensive collecting of statistical data. In Forrester's opinion, exactly the reverse is true. The model comes first and one of the first uses of the model should be to determine what data needs to be collected. Models that are built this way – upwards from the characteristics of the separate components and by estimating and incorporating all important factors – will give useful results.

The approach suggested by Forrester has not been widely used in academic research work outside the operations research field. It seems to be a versatile tool in researching new industrial or economic systems. However, the approach has been put into use in organisational development in the business world. The approach has developed over the years and much of the “learning organisation” concept is related to Forrester’s approach (e.g. Senge, 1990).

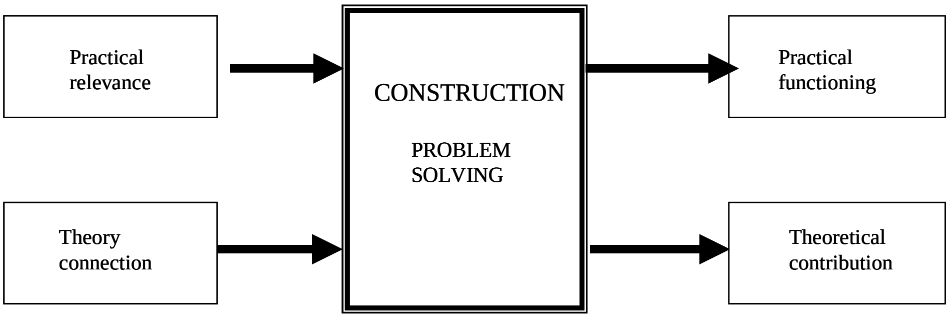

Figure 5.1 Elements of Constructive Research (Kasanen et al, 1993)

All problem solving exercises are not automatically constructive research. The essential element in constructive research is to tie both the problem as well as the solution with accumulated theoretical knowledge. The elements of constructive research are illustrated in figure 5.1. The novelty and actual working of the solution have to be demonstrated as well (Kasanen et al, 1993).

5.2 Methods within Constructive Research

The research area is new and there are very few aspects that have been previously researched. The task of the Intertrade research project was to find out the cost structure of electronic grocery shopping. The cost structure was divided into three parts, which were researched separately and using a different methodology. Home delivery or “the last mile”, as it is often referred to as, was researched quantitatively on the basis of real shopping basket data. The local distribution centre cost structure is based on qualitative modelling. As supporting research activities, possible changes in supplier costs and upstream distribution were researched by means of case interviews and unattended reception by piloting. This chapter describes the various methodologies used in the area of this dissertation and the reasons for using them.

5.2.1 Qualitative modelling

The research method used for researching local distribution centre operations for electronic grocery shopping can best be described as a combination of qualitative modelling as well as quantitative modelling. The qualitative part consists of the construction of the LDC. The analyses using cost data can be seen as the quantitative part.

The data collection method was expert interviews supported by secondary data analysis. Even if the collection of information incorporated features of case research and methods such as best practice were utilised, the overall approach was constructive. The constructive research approach was used because the aim was to research local distribution centre operations in Finland and there are none in existence. Many operating outlets in the USA were analysed on the basis of information that is publicly available. Companies in the USA in the process of becoming publicly listed have to provide very detailed descriptions of their operations to the public. The U.S. Securities and Exchange Commission has the companies' filings available online (SEC, 2001). Information concerning companies such as Streamline and Webvan was carefully analysed in order to find the best practices and benchmark figures for cost structures. A company in Sweden, Matomera, was visited and their local distribution centre operations were analysed on the basis of information obtained directly from the company.

Due to the differences in economies and retailing systems, the cost data from the U.S. is not directly applicable to Finland. When using the data from the U.S. market the emphasis is on the qualitative side. How companies have built their distributions centres, how they have used automation and groceries are handled inside the outlet. The cost data from the U.S. companies was not used in the quantitative analyses.

All this information, and the know-how of the experts of the S-Group, was used in this qualitative modelling as part of the constructive research. Constructive research can be very useful for problem solving in new areas of management accounting (Kasanen et al,1993). This task was to calculate the cost structure of a new operational unit and the method proved to be feasible.

The detailed operational structure and layout of a local distribution centre (Jaakola, 1999) and a more theoretical approach towards optimal design (Yrjölä & Tanskanen, 1999) used this methodology. The overall structure is discussed on the basis of qualitative construction in Yrjölä (2001) and Kämäräinen (2000). In publications not directly linked to this dissertation home delivery was studied with a similar methodology by Punakivi & Holmström (2000) and Småros & Holmström (2000). Holmström & al (1999b) studied the overall structure.

5.2.2 Quantitative modelling

The main focus of the modelling research was to determine the cost structure of home delivery. The first task was to build a geographical distribution model to calculate the cost of distribution. There was only very limited e-commerce data available from the S-group from their pilot operations in a few smaller cities in Finland. This data was not sufficient to give any support for testing the hypothesis. It was decided to use shopping basket data from a traditional supermarket for this testing.

The method for primary data collection was sampling. The basic sample consisted of shopping basket data (electronic point of sales data) from five supermarkets for one randomly selected week. Only shopping basket data connected to a loyalty card was used. A geographical area where most of these loyalty cardholders live was specified. The shopping baskets with a loyalty card address outside this area, as well as baskets with a value of less than €25, were excluded from the study. The sample should represent the characteristics of the population it purports to represent (Emory, 1985). Even if the validity of the sample is not very high in describing the characteristics of potential e-grocery shopping baskets, the validity is believed to be sufficiently accurate and precise to describe the potential geographical delivery point of the groceries.

The geographical location of each shopping basket buyer was incorporated into the data and households were given a number in order to maintain customer privacy. On the basis of this, we were able to consolidate all the purchases of each household in a certain area and ascertain the location of the final delivery. The selected area was a central part of the suburban city of Espoo, an integral part of the Helsinki metropolitan area.

The area where the shopping basket buyers live is approximately 60 square kilometres in area and the model includes a map of the area with the details of the road network. The software package used was RoutePro 6.1 by CAPS Logistics, which was very suitable for this kind of geographical distribution simulation. The data included 1639 shopping baskets, delivered to 1216 households, representing 1.63 percent of the market share. The cost structure was researched by modelling different service models used for home delivery and applying them to these shopping baskets and their final destination. The data was scaled for different market shares in order to give an understanding of cost structure as a function of customer density.

Questions concerning the areas near the household require much less volume than the questions up the stream. This implies a multiple model approach for further research. Questions emerging at different levels of volume should be simulated with models focusing on each level separately (Yrjölä et al, 2000). The author of this thesis designed the research agenda for the home delivery cost structure including the basic model design and data collection. Using the model to run the analyses with different drop densities was carried out as a team effort. After the general cost structure was analysed the team members continued with the model to make further, more detailed analyses on different service models and operational options.

Those publications based on quantitative modelling which are directly linked to this dissertation studied the cost structure of home delivery with real shopping basket data. Kämäräinen et al (2000b) and Punakivi & Saranen (2001) compare the cost differences between different service models and the differences between attended and unattended reception. Punakivi et al (2001) compare delivery costs using delivery boxes instead of reception boxes in unattended home delivery. Punakivi (2000) analyses the added value of route optimisation.

5.2.3 Supporting research activities

In addition to the modelling, there was a need to perform some supporting research activities so as to improve the reliability of the results presented in this dissertation and test the validity of the models constructed. The question of cost structure changes in the upstream of the supply chain was studied by means of interviews. The validity of unattended delivery and its cost model were studied with the help of a pilot project covering 50 households. These methodologically weaker studies, case interviews, and piloting are discussed in this section.

Case Interviews

It would be ideal to test the question concerning the middle and upstream cost structure with a large set of data. Unfortunately, there was no relevant data available as a result of the fact that there are no businesses currently using the new type of supply chain. This is the reason why the question was not quantified and the purpose was not to find out the exact cost structure of the middle and upstream supply chain at this point in time. To be able to quantify the whole supply chain cost structure, only a quantitative method will be able to give reliable results. This is definitely an area for further research when relevant data becomes available.

When describing and exploring new phenomena in order to build a new theory, inductive case study research is a suitable method (Eisenhardt, 1989; Handfield & Melnyk, 1998). The research approach is inductive and relies on direct observation of what is covered by the theory (Glaser & Strauss, 1967). Building the theory can utilise both qualitative and quantitative data and it is a suitable method for the investigation of complex real-life events (Yin, 1989). To better understand complex phenomena is generally the reason why case study research techniques are used. Phenomena such as process changes often do not allow for simple and unambiguous research design and quantification (Gummesson, 1991).

Even though the interview approach used in this research was not genuine case research, it did have some similarities. The principal difference was that the purpose was not theory building; it was conducted only to find the answer to a simple 'yes/no' type of question. The similarity lay in the interview case selection and the overall inductive approach. The method for primary data collection was semistructured interviews (Ellram, 1996). The structure of the interviews is documented in appendix 3.

The need was to find sufficient evidence to be able to assess whether changes in the downstream of the grocery supply chain will add or reduce costs in the middle and the upstream. Changing the process in downstream operations will not necessarily require process changes that increase the costs of all types of suppliers. It may also enable changes that improve efficiency for those suppliers that need to change their operations. The way the question is approached allows for the ignoring of all suppliers who can operate in the new environment with their current processes. Even if the new environment could encourage them to introduce process changes, companies will not make a change voluntarily that will have an adverse effect on their profitability.

The aim was to concentrate on those suppliers who are expected to need to change their process if the supermarket is replaced by a local distribution centre. The two first cases, a brewery and a supplier of dairy products, were selected on the basis of their goods volume in the supply chain. The third case, a supplier of packaged meat products, was selected on the basis of its completely different type of operation in comparison to the other two. Case selection should preferably be selective, in order to choose cases that are likely to replicate or extend the emergent theory (Eisenhardt, 1989).

Piloting

Researching a new business model without real quantitative data and having to make several assumptions can lead to results which may be theoretically correct but which lack external validity (Niiniluoto, 1980). This means that the results do not provide measurements of any real process or phenomenon. To improve the external validity of the research an experiment was conducted with the help of the commercial project partners. The purpose of this experiment was to test unattended delivery in a real environment. This experiment was called the e-grocery pilot and was planned to last a minimum period of six months. The pilot lasted for a year and developed into a commercial service after the experimental period.

The e-grocery pilot was organised with 50 reception boxes that were installed free of charge to households willing to participate in the experiment. The households paid a fixed fee of € 33 per month for the opportunity to receive delivery of groceries twice a week. The groceries were ordered on line and picked from an existing supermarket. From the research point of view, this pilot with 50 selected households is not sufficient for detailed quantitative analyses. However, a qualitative analysis of user interviews carried out twice during the piloting process was used to assess the technical and practical feasibility of the new business model.

Quantitative analysis on the shopping basket data from the pilot study was used to analyse the changes in consumer purchasing behaviour. Furthermore, the distribution costs structure from the pilot study was analysed and compared to the model used with the larger set of data. These quantitative analyses are not sufficient to prove that the theoretical analysis is absolutely correct; the scale of the pilot study is not sufficient for that purpose. The analyses of the pilot study provide an indication of whether the results agree or disagree with the theoretical evidence. This adds reliability and practical utility and helps us to focus on the critical issues for practical implementation.

Other linked research activities

This dissertation covers only a part of the research work carried out on electronic grocery shopping in the Ecomlog and Intertrade projects. This work concentrates on the basic overall cost structure of the new supply chain for groceries, from suppliers all the way to households. In addition to the constructional research, the profitability of investments in automation in the local distribution centre has been analysed (Kämäräinen et al, 2001a).

In the home delivery area the overall change in transportation infrastructure has been analysed from different angles (Punakivi & Holmström, 2001; Yrjölä, 2000; Yrjölä & Holmström, 2000). A generic model for distribution costs, based on the characteristics of the road network and customer density, has been studied by Saranen & Småros (2001).

The overall structure has been analysed additionally in several ways. Småros (2002) has analysed ways to increase the attractiveness of EGS. New service opportunities and ECR in the EGS environment have been analysed (Småros et al, 2000; Småros & Kämäräinen, 2000). Finally, different strategies for EGS implementation have been researched by Tanskanen (2000). A summary of the research findings of this dissertation and other research work carried out during the project is presented in Yrjölä et al (2002).

The research environment and the responsibilities and contributions of individual researchers have been described in detail in appendix 5.

6 Results of the Modelling Exercises

This chapter will show the results of the research conducted using the questions formulated in Chapter Three to test the main hypothesis. The two research questions are first dealt with one by one and the understanding concerning each obtained through the research process is discussed separately. The working hypotheses are tested and the results are presented. Finally, the results are combined to test the main hypothesis of this dissertation: under which circumstances can e-grocery with home delivery be more efficient than operating a supermarket?

6.1 Local distribution centre for e-grocery

The Local Distribution Centre (LDC) is the structure in the e-grocery environment that replaces the supermarket in the supply chain. The first research question is how the cost structure of an LDC compares to the cost structure of a supermarket. Potentially, the Local Distribution Centre could replace more than just the supermarket in order to make further savings in midstream logistics. In order to make a direct cost comparison possible and keep the structure simple it has been assumed that the logistical structure from product suppliers to local distribution centres is identical to the current structure from suppliers to supermarkets.

The design principles of an LDC are first discussed on the basis of theory and examples of outlets that have been constructed. A design for a centre built in current supermarket premises is explained in detail. Finally, the operational costs of the centre are compared to the costs of the supermarket. Comparisons are made between using an LDC or a supermarket as the basis of an e-grocery service. The findings and cost analyses are mainly based on two tasks within the Intertrade project managed by the author, the Master’s Thesis of Tomi

Jaakola (Jaakola, 1999) and an analysis of the profitability of investments in picking efficiency (Kämäräinen et al, 2001a).

In addition to the financial analyses of the LDC operations, an alternative approach to picking is introduced (Yrjölä & Tanskanen, 1999; Yrjölä, 2001). This hybrid model combines a store and the LDC. The approach is based on supply chain design issues discussed in Chapter 2.

6.1.1 Local distribution centre design for e-grocery

The Local Distribution Centre (LDC) in an e-grocery can be seen as an assembly plant for shopping baskets, which consist of grocery items ordered by customers. In this approach general production principles (Shoenberger, 1982) such as Just In Time and lean manufacturing can be used as the basis for the design of the local distribution centre (Harmon, 1993).

Order picking is one of the biggest cost drivers in the e-grocery business. The emphasis in developing cost efficiency is on increasing picking speed and, in this way, reducing the labour costs of picking. Better picking speed can be achieved by paying attention to where the picking is carried out as well as to the level of automation (Reda, 1998).

The general cost structure of picking has been analysed by Frazella (1990) and, on the basis of this analysis, over 60 percent of the picking time is used for moving. The need to move can be reduced by investment; an extreme example of this is Webvan, whose highly automated distribution centres, costing between 25 and 35 million dollars, are based on a mathematical model giving optimum efficiency when the goods are moving and the movement of pickers is limited to the picking cell (Guglielmo, 2000, Webvan, 1999). Frazella has presented ten principles for the improvement of picking efficiency without larger investments. These have been followed in the design put forward by Jaakola

(1999), which can be seen as a low-cost approach to the creation of an efficient outlet.

The main goal in LDC design is to create an efficient flow of products through the centre. Efficient flow takes into account the nature of different product groups. Slower-moving products should not be in the way when faster-moving products are being handled. Product group characteristics have to be considered when designing product flows and the layout of the distribution centre. Product classification can be approached from two angles, the frequency of occurrence and the characteristics of demand.

Braithwaite and Samakh (1998) present a Pareto curve-based classification of products into three categories, A, B, and C, on the basis of sales revenue and volume. The purpose of their classification is to be able to calculate the cost-to-serve for each product group for different service levels for the whole supply chain. This will help in the making of informed decisions on service offering and pricing. The same classification approach can be applied to LDC design, but not directly (Yrjölä & Tanskanen, 1999). Frequency of occurrence has to be emphasised more because it directly affects the amount of picking that has to be done - if every order contains a certain item, it causes more work than if every tenth order contained ten of this same item.

Småros et al (2000) have presented a qualitative approach for consumer demand segmentation (Figure 6.1) with three demand segments: continuous demand, occasional demand, and the single purchase type of demand. Items with high frequency and relatively stable demand belong to the continuous demand group (Class A products). Items that have a lower frequency of occurrence belong to the occasional demand group (Class B products). Finally, items that only rarely appear in consumers' orders belong to the single purchase group (Class C products).

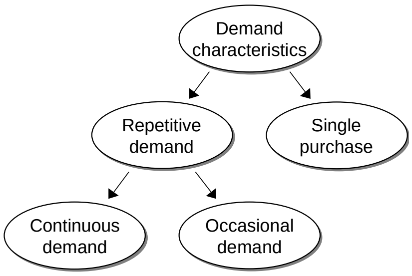

Figure 6.1 Demand segmentation of products (Småros et al. 2000).

The layout of the distribution centre should take these groups into consideration. The handling and movement of the continuous demand products must be minimised. Ideally, the products will be cross-docked in the distribution centre. There is no need to store these items on the shelves. Products that belong to this group must be placed near to inbound and outbound areas. In Figure 6.2, a layout solution for these items is presented.

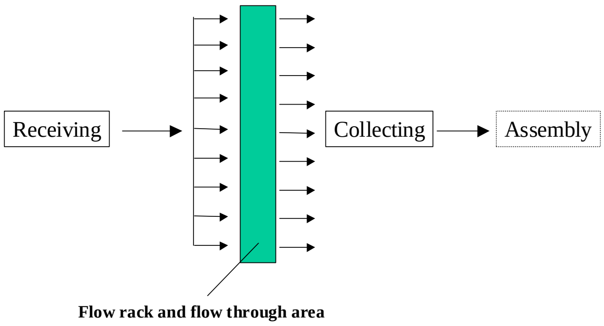

Figure 6.2 Solution for continuous demand products (Jaakola, 1999).

Products in the occasional demand group are unpacked from pallets to smaller units. In the design these items are stored in flow racks and on open shelves. U-shaped picking cells (Schonberger, 1982) of compatible products can be formed in order to increase picking efficiency (Figure 6.3). To avoid crossing paths, the shelves are loaded and unloaded from different sides. The aim is to make this product group flow through the distribution centre.

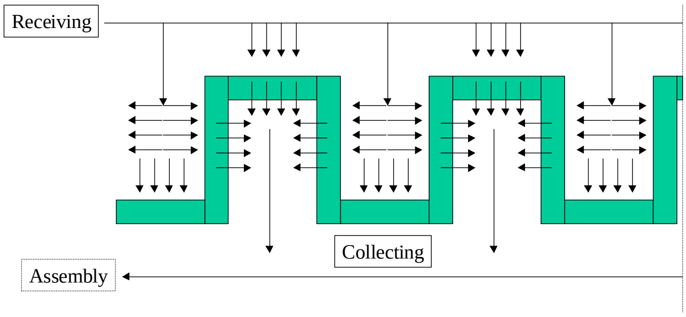

Figure 6.3 Picking cells for occasional demand items (Jaakola, 1999).

There is very little benefit to be gained from forming cells for products in the single purchase demand category, in consequence of their rare occurrence in orders. The most important aspect concerning this product group is to minimise the risk of stock-outs. To maintain good service quality it is essential that customers' orders can be filled completely. Figure 6.4 illustrates the design for storing items that have a low frequency of occurrence.

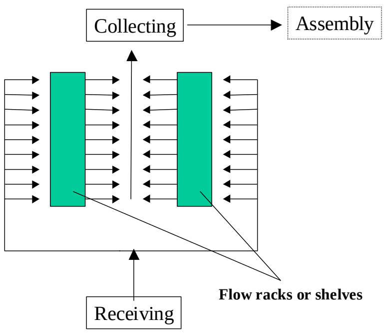

Figure 6.4 Solution for single purchase products (Jaakola, 1999).

Frequency of occurrence forms the basis for the product flow and layout design. However, other factors, such as the preservation temperatures and physical characteristics of the products, need to be considered.

Preservation temperatures are crucial when dealing with groceries. Proper preservation of the goods requires at least three different temperatures in the distribution centre: ambient, chilled, and frozen. This increases the complexity of grouping and layout planning. Items in various groups have to be placed in at least three different places because of preservation temperatures. The temperature aspect also affects shelf and technology solutions. For example, it should be possible to pick at least most of the frozen products from outside the freezer.

There are physical characteristics of the products that have to be taken into account, too, which makes things even more complicated. There are non-food items, such as detergents, that may not be stored in the same place as foodstuffs even if the temperature allowed it. The weight, dimensions, and durability of the products also affect the tuning of the layout plan. By placing items with a similar physical nature in the same area, picking routes can be planned so that heavy items are picked first and fragile items will end up on top of the picking tote.

After the various phases of picking the products have to be assembled into complete orders. Figure 6.5 illustrates the layout plan of the assembly area. Items are moved to the assembly area just before loading in order to keep the products at their appropriate preservation temperature for as long as possible. To make the final assembly process more efficient, the picked order totes are arranged according to customers' locations, for example postal codes (Harmon ,1993).

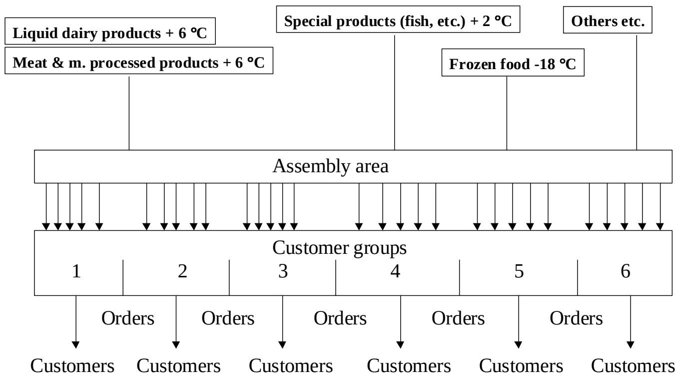

Figure 6.5 Order assembly solution (Jaakola, 1999).

The local distribution centre design presented here uses practically no automation. The closest reference point for it would be an assembly plant for made-to-order personal computers or cars, not a distribution centre for a meat packaging company. The distribution centre does not need any extraordinary technology to be effective. The first priority is organising the material flows in, and the layout of, the distribution centre for efficient order assembly.

Kämäräinen et al (2000) have studied investments in automation to increase picking speed in a distribution centre for the home delivery of groceries. Their conclusion is that automation can be successfully used for further increasing picking speed. However, it requires significant investment and the projected savings may not be realised if the full capacity of the distribution centre is not efficiently utilised. Due to fluctuating demand, capacity utilisation is often rather poor in the grocery business. This lowers the attractiveness of investing in automation. Creating flexible and expandable product flow and layout designs should be regarded as more important than rapidly increasing the level of automation.

Even if it is possible to make cost calculations based on fully automated and fully utilised distribution centres, the uncertainty grows with the level of complexity. The cost level that could be achieved would be lower (Kämäräinen et al, 2001) but comparison to existing businesses would be much more difficult. To understand the financial parameters of a local distribution centre and to get an answer to the first research question, all the cost items of the outlet designed have to be estimated and benchmarked separately.

The end result and outcome of this exercise was a detailed plan for a Local Distribution Centre (LDC) and a basic model for its operations. This hypothetical LDC was to be built on the premises of a currently-operating medium-sized supermarket with a floor space of 1200 square metres. The target was to keep investment at the lowest possible level while assuring the ability to pick two hundred order lines per hour per person, five working hours out of eight. The design takes into account the different temperature requirements, sales volumes, and physical characteristics of various product categories, as described earlier in this chapter. The calculations are based on converting an existing supermarket into a LDC, because it is unlikely that the retailers are willing to build or hire new premises for this purpose. This means that the internal lay out and areas round the building are not likely to be optimal for the new mode of operation. However, the cost will be decreased in an optimal case, thus making the results of this exercise to be conservative.

Once the LDC design had been completed and the investment-related costs estimated, the operational model and its costs were analysed. The detailed cost items and their values used are in Appendix 3. The operational costs, the cost of labour in particular, are the most decisive factors in the cost structure of the LDC when a reasonable business volume has been reached. It appeared obvious that investments in picking efficiency would lower overall costs at larger volumes, but this question was left for further research to deal with.

We had a detailed description of the operations and investments of several dedicated e-groceries (Webvan, Streamline, and Matomera: Appendix 3) and cost information concerning local store-based operations from the S-Group. The estimated costs of receiving, picking, and dispatch were compared to the benchmarks. Finally, the LDC design, operational plan and the cost analysis were presented to a group of specialists from the S-Group for verification. They made very good suggestions for minor modifications, which were incorporated into the final study. The cost structure of the LDC as a function of sales volume is illustrated in Figure 6.6. The lower curve in the chart is an optimistic estimate in which all factors affecting costs are estimated on the low side. The upper curve is a pessimistic scenario, in which cost factors are set at the maximum reasonable level. The values of the factors and the calculation of the various points of the curves are documented in Appendix 3.

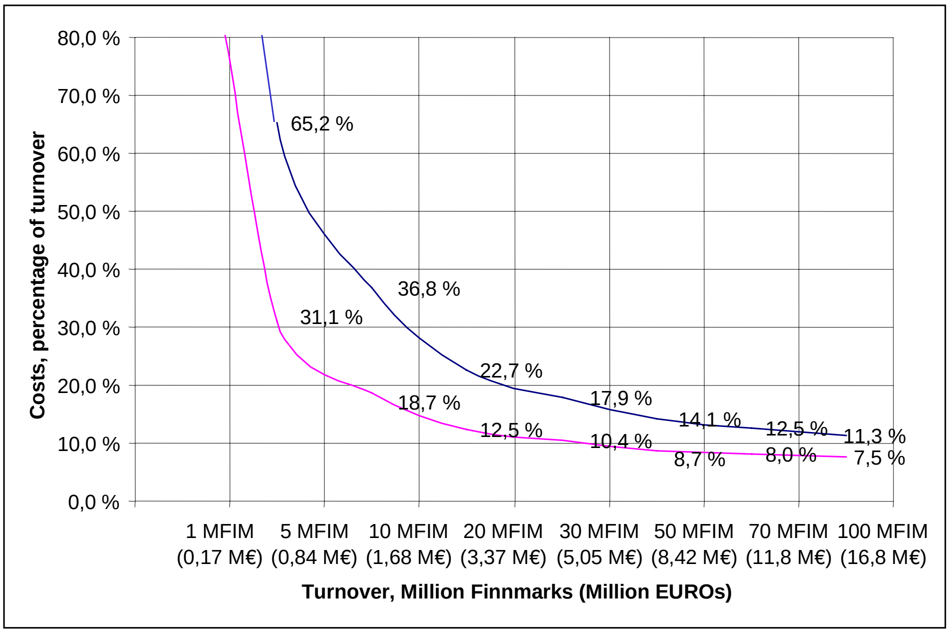

Figure 6.6 The costs of the Local Distribution Centre

The costs of an LDC are very high when the turnover is less than €2 million. It looks as if it is impossible to have a dedicated outlet for smaller volumes than that. This is due to the fact that all fixed costs are allocated to a small sales volume. Even if the picking were efficient, the portion of operational costs of all costs is small. A turnover of between €2 and 5 million brings the overall cost to a bearable level of clearly less than 20% of the value of the goods. When sales reach €10 million or more, the favourable operational costs are decisive and the overall costs reach 10% or even less in the optimistic scenario.

6.1.2 LDC cost comparison to a supermarket

There are two different ways to compare LDC cost structure to the cost structure of an average supermarket. A direct comparison will just compare the costs of the two different operations. This comparison alone will not give a full answer to any relevant question, because LDC operations will not take the shopping basket to the customer. The supermarket costs include all the cost of delivering the shopping basket to the consumer, because, in that business model, the consumer will take care of the costs of the so-called “last mile”. The costs of personal time and travel of the consumer are not included in the costs of supermarket in this comparison. Even if the direct comparison is not relevant, the size of the difference in the costs will be important when testing the main hypothesis of this dissertation.

Another possibility is to compare the costs of a supermarket-based e-grocery operation to those of an LDC-based operation. This will give a better understanding of the cost drivers and their sensitivity to sales volume.

Supermarket operations vary from market to market and so do cost structures. In the United States the operational costs of a typical supermarket (Smart store research by Andersen Consulting) are 17 percent of the revenue (Macht, 1996). The corporate overhead is 3 percent and distribution cost 4 percent, making the total cost 24 percent of the revenue. In the United Kingdom, Tesco’s cost structure has been published in connection with a comparison to Webvan’s costs (Business Week, 2001). This comparison is in Table 6.7.

	TESCO.COM	% OF SALE	TESCO STORE	% OF SALE	WEBVAN	% OF SALE
AVERAGE SALE	$123.25	100%	$34.80	100%	$114.00	100%
MINUS:						
COST OF GROCERIES	$85.66	70%	$26.10	75%	$ 83.00	73%
CASHIERS IN STORE	-	-	$ .87	3%	-	-
OTHER STORE COSTS	$15.16	12%	$ 4.28	12%	-	-
MARKETING AND ADMIN.	$ 5.67	5%	$ 1.60	5%	$133.04	117%
PICKING AND DELIVERY	$17.80	14%	-	-	$ 30.00	26%
PLUS:						
DELIVERY FEE	$ 7.25	6%	-	-	-	-
NET PROFIT (LOSS)*	$ 6.21	5%	$ 1.95	6%	($132.04)	NM

* Including delivery fee, before taxes

Data: BusinessWeek, ABN AMRO, Schroder Salomon Smith Barney, Booz, Allen & Hamilton, Jupiter

Table 6.7 Tesco’s cost structure in comparison with Webvan

Tesco does not have a separate distribution cost, and thus the cost of goods sold must include the cost of distribution up to the supermarket. The other difference is that marketing and administration have been added together as 5 percent of revenue, whereas the Andersen Consulting figures have 3 percent as corporate overhead. The pure store-related costs of Tesco are 15 percent of revenue without marketing. If marketing is eliminated from the Andersen operational costs of 17 percent, we end up with the same amount of cost, namely 15 percent. There are no statistics for Finnish supermarket cost structure, but a cost analysis of five medium-sized supermarkets in Helsinki gives operational cost averages that are very near the cost structure provided by Tesco. This analysis was performed with confidential cost information provided by the S-Group and therefore cannot be presented here in detail.

The operational costs of UK supermarkets was 19.6 percent of the turnover in 1999 (UK Monopolies and Merger's Commission, 2000). The overall trend in operating costs has been upward. Between 1996 and 1999, operating costs as a percentage of sales rose by one point. A number of factors have influenced this trend, most importantly the fact, that retail prices have changed little while costs have been subject to inflationary pressure. TESCO's total operational costs presented in Table 6.7 are 20 percent, which is very close the average in the UK. On the basis of the comparisons, it can be assumed that the store level operational costs of Tesco supermarkets, 15 percent of revenue, apply to similar markets in developed countries.

Sales per square metre in grocery stores in Finland come to 34,000 FIM (€5720) per annum (A. C. Nielsen,1999). The sales volumes in an LDC can be 2.5 to 3 times the sales of a supermarket with the same floor space (Jaakola,1999). This gives a 1,200 square-metre LDC a capacity of 100 to 120 million FIM (€17 to 20 million) within normal business hours. The LDC model becomes cheaper to run than a supermarket at sales volumes of €2 million in the optimistic scenario and €8 million in the pessimistic scenario. The cost advantage with annual sales of €16 million is close to four percent units in the pessimistic scenario and seven and a half percent units in the optimistic scenario. Is this cost advantage sufficient to justify home delivery? This will be discussed later, in Section 6.3. As a conclusion it can be argued that there is substantial amount of evidence to support the first working hypothesis 1:

Hypothesis 1: The operational costs of a local distribution centre with high business volumes are lower than the operational costs of a supermarket

The other part of the comparison will not give any clear pointers as regards the profitability of operations but will help us in understanding the cost structures better: is it economically justifiable to use a supermarket as a picking place for an e-grocery operation? The Tesco figures in Table 6.7, with the additional information that the 14 percent cost of picking and delivery is divided roughly half and half between these two activities (Business Week, 2001), give a reasonable answer to this side question. When the picking cost of 7 percent is added to the store-related costs of 12 percent, if we leave out the cashier's work we arrive at a figure of 19 percent for the total cost of picking from a store. From Figure 6.6 it can be seen that picking from a store is less expensive with sales volumes of less than €1 million in all cases. With sales volumes of €1 to 3 million it depends on the case and with sales volumes of more than €3 million the LDC appears to be more efficient even in the pessimistic case.

6.1.3 The hybrid model

This section will introduce an alternative to the two approaches commonly used to pick the groceries in EGS operations, the store-based picking used, for example, by Tesco, and the dedicated Local Distribution Centre used by most dot com grocery companies in the USA. This alternative is called the "Hybrid Model" and it is a combination of the two approaches (Yrjölä & Tanskanen, 1999; Yrjölä, 2001).

The Hybrid Model is based on supermarkets that are redesigned so that they can more effectively start order picking and direct home delivery than a conventional supermarket. But, at the same time, the conventional store included in the structure stays open for consumers to do their DIY shopping. The Hybrid Model is an evolutionary model for developing physical distribution in electronic grocery shopping. It enables a stepwise development of the physical distribution structure towards a solution dedicated to more Internet shopping with reduced risks and investment costs. The overall supply chain costs will be reduced for part of the products, which will by-pass most of the conventional structure. The Hybrid Model is illustrated in Figure 6.8.

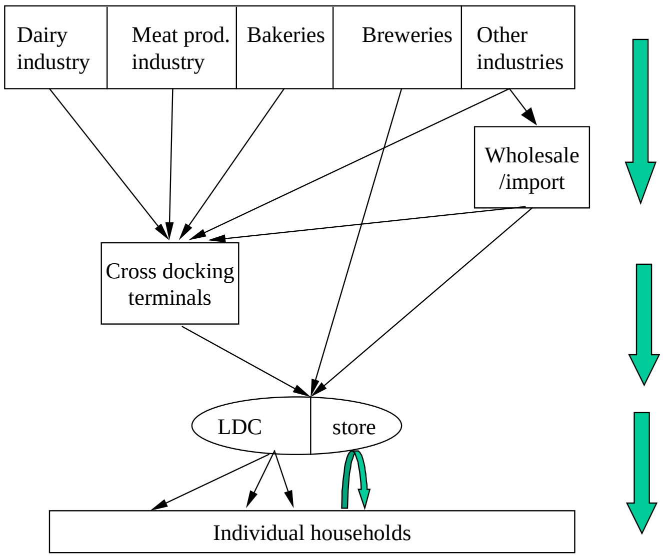

Figure 6.8 The Hybrid Model (Yrjölä et al, 2000)

The Hybrid Model is constructed for true EGS with smaller volumes and mostly on the basis of investments already made. The grocery products are initially divided into three categories on the basis of sales volume, as in the dedicated LDC design previously discussed. In the construction of the LDC, product classification was carried out in order to design the handling procedures at the LDC. In the Hybrid Model approach the product classification is made in order to select the supply chain for the product. For the making of adjustments, the product and product categories can be analysed as to their suitability for the standard supply chain structure suggested for each type.

The cost-to-serve, focus of the supply chain design, CODP and type and location of inventories are summarised in table 6.9. The cost to serve is very important for Class A products and the general focus is on cost. The importance of cost to serve is lowest for Class C products, that need a responsiveness focused supply chain. The supply chain for Class B products is focused on efficiency with medium importance of cost to serve.

Category	A	B	C
Cost-to-serve	Very important	Important	Not so important
Supply chain focus	Cost	Efficiency	Responsiveness
CODP	Supplier/LDC	Store/LDC	Store
Inventories	At the supplier	Automated	Manual

Table 6.9 The characteristics of the supply chain for class A, B and C products

In the basic design of the Hybrid Model the Class A products are not kept as inventory. Class A products come directly from the industry to the LDC on the basis of customer orders. In the LDC the products are sorted into the home delivery totes. For some Class A products an optimal operation can be based on estimated demand, with some short-term inventory instead of direct customer orders. This could be beneficial, for example, in enabling transportation from the supplier to the LDC in full truckloads. In Finland, typical products found in Category A are brewery and dairy products.

Class B products have some inventory, which may be automated or manual, depending on picking volumes. For this category, the emphasis is on efficient picking. In today's supermarket the construction and layout are not designed to support picking efficiency. Quite the contrary, the design makes the consumer spend as much time as possible in the store so as to maximise impulse purchasing. The delivery totes with the Class A products receive the ordered Class B products either automatically or manually from the Class B product inventory. Typical Class B products have medium purchase frequency and are not heavy or bulky. Canned food, meat products, rice, and pasta are good candidates for the Class B product group in Finland.

Category C products use the store as an inventory and picking is done manually. A good planning and control system can make the picking more efficient than in the "We shop for you" services in which one customer order is picked at a time. Tesco (Business Week, 2001) has succeeded in making store picking efficient, but it can possibly be made even more efficient. Picking from the store can, for example, be controlled by the home delivery routing system. When a full home delivery vehicle is being loaded with Class A and B products, the Class C products which are needed from the store can be grouped so as to make it possible for a couple of efficient pick-up runs through the store to complete all orders and have them ready to go. A typical Class C product is a small bottle of West Indian Chilli Sauce. The store naturally carries all Class A and B products, but the quantities and space allocation for these products are just a fraction of those in a conventional store.

The largest area of cost in the conventional supply chain from the supplier to the store checkout register is the operational costs within a store. These are 17% of the value of the goods on the basis of the SmartStore figures (Table 1.3) and 15% on the basis of those from Tesco (Table 6.7). In the initial design of the Hybrid Model the emphasis has been on eliminating store handling, as well as some inventory costs for the volume part of the logistics stream. The reduction of the store-based cost gives room for the extra costs of home delivery. On the other hand, today's supermarket can carry up to or even over 15,000 products with very low purchase frequency. Consumers will expect these products to be available in any attractive shopping environment in the future. Using the store to provide products with low purchase frequency lowers the start-up investments for the EGS service while still enabling fast home delivery.

6.2 The success factors in home delivery

The second research question concerns the cost structure of home delivery. What are the key factors affecting costs and how do costs change when sales volumes grow? The purpose of this section is to describe and analyse the key factors that affect the cost structure of the home delivery of groceries. Home delivery sounds very simple, but in fact there are several service offerings and each has several alternative execution options. The service models and their value to the consumer are first analysed. Then the cost structures of the models are analysed on the basis of the quantitative modelling of true shopping basket data.

6.2.1 Home delivery service models

Public transport gives good examples of different service models. A bus or a train has a pre-set timetable and route. People wishing to use the service adjust their own time schedule and go to a bus stop or train station to be able to use the service. There are other forms of services for people who cannot or do not want to use these collective services. By ordering a taxi the customer can decide the timing and routing of the service. A bus or train ride can be provided much more efficiently per customer than a taxi ride. This is why the fare is normally very much more expensive when using a taxi. Customers understand this and if they really need or want a taxi they are prepared to pay the heavy premium for the added value and much bigger production cost of the service. Ordering a bus for one person to make a tailored trip would be even more expensive.

What does this have in common with home delivery in e-grocery? The same rules of economics should apply to both services. However, it seems that so far the service providers in e-grocery have given their customers a taxi service with luxury buses and charged either nothing or just a nominal fare. The customers have not been prepared to pay for the added production cost of the service because they have not perceived it to provide much added value.

This dilemma has been partly due to the fact that the service providers have been planning to create bus routes, with their consequent economy of scale, but have ended up with a taxi service because of the low amount and low density of customers. Laseter et al (2000) have demonstrated that even in the larger US cities the density of population will not allow for a very low cost provision of home delivery services. Their analysis is made in connection with the service model, in which the customer decides the timing of the service. This is why it is important to look at other possible service models.

The starting point of home delivery service models was attended delivery in a certain time window. The problem with this service model is that to be efficient it needs huge customer density. The reason is that the delivery vehicle needs to travel around the distribution area and visit the same places many times a day to meet the promised time windows (Punakivi & Saranen, 2001). If the time window is larger it makes the production cost of the service lower. On the other hand, when the time window grows, the value of the service to most customers disappears. To get their groceries delivered to their home they have to stay at home for hours to wait for the delivery.

Webvan started its home delivery service with half-hour time windows, the smallest in the market. Most companies use one- or two-hour time windows, which, from the customer’s point of view, can still be acceptable if the customer can select the time. Three pre-set (based on postal code) two-hour time windows used by, for example, Matomera in Sweden, did not seem to attract customers in the long run, because the service was discontinued due to lack of demand (Bergendahl, 2001). For example customers living in a certain postal area were offered delivery between 5 and 7 p.m. and customers in the next area between 6 and 8 p.m. The idea of these partly-overlapping time windows offered according to postal code was to be able to get flexibility in route planning so as to make savings in transportation costs. Webvan, on the other hand, had to change the time window to one hour. Obviously, the half-hour time window was too expensive. These examples provide evidence that with the attended reception model customers are willing to accept a time window of up to two hours but they have to be able to select it themselves.

In the attended delivery service model, in most cases orders have to be placed by midnight the day before delivery. Some companies have offered the possibility of ordering in the morning of the day of delivery.

Some e-grocers offer the customer the opportunity to pick up the ready-assembled shopping basket himself from the store. This way the cost of home delivery goes directly to the customer and the value of the service is limited to the shopping time saved. This service model can be used for a small amount of customers, but to be able to work well with a large amount of business it is likely to require additional investments in order to avoid customer queues during the pick-up process. The customer's motivation to use this kind of service is time saving; thus, queuing would lower the value of the service.

The other approach to home delivery is the unattended reception of groceries. This will give more flexibility of transportation, but normally needs additional investment. A reception box is a lockable box with different compartments for the temperatures required to preserve various types of groceries. Streamline's service was based on weekly deliveries to reception boxes installed in the customer's garage. From the customer's point of view this in fact means that the supermarket is distributed to the households. The products that the customer would pick in the store during the week are brought to the reception box and the customer can take the products from the box when needed. The downside of this approach is that in most cases the customer has to change his or her shopping habits. One delivery per week means planning ahead and an analysis of the real needs of the household. Of course, the weekly delivery can be complemented with occasional visits to a local store or petrol station grocery corner, but without planning the value of this kind of service model is questionable.

Streamline's service model was a true process re-engineering, not just converting the supermarket into a digital form. This kind of service model enables new types of demand/supply structures (Småros & Holmström, 2000). Buying is not directly converted to ordering, because in most cases the consumer's real need is to have a certain product always available at home. The Streamline approach offered a change in the grocery supply chain to one based on true consumer needs. There are certainly grocery products that customers want to order, but there is a wide range of products, which can be described as "Don't run out" or "Keep it coming" products, where eliminating ordering adds value to the service.

A household with young children consuming nine litres of milk per week on average does not need to order 6 one-and-a-half-litre bottles week after week. They can be delivered without an order. Toilet paper and toothpaste are further examples of products that could use the "don't run out" service model.

The difference in the Streamline approach is customer loyalty. Streamline customers, according to the company's reports, bought more than 90 percent of their groceries through the service. Taking into account the fact that a normal household very seldom needs more than 200 to 250 SKUs of groceries on a continuous basis (Groceryworks, 2000), demand for products is, for the most part, very predictable and stable. The pilot project in Finland conducted with the S-Group, covering 50 households (Riihonen, 2001) in the Helsinki suburban area, seems to support this, even if the number of households is too small to give any statistical evidence.

Another way to enable unattended delivery is to use a delivery box. A good example of a delivery box is that of Homeport in London, England (Punakivi et al, 2001). It is an insulated box that is delivered to the household location and attached with a locking mechanism outside the front door. The investments needed are smaller, just the locking base at the customer end and the boxes, which can be shared. The solution gives almost the same benefits as the reception box, but perishable groceries requiring cool or freezing temperatures have to be removed from the box within a certain time frame. The other difference is the need to collect the empty boxes at some point of time.

There are even more alternatives for home delivery service models, but the ones described here are analysed quantitatively with data from the second largest grocery retailer in Finland, the S-group. Some further options for unattended delivery, namely shared reception boxes and scheduled attended delivery routes, are discussed in the summary part of this section.

6.2.2 Home delivery research by quantitative modelling

Home delivery could be estimated with a simple spreadsheet model in order to get an indication of the cost involved. However, to develop a deep understanding of the cost structure of home delivery and the various factors affecting it, a more accurate method is needed. In order to be able to compare the different service models and their efficiency, a model based on a digital map was built to enable simulations with real shopping data from one of the major grocery chains, the S-Group. Shopping basket data from five supermarkets for one full week was used and baskets with a value of less than €25 were discarded. This limit could have been much higher, because early experience in the UK (CIES, 2000) and Scandinavia (Matomera, 1999) suggested that the average shopping basket value in EGS tends to be from €80 to €150. The idea was to eliminate unplanned casual shopping trips. The geographical location of each shopping basket buyer was incorporated into the data and households were given a number so as to maintain customer privacy. On the basis of this data it became possible to consolidate all the purchases of each household in the area and establish the geographical location of the household for home delivery modelling purposes. The selected area was a central part of the suburban city of Espoo, a vital part of the Helsinki metropolitan area.

The effective area where the selected shopping basket buyers live covers approximately 60 square kilometres, and the model includes a map of the area together with road network details. Because of the suburban nature of the area the whole map area covers some 135 square kilometres. The software used is RoutePro 6.1 from CAPS Logistics, which appeared to be suitable for this kind of geographical distribution modelling. The service models first analysed are summarised in Figure 6.10. A more detailed and more technical description of the modelling process has been presented by Punakivi and Saranen (2001).
The data and the assumptions of the model are presented here only on a general level.

CASE	ORDER	DELIVERY	RECEPTION	DELIVERY TIME WINDOW	EXAMPLE
1	by 10:00	same day	manned	3 delivery time windows: 17-19, 18-20, 19-21	Matomera, Sweden Ruok@net, Finland
2	by 24:00	next day	manned	1 hour delivery time windows between 12 and 21	Ykköshalli, Finland Eurospar, Finland WebVan (½h), USA Tesco (2h), UK
3	by 24:00	next day	unmanned (reception box)	delivery between 8 and 18	Streamline, USA S-kanava, Finland
4 *)	by 24:00	next day (fixed day)	unmanned (reception box)	delivery between 8 and 18, once a week on a fixed customer chosen day	Optimal case in box concept
5 **)				all orders delivered with own car, simulating the situation where households are doing the shopping themselves	Traditional grocery shopping
6	by 24:00	next day	manned / unmanned (reception box)	**unmanned:** delivery between 8:00 and 18:00, **manned:** 1 hour customer chosen delivery time window between 8:00 and 18:00. The amount of manned receptions:0-100%	

*) Case 4 simulates the best possible case from the e-grocer's point of view, meaning that orders are sorted by postal code and devided evenly on all delivery days. This kind of situation can be reached by for example pricing.
**) Case 5 enables the comparison of the different e-grocery cases to the current situation where customers visit supermarkets.

Figure 6.10 Different service models analysed (Punakivi & Saranen, 2001)

The basic characteristics and limiting values of the vehicle fleet in the simulations were the following.

Max 60 orders per route

Max 3000 litres per route (to describe the volume of packing materials etc; the real volume of the van is normally 6-12m^3)

Working time max 11 hours per van

Working time max 5 hours per route

Costs of van & driver: 135 FIM (€22.5) per hour (outsourced)

Loading time per route: 20 min

Drop-off time per customer: 2 min

The number of customer households in the data was 1450 and the number of shopping baskets worth €25 or more was 1639. This is only 1.2 shopping baskets per household per week, much less than the average in Finland of 4.6 (Granfelt, 1995). There are two reasons for this difference: firstly, the elimination of shopping baskets worth less than €25 and secondly, the fact that customers are using other grocery chains as well. The service options for home delivery were modelled and the distribution tasks were optimised within the limitations of each business model. The indexed results of the simulation are summarised in Figure 6.11.

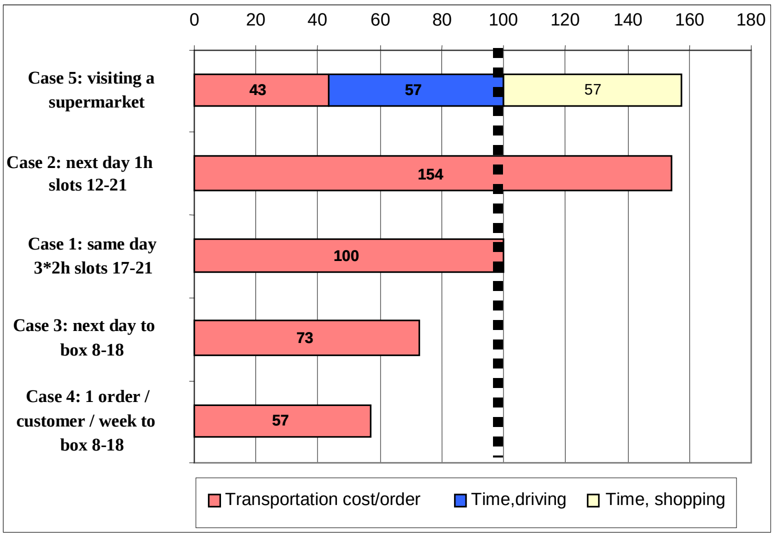

Figure 6.11 The indexed transportation costs for Cases 1 to 5 (Punakivi & Saranen, 2001)

Figure 6.11 presents the cost levels of the basic e-grocery home delivery concepts compared to the calculated average costs of the customer visiting a supermarket himself (Case 5, presented first). The cost of "self service" is indexed at 100 in order to be the reference bar in the figure.

The index (100) contains the costs of using one's own car and the amount of spare time used for driving. The costs of driving to and from the store are calculated from the simulated mileage using an average cost multiplier of 0.9 FIM/km (€0.15/km), including the costs of petrol, insurance, tyres, and service (Aromaa, 1999). The average one-way distance to the grocery shop is 3.5 km (Granfelt, 1995). The cost to the consumer of the time taken is calculated at a rate of 20 FIM/h (€3.36/h), which is in line with the value placed on leisure time by the Ministry of Transport when assessing time-saving investments in the road network. The average driving and shopping time of 50 min/shopping trip is divided into half for shopping and half for driving (Raijas, 1994). The cost of the time spent shopping has been left out in the index 100, as only the transportation-related costs are being compared. The cost of the customer doing the picking and packing in the store could have been used in the comparison of the costs of a local distribution centre versus a supermarket. However, the valuation of consumer time is problematic and should not be emphasised too much.

The differences in the cost levels of the e-grocery home delivery concepts shown in Figure 6.11 are clear. A one-hour delivery time window (Case 2) increases the delivery costs by 54 percent when compared to a two-hour delivery window (Case 1), which happened to be at the same cost level as the do-it-yourself option. An important finding was the difference between attended and unattended reception. The home delivery transportation cost with attended one-hour reception (Case 2) is 2.7 times the cost of once-a-week unattended delivery (Case 4).

What is the critical factor in making the differences so large? To demonstrate the dependencies, the average mileage per order and the number of deliveries per hour in each of the cases are shown in Figure 6.12. This demonstrates that the cost efficiency of a home delivery service model can be described with the average mileage driven per order, which directly correlates with the number of stops per hour. With attended reception the delivery vehicle needs to drive back and forth in the distribution area to meet the delivery time windows. The smaller the time window, the more additional miles are driven. To understand this better, unattended delivery was studied further with a separate data set.

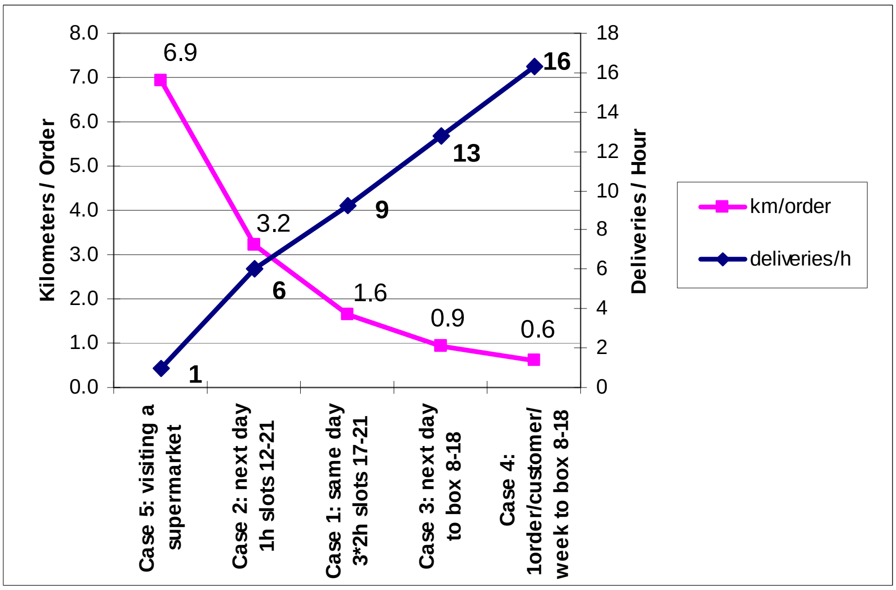

Figure 6.12 Mileage per order and number of deliveries per hour in different home delivery service concepts (Punakivi & Saranen, 2001)

Costs of attended vs. unattended reception

The further analysis of attended and unattended reception (Case 6) was performed with a data set from one day that included 462 orders. Attended deliveries were simulated using “customer-chosen” one-hour delivery time windows, chosen according to the real shopping time between 8 a m and 6 p m. Unattended deliveries were optimised using open delivery time window between 8 a m and 6 p m. In the analysis the amount of attended receptions was gradually increased in order to find out the costs of a mixed model.

Figure 6.13 shows the number of vehicles needed to deliver the orders and the indexed average time per stop as a general cost driver. The most significant observation in this figure is that the number of vehicles needed increases rapidly as soon as attended reception is incorporated into the delivery process.

Even having 10% of the deliveries along the route attended will double the number of vehicles needed in comparison to totally unattended delivery.

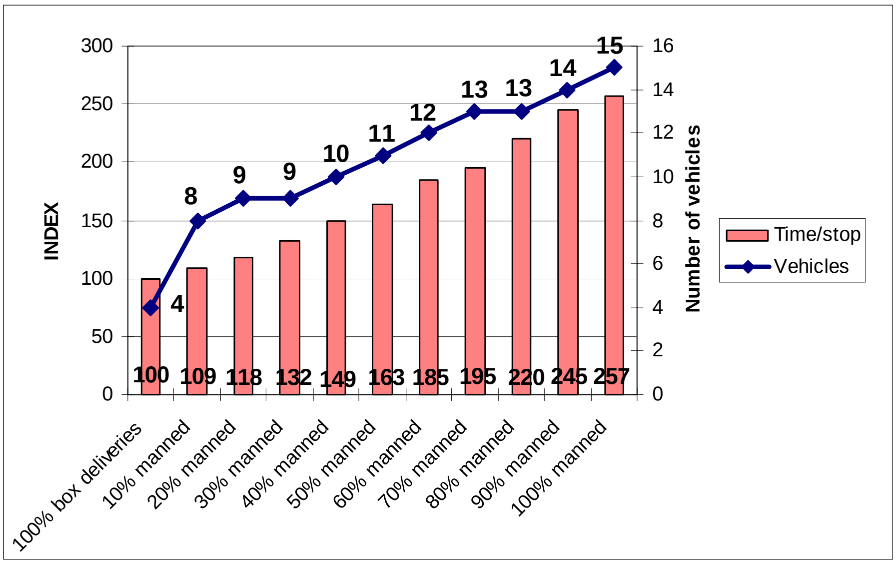

Figure 6.13 The average working time per stop and the number of vehicles needed (Punakivi & Saranen, 2001).

The curve in Figure 6.14 generalises the results by illustrating the additional portion of the home delivery transportation costs when various proportions of attended reception are incorporated into home delivery. This approach takes into account only the cost of the increased working time. In reality the growing number of vehicles will generate additional fixed costs per vehicle needed.

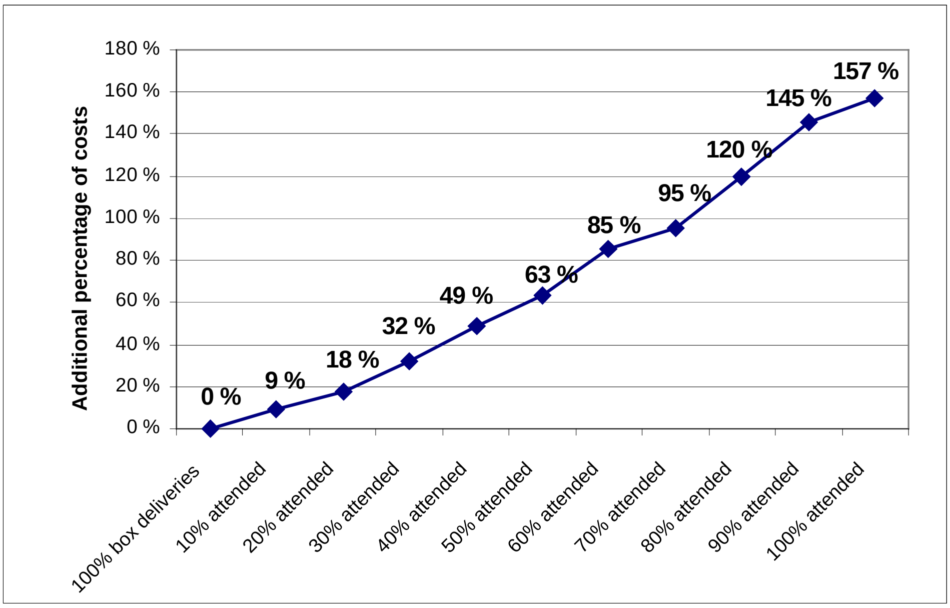

Figure 6.14 The additional percentage of costs when using attended reception.

The simulation results show that the cost of an attended delivery is 2.57 times the cost of an unattended one. This is a 157% additional cost or, on the other hand, a 61 percent cost-saving potential for a company making attended deliveries. Unfortunately, this cost-saving potential will need investments in order to be realised. The investments are discussed in the summary of this section, together with further ways to make unattended deliveries.

As a final point of the quantitative analyses it is pointed out that the costs presented in the previous two figures are average value costs. This means that the cost of unattended delivery will be higher if it is made in a mixed service model, because all deliveries are allocated the same portion of added cost. This does not give a fair comparison, because all added cost is due to the attended deliveries and the unattended should not be allocated any part of the increased cost. In Figure 6.15 the added cost is allocated to the attended stops only and the unattended stops cost the same (index 100) in all cases. The figure is based on the same data as the previous two and gives an activity-based costing of attended stops in a mixed delivery environment.

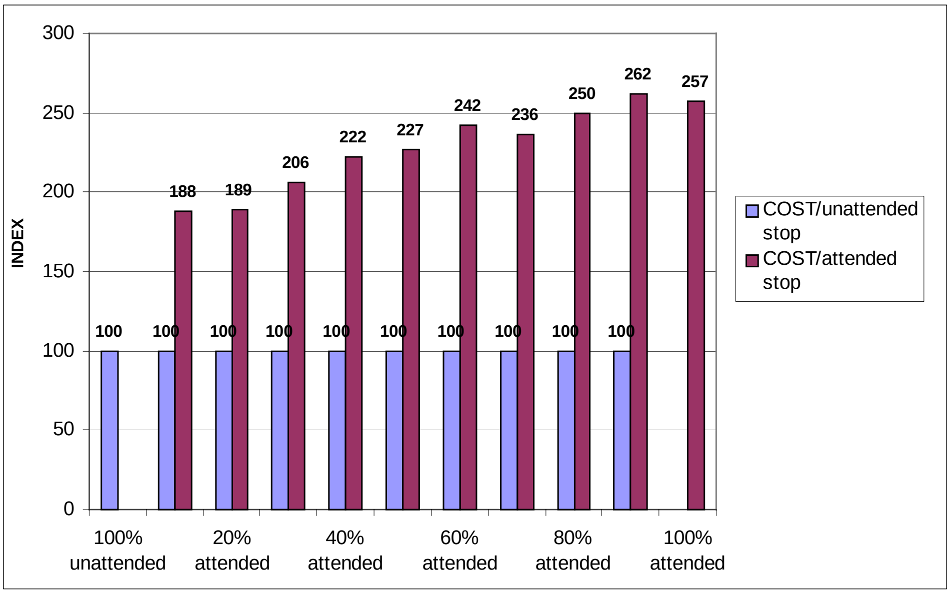

Figure 6.15 The costs of attended and unattended stops.

Even if an attended stop costs almost twice as much as an unattended one in the low proportion cases, it should be noted that it can be cheaper to mix attended deliveries in low quantities in a mostly unattended operation than to service attended routes separately.

6.2.3 Sensitivity to Drop Density

The first objective of the study was to find out the most efficient delivery operation and its costs and to be able to quantify the efficiency of different service models. The more general objective was to understand how the cost of home delivery reacts to drop density in order to find an answer to the research question.

To test the sensitivity of drop density, the shopping basket data was multiplied to selected “market share” projections in the test area. The delivery cost as a percentage of the value of the goods was calculated for these market share projections, using the most and least efficient service models. The factor most useful in explaining the cost of home delivery in the EGS business turned out to be sales per square kilometre (Yrjölä, 2001). The higher sales density, the lower the cost of home delivery. The critical threshold in our tests was 1 million Finnish Marks (€167,000) of annual sales per square kilometre, evenly spread over all 12 months of the year. Any increase in sales after that did not have a substantial effect on delivery efficiency. In other words, when the average distance between drops goes below 500 metres, any decrease in distance has very little effect on total costs. The cost structure of home delivery is shown in Figure 6.16 as a percentage of the value of the groceries.

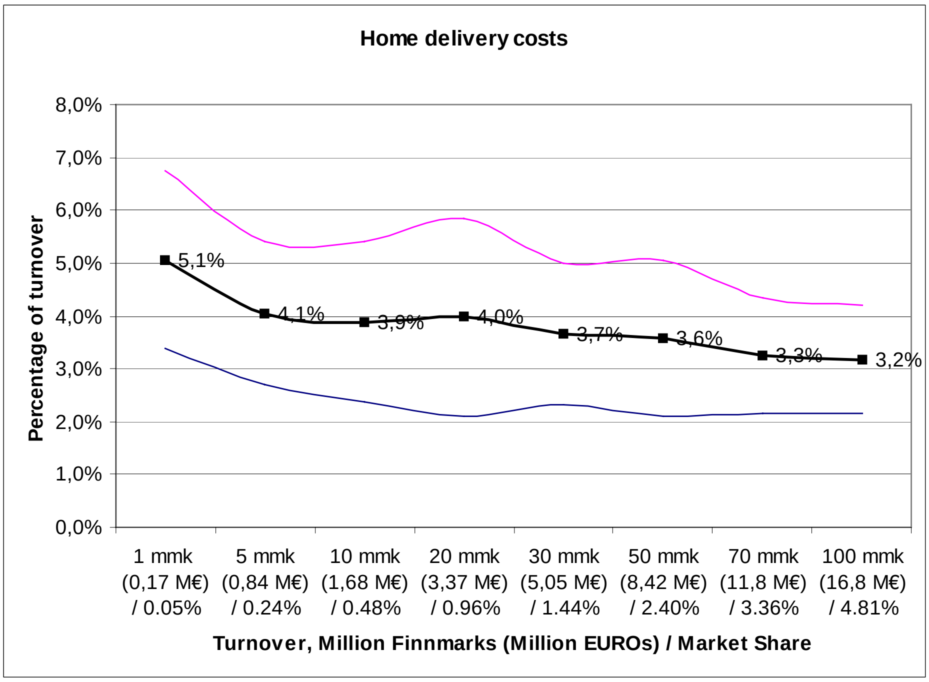

Figure 6.16 Home delivery cost structure. The cost structure of home delivery is shown as a percentage of the value of the groceries (Yrjölä, 2001).

The costs were calculated on the basis of simulated cases with an annual turnover of from 1 million Finnish marks up to 100 million marks (€0.17 million up to €16.8 million). The total annual consumption of grocery products in the simulation area is estimated at 2080 million marks (€350 million) on the basis of 195,000 inhabitants with an average annual consumption of 10,300 marks (€1734) per person (LTT, 1995). The market share percentages presented together with the annual turnover are based on these assumptions.

The lowest curve is the optimal case with the best service model, once-a-week unattended delivery. The upper curve is the cost of the most inefficient service model, next-day attended delivery with a one-hour time window. The possible limitations and restrictions of the Local Distribution Centre have not been taken into account in the simulation. Therefore, the average of these curves has been used to describe the expected delivery costs. It is expected that using the average will give a conservative estimate of the delivery costs. The various points of the curves come straight from individual simulation cases, which can be reconstructed and repeated. This is the reason for the slight accidental increase in costs in the middle section of the curve, against the general decreasing tendency. A detailed description of the computer model and the data used for the simulation is in appendix 3.

As a summary it can be argued that the results of the modelling give supporting evidence to the working hypotheses 2 and 3:

Hypothesis 2: The home delivery costs can be substantially lowered by unattended reception

Hypothesis 3: The home delivery cost is a function of geographical customer density

Additional Efficiency Measures

There are still other ways to make home delivery more efficient, with or without investment. Those are only discussed briefly here and more detailed studies are left for further research. First of all, if consumers do not need a “taxi” service for their groceries, a true “bus” alternative can be created to save everybody money. In the first business models the customer was always granted liberty to select their home delivery time window in the attended service model. According to studies made in the U.S. the density of population even in the larger cities is not sufficient to make this model work at low cost (Laseter et al, 2000).

In personal transportation consumers are happy to use a bus to save money without the luxury of being able to dictate the timetable of the service. Families with children normally have a weekly rhythm, with sporting activities and hobbies. Some evenings of the week it is practically impossible not to be around the home. This would provide the chance of offering a fixed-day(s) attended delivery service with optimised scheduled standard routes for families willing to commit themselves to receiving their groceries on a certain day/s of the week on a continuous basis. The operational cost of this kind of service is not likely to be far from that of unattended service. The best part of it is that there is no additional investment needed. Webvan actually tried a similar type of approach to lowering its distribution costs by offering dynamic delivery pricing. Customers placing an order paid a cheaper delivery charge if they accepted the same delivery window as another customer nearby with a delivery time confirmed earlier.

Even if unattended delivery needs investments it will not be necessary for the e-grocer to make them, as in the case of Streamline. Some employers in Finland have indicated an interest in creating an unattended reception facility for their employees at the office. This can be done, for example, with a shared reception locker system in the company’s car park. People ordering groceries will reserve a reception unit for the day of the delivery. The e-grocer will deliver at some suitable time of the day and the groceries travel home in the car of the employee at the normal time. There are several companies developing these reception solutions, such as Hollming in Finland and the large international appliance manufacturer Whirlpool. The employer can have two reasons to invest in reception facilities: firstly, part of the time saved by the employee can manifest itself as an additional amount or better quality of work. Secondly, companies need all kinds of groceries themselves and this provides a solution to the problem of how to shop for them. Sending somebody to a supermarket in Finland to do the shopping can easily cost much more than the groceries themselves.

Investment in unattended reception could, in the long run, be part of the cost of the home. If the reception equipment is in-built and opens to the inside as well as the outside, it can be seen as an additional fridge and freezer, not entirely used just for the purpose of receiving goods. However, even if these kinds of applications have already been put into practice, for example in the Netherlands (Siemens, 2001), it will be many years before the amount of homes equipped with built-in reception equipment is substantial. This is why investment in unattended reception has to be seen as a separate investment for the time being. The cost of a standalone single reception box varies from a starting price estimate of €500 (Whirlpool, 2000) to a true purchase price of €1,700 (Hollming, 2001) for a non-mass produced product. The price will presumably go down with possible mass production, but it looks likely that the investment in a single box will be in the range of €1000. If this cost is spread over an eight-year period, assuming €50 annually for electricity, the annual cost of the equipment is going to be €175. This is 2.8% of the grocery purchases per annum of a four-person household in Finland with 90 percent loyalty. When looking at the difference between the cost of attended and unattended delivery in Figure 6.16 we can see that with low customer density the investment is well-justified. However, when there is high drop density, the overall cost goes down, making the difference smaller so that the investment can be seen as questionable. However, the box will free families to receive their groceries and, in fact, maybe other merchandise bought over the Web, without having to be at home to wait for its delivery. How much value they will place on this, time will tell.

6.3 The cost structure of the whole supply chain

This section will discuss the cost structure of the entire supply chain, from the supplier up to the household, in an electronic grocery shopping environment. The change from supermarkets to a Local Distribution Centre will have implications for suppliers of groceries. These implications are discussed first. Then, the results presented earlier in this chapter are summarised and the costs of the EGS supply chain are presented in relation to the sales volumes. The efficiency indicators of the supermarket environment are compared to the EGS environment. Finally, new efficiency indicators are introduced for the new environment.

6.3.1 Implications for the middle and upstream of the supply chain

When the downstream operations of a supply chain are changed or extensively modified, there can be implications to the middle and upstream. If the change in downstream operations has a positive effect on the cost structure there might be modifications needed elsewhere in the chain that will have an adverse effect on the overall cost structure. This is why an additional research question needs to be answered: are the implications of a change in the downstream positive or negative for the middle and upstream?

The purpose of this section is to find evidence as to what implications the change from supermarket to local distribution centre in the grocery supply chain has on the costs of the middle and upstream of the chain. The only operational changes necessarily needed are changes in the manufacturing and primary distribution of Class A products. Class B and C products can be handled the way they are handled in the supermarket-based supply chain. It is possible that changes would also be made for these products in a large scale e-grocery environment. These changes, however, would be made voluntarily to make things more efficient, not because the changes would be necessary for an LDC based downstream to operate properly.

The reason why changes are necessary in the Class A product supply chain is the difference in the downstream process for them. Class A products are not stored in the LDC as they are in a store; they are only cross-docked on the basis of customer orders. Even if most Class A products are delivered directly from the supplier to the supermarket, the supermarket forms a reasonable buffer between supply and demand, keeping an inventory at least on the supermarket floor. When the supplies are based on customer orders, changes will definitely be needed. Are these changes going to reduce or add to the cost? The purpose of this section is not to quantify exactly any changes in cost structure. The aim is merely to find enough evidence to show the most likely direction. The data was collected by interviewing executives and managers concerned with the logistics, manufacturing and marketing of three different Class A product suppliers: a brewery, a dairy products manufacturer, and a meat packaging company. The findings and conclusions were presented to selected experts in the companies for confirmation. The methodological approach bears similarities to the case methodology (Eisenhart, 1989). By analysing cases the research is inductively finding new knowledge. The difference is that the purpose of the interviews here is just to find an answer to one question, not to build a theory as in the case research.

The details of expert interviewees, with their personal data and positions held, are in Appendix 4.

Breweries

The analysis of the impact of e-grocery on the brewery industry is mainly based on interviews with representatives of the two largest breweries in Finland, Hartwall and Sinebrychoff (Appendix 4). Furthermore, the potential changes and implications have been discussed with the members of the technical committee of the Brewery Union of Finland.

The total production volume of the brewery industry in Finland is close to 800 million litres per annum. Half of this volume, approximately 400 million litres per annum, is distributed through grocery retailers. This is 80 litres per capita and, for a four-person household, this means 320 litres per annum. The amount implies that the current structure of grocery retailing can be a limiting factor for the growth of the brewery industry, because the carrying capacity of a person is limited. This will be discussed later in Section 7.3, together with the areas for further research; the purpose here is to analyse the cost structure only.

The Finnish brewery industry is committed to common recyclable and reusable packaging standards and this policy is supported by the society in the form of taxation. ‘Package’ here means a bottle or a can. Using packages other than those approved in the common recycling system leads to an environmental tax of FIM 4 per litre (€0.67). The return rate of the packages is more than 90 percent (Panimoliitto, 2001), partly because of a deposit paid at the time of purchase. The deposit is paid back to the consumer when the packages are returned empty and intact. The normal place to which packages are returned today is a supermarket, which is compensated by the breweries with a handling fee. The empty packages are inserted into empty cases and loaded on to the brewery distribution truck when deliveries take place. The common returning system works for all member breweries, which means that a bottle can visit several breweries in its lifetime. The cans are crushed and pressed flat at the time of return and the material is recycled.

The recycling system has to be rebuilt in a larger-scale e-grocery environment. It might be that the best way is not to handle the empty packages at the LDC; the home delivery operator might be able to perform the handling more efficiently. However, it seems that the ready-for-loading cases of empty bottles should be stored at the LDC so as to be able to return them in conjunction with deliveries. It seemed to be difficult for the experts in the brewery industry to predict accurately how this issue should be solved in the long run. The new re-usable plastic bottles are gaining ground in the recycling system and they are much lighter in weight, too. On the other hand, there are substantial investments which have been made on the basis of the use of glass bottles. The system is not problem-free today as far as the supermarkets are concerned, and nor it is cheap. Whether the new system is going to be more expensive or cheaper is not clear. However, it seems that the investments that have to be made will have a negative impact on distribution costs. This will not offset the positive impacts but will make the overall efficiency improvement potential smaller.

The larger breweries transport their products all the way to the supermarkets with their own vehicle fleet. This distribution task extends to well inside the supermarket, because the drivers take the cases all the way to the supermarket floor. On top of this, in most supermarkets the drivers of the distribution trucks even put the bottles on to the shelves. On days when there is no delivery, merchandisers hired by the breweries go into the stores to organise shelves and floor areas carrying brewery products. The cost of this in-store work has been estimated to be in the range of 150 million marks per annum for the whole industry. This is approximately €25 million and does not include the unloading costs at the store. This in-store work will be eliminated for beverages that are only cross-docked on their way to the household. This will certainly make the overall impact positive from the distribution point of view.

Today’s order processing and dispatching systems are designed for deliveries to supermarkets and restaurants. The delivery time for an order is normally 48 hours. Shorter delivery times are not usually requested as a result of the fact that supermarkets normally have reasonable buffer inventories of brewery products on the supermarket floor. It is anticipated that an order fulfilment cycle of 24 hours will be required for the LDCs to be able to operate efficiently. This will require investments in order processing and picking procedures.

Sourcing and manufacturing will not be affected by the change in the downstream. Production planning might benefit from the better quality demand information, thus having a slight positive influence on overall operating costs. In summary, it looks as if the total impact of the change to LCDs would be slightly positive in terms of operational costs. The development requires investments, but, on the other hand, the in-store work will be eliminated. However, the experts in the industry believe that delivery all the way to the household can have a much greater impact on sales volumes when demand is not limited by the buyer's carrying capacity.

Dairy Industry

The dairy industry was studied by interviewing four executives and managers in logistics and general development positions (Appendix 4). They all work for Valio plc, Finland's leading producer of dairy products, with a market share of more than fifty percent in all dairy product categories. More than 70 percent of the milk produced commercially in Finland is processed further by Valio. Additionally, a workshop for the top management of the company was specially organised to study the potential implications e-grocery will have for the dairy products business. The twelve executives and managers attending represented the whole range of the company's operations.

The sourcing and actual manufacturing processes will not be affected by any possible change in the structure of the downstream. All the other functions of the company will have to adapt, at least slightly, to the change. However, all the adaptations have the potential to save costs, as described later. Furthermore, some of the dairy products have the same limitation as brewery products: the carrying capacity of the consumer. In addition to milk and milk-related products, Valio is one of the major producers of fruit juices, which makes this aspect even more important.

There are clear advantages in more accurate order-based operation as a result of more predictable demand in the e-grocery environment. The dairy companies are used to delivering in small time windows at short notice and even with small orders. Order processing and picking procedures are not likely to need extensive modifications. Customer demand-based operation will help production planning to match demand more accurately. Since some products can be stored for days or even weeks, a more constant demand will provide greater opportunities for the optimisation of production batch sizes and, in this way, reduce manufacturing costs.

There are two potentially major advantages seen in the e-grocery supply chain model: the packaging and distribution of small orders. Valio's current costs for packaging material alone come to €96 million (FIM 570 million) per annum. This is a major cost item for a company with a €1500 million turnover. Packaging is designed to remain intact through many handling processes in the supply chain up to the supermarket shelf. In addition, the packaging has to survive the non-professional picking process, cashier handling, and non-professional packing and transportation at an unregulated temperature to the final destination, the household refrigerator. Changing this to an all-professional two-step supply chain at correct temperatures in purpose-designed transportation totes gives more alternatives for packaging design and materials. It is impossible to quantify the potential savings exactly, but, according to the experts, savings of ten to twenty percent in packaging material costs could be achieved.

The other potential place for savings is the distribution of small orders. Valio has some 18,000 active customers to whom the company delivers with its own fleet. The fleet consists of refrigerated vehicles, from a minimum of 12 metric tons up to the maximum allowed weight. The 4200 grocery stores take two-thirds of total sales, the rest being accounted for by different kinds of “large kitchens”. The smallest customers are typically children’s day care centres with minimal delivery volumes. If the home delivery of groceries creates a temperature-regulated efficient delivery network, the smallest deliveries could potentially be outsourced to the operators of this network. Even without accurate calculations the experts see a substantial savings potential here.

The conclusions here are based on the operations of the market leader, Valio plc, and it should be noted that they are not fully compatible with other companies in the dairy industry. However, Valio alone represents well over half of the industry, and there are no signs that the rest of the industry in Finland would work very differently. More caution should be exercised when trying to apply these conclusions directly to other markets, especially to bigger markets with a large number of big companies.

Meat Industry

The meat industry in Finland has a clear market leader, Atria plc, with a 40 percent market share. The conclusions presented here are based on discussions with the logistics director of the company and the leading consultant of EP-Logistics (today integrated with Sysopen Plc), a logistics consulting company that has been helping Atria to build a new distribution centre as an extension to its main production plant.

The new centre handles approximately half a million kilos of meat per day. This amount consists of some 4000 orders, with an average of 8 order lines each. The average order has eight boxes, 5 full boxes and 3 picked ones. The picking is highly automated and fully paperless. 24 picking cells each have just one person picking up to 250 orders in one eight-hour shift. The customers are divided into service level classes (This has been done by Atria and is not connected to the division of products in categories in the hybrid model). For

Class A and Class B customers the orders are delivered next morning if the order is received by 3 p.m. The orders are normally built on pallets, which can be built to match the customer's shelf system so as to facilitate unpacking.

The transportation is outsourced and most of the distribution to the supermarkets is carried out by the retailing chains and consolidated with other products needing controlled temperatures. The company has 600 to 700 SKUs and almost all have to be kept optimally at a temperature between +0 and +2 degrees Celsius. The sales time for the products ranges from 3 to 10 days from delivery to the supermarket.

Atria's new logistics facility is compatible with an LDC-based downstream operation. The customer order-based deliveries can be built on pallets so that they are easy to unload straight to delivery totes heading to households. No further investments need to be made. But there is one big change that will affect the efficiency and profitability of the company: sales estimates. One of Atria's biggest problems today is forecasting demand. Every morning only a third of the orders for the following day are known. The rest will come in during the early afternoon, but these are not based on what households want to buy but on what the shopkeepers think they will be able to sell to their customers.

The change to an LDC-based downstream may have a slight positive impact on distribution costs, but a predictable stable expected demand could have a substantial impact on production planning. A normal household uses a selection of 200 SKUs (CLM, 2000) and the e-grocery of this household should be built to make ordering these items easiest. When the number of households grows, the predictability of what is going to be ordered grows until the demand is almost stable. This is due to the fact that e-grocery forces households to carry out forward planning. When demand signals come straight from consumers, they will not affected by commercial issues between the different players in the supply chain.

Again, it is impossible to put a monetary value on predictable demand for the meat industry, but this is not necessary for the purposes of this study. According to the experts, the cost savings could be up to ten percent. The meat industry is likely to benefit from the change from supermarkets to LDCs that operate on the basis of households' true demands.

Summary of the interviews and conclusions

To test the working hypothesis 4, the implications for the downstream chain have been collected in Table 6.17. The impact on costs in various functions in the companies studied are indicated with the following scale:

extremely negative impact	(---)
substantially negative impact	(--)
slightly negative impact	(-)
no impact	(+-)
slightly positive impact	(+)
substantially positive impact	(++)
extremely positive impact	(+++)

	Sourcing and production planning	Manufacturing	Packaging and dispatching	Distribution
Breweries	+-	+-	--	+++
Dairy industry	++	+-	++	+
Meat packaging	++	+-	+-	+
" AVERAGE"	+	+-	+-	++

TABLE 6.17 The implications of customer order-based operation for the middle and upstream operations of the supply chain

There are no extreme implications to the cost structure of these companies, but sourcing and production planning, as well as distribution, seem to benefit from the change. Manufacturing does not seem to undergo any changes and for after-production activities the dairy industry can identify some benefits. The brewery industry expects added costs in terms of investments in order processing and the handling of smaller orders.

However, even if there are implications that tend to increase costs, there are others that will offset the increase. Both by function and by industry the AVERAGE impact seems to be at least slightly positive. This is the basis on which we consider the evidence to give support to the working hypothesis 4:

Hypothesis 4: The operational costs of the first tier suppliers will not increase due to the change from supermarkets to local distribution centres with home delivery

The evidence is not very strong and the number of cases in the interviews was limited.

6.3.2 Comparison of EGS and Supermarket Retailing

The main hypothesis of this dissertation is as follows: e-grocery with home delivery can be more efficient than today's supermarket. To be able to test the hypothesis, first there are two research questions that need to be studied in order to gain an understanding of the various areas in which costs are borne. Changing the supermarket level in the supply chain to purpose built local distribution centres changes the cost structure in a way that is favourable to an e-grocery with larger sales volumes. This was discussed in detail in Section 6.1. The additional cost of home delivery is substantial with low customer densities, but with appropriate service models and higher customer densities the efficiency grows. It seems to be possible to achieve a feasible cost level for home delivery with reasonable sales volumes. This was the main point of Section 6.2.

To be able to cover the implications for the whole supply chain it has to be known whether e-grocery will have a negative or positive effect on the costs of the middle and upstream of the supply chain. The information that was collected by studying leading companies in three different food industries shows that there will be some additional costs to the suppliers if they are to be able to realise the benefits in downstream operations. However, the positive implications seem to at least offset the negative ones, making the overall effect positive. The methodology used is too weak to enable the implications to be quantified. The emphasis is on quantifying the costs of the e-grocery's downstream operations and obtaining reasonable evidence that efficiency gains there do not lead to decreased efficiency in upstream operations.

Figure 6.18 summarises the cost of the downstream operations of a dedicated electronic grocery shopping environment. Figures 6.6 and 6.16 present a bracket of costs for the objects of the first two research questions, LDC operations and home delivery. The bold line in the middle is the sum of averages of the optimistic and pessimistic curves in figures 6.6 and 6.16. The deviations of the optimistic and pessimistic scenarios from the average were halved and then summed up and form the dotted lines in the chart. The deviations from average were halved in order to eliminate the extremes in which all factors are either extremely optimistic or extremely pessimistic at the same time. This gives a reasonably likely estimate of the area where the total costs should be.

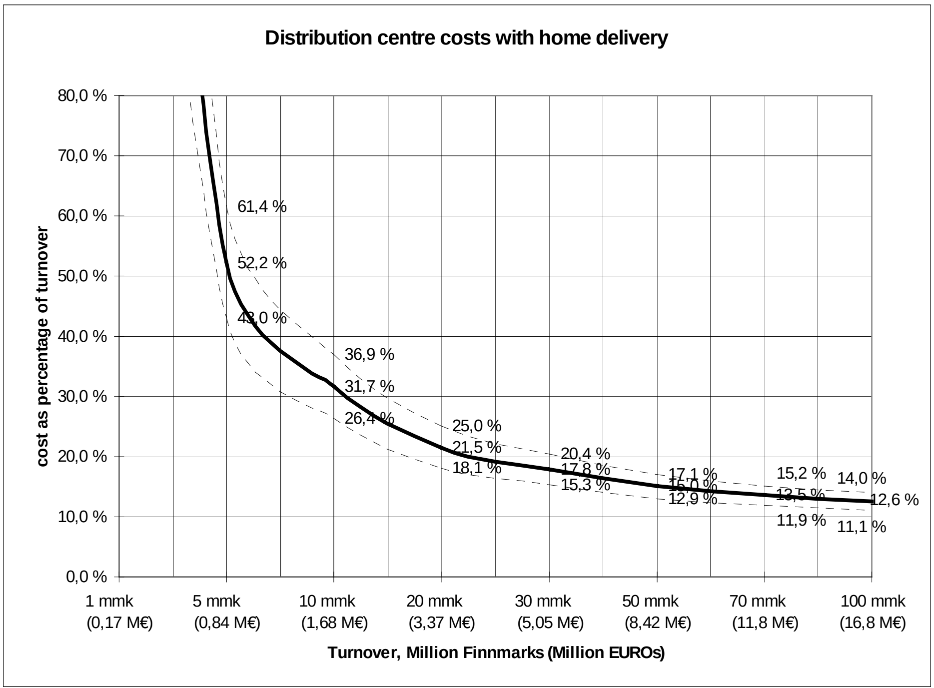

Figure 6.18 The EGS Downstream Cost Structure (Yrjölä, 2001)

The research findings agree with the figures presented by Streamline in Table 1.3. The operational downstream costs in a large scale EGS seem to be between 11 and 14 percent of the value of goods, compared to the 13 presented by Streamline. It is not known if the 13 percent was intended to include the cost of the reception boxes that were installed at the household. On the other hand, the USD 30 monthly service fee charged additionally to the customer (Kämäräinen et al, 2001b) is not included in the figures either. A logical assumption would be that the service fee should cover the cost of the reception box and the once-a-week delivery or part of the cost of that. The monthly cost estimate made here in Section 6.2 was €175 per annum, which is €15 per month.

The comparisons with supermarkets are made using average costs. Can the economy of scale of a supermarket make this comparison incorrect? On the basis of the trends and figures in grocery retailing presented at the very beginning on pages 7 and 8, it can be argued that the economy of scale has already developed as much as it can. Retailers can state that supermarkets can be made even more efficient. The counter argument is, that decreasing the number of stores, increasing the size of the outlets, and decreasing the number of personnel at this point of time is supply chain sub-optimisation. If the costs on the retailer's side are decreased, they will not disappear, they will be paid by the consumers.

There are over 100,000 consumers in the province of Uusimaa (an area with some 1.3 million people, including Helsinki) today without any grocery shop within a distance of two kilometres. At the same time, over one hundred grocery shops are in the process of being closed down in Helsinki alone (Salmela, 2002). The larger shops, however, offer greater product range and more opportunity to one-stop shopping, which can reduce the number of shopping trips. On the other hand, visiting these larger outlets without a car is usually difficult.

When the distance to the supermarket grows, the cost of travelling and shopping and travelling time will increase. The number of grocery stores in the Helsinki metropolitan area is estimated to be likely to decrease from some 1,100 in 1985 down to less than 400 by 2005. This will require more consumers to use private cars to shop for groceries and, for those using a car already, driving distances are showing a tendency to grow. The cost of the time spent shopping will not materialise for a normal consumer and makes it problematic to use as an argument. On the basis of a recent study, the cost of one shopping visit made by a municipal home nurse for the elderly is over €13. The value of the groceries bought during one visit is, on average, €10 (Salmela, 2002).

The key efficiency indicators for supermarkets are sales per store area and sales per store employee. The research findings suggest that EGS should be measured using new indicators. The efficiency of EGS is based on other factors than the efficiency of supermarkets. At the LDC efficiency grows when sales volume grows. The most important factor of the LDC efficiency seems to be the picking speed, which can be measured by sales per employee. Space efficiency will lose importance, because the cost of space will be lowered considerably. This is due to cheaper space unit price and better space efficiency. The outlets can be placed in much cheaper premises and the sales per square metre will be more than double compared to supermarkets (Matomera, 1999).

Sales volume will not automatically increase the efficiency of home delivery. The sales density combined with the service model, are the key drivers of efficiency. Even with reasonably large sales volumes, efficiency can be destroyed by poor drop density or by a service model that forces the delivery vehicle to drive continuously from one end of the distribution area to the other to meet the promised time windows.

The research findings suggest that EGS should be measured with new performance indicators: sales per LDC and sales per geographical area. Sales per LDC describes the potential to increase the picking speed in the LDC with investments and full-time utilisation, thus increasing efficiency. A picking speed of 450 order lines per hour will not make an LDC efficient if it is used for only two hours a day (Kämäräinen et al, 2001a). The sales per square metre in an LDC can naturally still be used as performance indicator, but it will not be very important. The LDC can be placed in areas where space can be hired with low cost and the size of the outlet can be more flexible, because there are no visiting consumer, that have to be taken into account.

Sales per geographical area (square kilometre or square mile) gives an overall indication of the efficiency potential for an EGS business in a certain area. Even if sales per LDC are sufficient, the geographical distribution area has to be small enough to enable efficient home delivery.

In the modelling the shopping baskets were delivered to households situated within a geographical area of 60 square kilometres. Figure 6.18 suggests that 40 million marks' worth (€6,7 million) of annual sales to the households in these 60 square kilometres leads to 17 percent overall operating costs, the same as a typical supermarket in the United States (Table 1.3). The cost structure of supermarket retailing varies from market to market, but as discussed earlier in section 6.1.2, the differences seem not to be very large. If the turnover in that area is over 60 million marks (€10 million), equalling 1 million marks (€168,000) sales per square kilometre, it is likely that a dedicated EGS is more efficient than a supermarket, because the upper dotted line describing the more conservative cost estimate is also below 17 percent.

However, this is based on the assumption that the supermarket-level marketing costs, estimated to be 2 percent of the value of the goods, will disappear in the LDC-based supply chain. It seems clear that the LDC itself will not have marketing costs. But it is safe to assume that these marketing costs are going to exist on the corporate level. These marketing costs could be somewhat lower than in the supermarket environment, because there is no need for local advertisement. On the other hand, there is likely to be some added cost related to web development and maintenance.

Considering all above, the comparable cost percentage should be very near 15, as discussed in Section 6.1. This cost level is achieved at sales worth FIM 50 million (€8.4 million) with the average curve and FIM 75 million (€12.6 million) with the pessimistic scenario. Since the pessimistic scenario can most likely be achieved without unattended reception, the cost of unattended reception will not have to be taken into account. When taking marketing costs into consideration, the sales level per square kilometre at which e-grocery is likely to be more efficient becomes FIM 1.25 million. In new currencies this gives an easier-to-remember rule of thumb: if grocery sales are more than €200,000 per square kilometre per annum, it is highly likely that delivering the groceries from an LDC to the household will be cheaper than running a supermarket.

On the basis of the testing and finding support to the four working hypotheses the research findings are supportive to the main hypothesis:

Main Hypothesis: e-grocery with home delivery can be more efficient than supermarket retailing handling a similar volume of sales.

This appears to be the case even if in direct comparison consumers support the supermarkets financially by doing the picking work and taking up the cost of the "last mile". The difference is not big and it requires forward planning and a new attitude from the consumer's side. This is not likely to persuade all consumers to change their shopping habits overnight. Furthermore, the initial analysis gave evidence that there can be additional cost-saving potential in the middle and upstream of the supply chain. Finally, at least some consumers are likely to notice sooner or later that shopping is not free of cost and not always fun. Some consumers might be willing to pay extra for the service. All this suggests that sooner or later there will be an e-grocery market.

The success of TESCO in the UK shows that supermarket-based e-grocery can be made profitably. Furthermore, there is hardly going to be a single channel retailing in the future, store or e-grocery. The conclusion made here suggests, that a dedicated e-grocery is a viable option. If there is enough demand, it is possible to build a dedicated service to complement the other service options. Which of these service options or channels will have the biggest market share is hard to predict. Consumers and quality of the services will eventually decide the development.

EGS has other positive aspects that need to be further researched. The EGS supply chain takes care of the “last mile” more efficiently than consumers, requiring far fewer miles to be driven. Initial research shows that EGS can reduce urban private car traffic and have a favourable environmental impact (Punakivi & Holmström, 2001). Another aspect that needs further research is EGS combined with recycling. That is another area with a potentially positive environmental impact. Most of the findings in this research suggest that speeding up the development of EGS should be seriously considered. This means changing the current supply chain of groceries and delivering goods directly to their final destination: to the household.

7 Validity and reliability

This chapter will discuss the validity and reliability of the results of this dissertation. When building models of industrial or economic systems one can learn quickly and at reasonably low cost answers that are seldom obtainable from trials conducted on real organisations (Forrester, 1961). The controlled laboratory experiment is a powerful tool - when used properly. The results given by models do not come from a real working system and one should adopt a critical attitude when generalising them or using them as the basis for real-life actions.

Validity includes both construct validity and external validity. Construct validity means setting correct measures for the concepts that are researched. External validity means the ability to generalise the results of the research. Both are referenced when discussing the limitations of the modelling in detail. Finally, the general validity is summarised in 7.2, together with assessment of the reliability of the results.

7.1 Limitations of the modelling

According to Forrester, the model should come first and then what form of data needs to be collected should be determined. Thus, the limitations of the models constructed will be discussed first. Then the parameters and data collected and used to produce the quantitative results are analysed.

7.1.1 Models

The starting point of the construction of the LDC was benchmarking several known operations and then combining this information with the local expertise of the S-Group. The validity of the construction was reviewed by experts from one commercial organisation only. This means that the construction could have limitations regarding its external validity, especially on an international level.

The middle stream transportation of grocery products varies slightly from company to company. The differences between different countries might be much bigger. Thus, applying the results to other markets should be preceded by careful assessments of the model's validity for the market in question.

There is one known defect in construct validity in the LCD model. The model does not take into consideration possible workload peaks in picking. This does not affect the results in operation with unattended delivery, because the time windows are usually large enough to give flexibility to the picking operation. The results with larger volumes with unattended delivery do not take into account possible workload peaks resulting from the consolidation of delivery time windows.

The home delivery model is based on a selected geographical area, presented in the form of its digital map, and the different service models were simulated with a route optimisation tool. A limitation that might affect the results and their external validity is that the simulations covered one geographical area only. This means that the results might be different with another area, even one with the same density of population. The influence of the nature of the road network was not researched. The total area was 135 square kilometres, but because of the suburban nature of the area there are large areas of forest and parkland. The number of square kilometres with actual deliveries was counted as only 60 on the map. In order to be conservative, a figure of 60 square kilometres was used in the calculations.

The time and travel costs of the consumer have not been taken into account in any of the cost comparisons between the supermarket and e-grocery. However, in the home delivery cost simulations the potential consumer time and travel costs are presented to give an indication of the costs involved. These cost predictions do not take into consideration that shopping trips can be combined with other trips, thus making the allocation of cost to shopping lower. In the statistical analysis of shopping habits in the introduction, the mileage driven and time spent travelling and shopping the effect of combining shopping trips has been eliminated.

7.1.2 Parameters

Some parameters were based on facts such as the salaries of warehouse workers and facility rent. Some parameters used to calculate the cost structure were selected to represent best estimates. All the parameters were reviewed by experts from the retailing business, namely the S-Group. Furthermore, the pilot operation with the S-group gave some benchmark to certain parameters, such as unattended drop time. This contributed towards better construct validity, but the parameters should be assessed for different markets so as to take into account the specific circumstances of the market in question. The drop time for both attended and unattended drop in Finland was set at two minutes, because an attended home delivery in Finland very seldom leads to any social conversion. For example, in the U.K. an attended drop might take up to ten minutes and the shopping basket might be checked item by item with the delivery person waiting (Retail Logistics Task Force, 2001a).

7.1.3 Data

The shopping basket data from the S-group included 1639 shopping baskets with a value of €25 or more. After the shopping baskets had been analysed in detail, this limit appeared to eliminate casual visits to the store from the data set. To be able to construct a data set that better represents the purchasing behaviour of a loyal EGS customer, all the purchases of a household should be consolidated. In the current store-based grocery retailing environment the only source from which this kind of data could be obtained is the household.

The selection of data diminishes the construct validity of the research. Using selected supermarket based shopping data for analysing the cost structure of the e-grocery will not give an accurate picture of the electronic shopping environment. The reason for using the data from conventional stores is due to the fact, that the available e-grocery was too small to be used for the quantitative analyses. In the larger volume analyses, however, the statistics of average grocery purchases per household member are used. In those analyses the role of the shopping basket data is only to give geographical location information, which is exact at the level of accuracy the simulation model operates at.

7.2 Empirical Testing of the Model

This section will discuss the validity and reliability of the research in order to evaluate the quality of this research.

The limitations discussed in the preceding section reduce the construct validity of the research. This is why the results are presented as an area of cost instead of exact figures. Multiple sources of information have been used to improve the construct validity. The data, parameters, and finally the results have been benchmarked to all available data on similar operations (Appendix 4).

A pilot operation with 50 households was started in the area, where the simulations were made of. This was based on unattended delivery with reception boxes at households. The distribution simulation model results were compared to the real distribution case with a delivery route optimised by the model. The driving times and drop times were measured by Mikko Punakivi with a stopwatch in the delivery van in November 2001. The results were compared to the respective figures given by the model. The pilot results agreed with the model figures so accurately that there was no reason to make any adjustments either to the model or to its parameters. Even if the comparison was made with a small amount of deliveries, it is argued that the construct validity of the home delivery model is at a satisfactory level.

The pilot operation picking was done in a store, so there was no possibility for direct comparison of the picking speed, the most essential parameter of the LDC operation. The picking speed measured at the store matched the figures of other similar operations of 100 order lines per hour. The picking speed used as a parameter for the LDC was 170 (pessimistic) to 230 (optimistic) order lines per hour, based on five picking hours in an eight-hour working day. This was based on a speed of 200 order lines per hour, measured by Matomera in Sweden in their purpose-built LDC without automation. On the basis of this it is argued that the construct validity of the LDC research is sufficient to present the quantitative results with the margin of error given by the optimistic and pessimistic sets of parameters.

The middle and upstream analysis is methodologically weak. Thus, presenting any quantitative results based on this part of the research is impossible. However, the construct validity of this case study was improved by interviewing several executives or experts from all three companies and then presenting the analysis to other experts for reference (Appendix 4). It is argued that the construct validity of the case interview-based analyses is sufficient for the conclusions presented in Chapter 4 to be capable of being drawn.

The grocery market is compact and the country is homogeneous. All the grocery chains operate nationwide and the nature of the road network and landscape is similar throughout the country. The density of population varies very much, most of the population is in the south making the northern part of the country almost inhabitant in European terms. Taking this difference in density of population into account it is argued that the findings can be generalised to the whole grocery market of Finland in the current market situation. However, the competition from other European countries is trying to gain foothold in Finland, but it is too early to tell, if this is going to have any substantial effect on the market situation. The results are not directly applicable to any other markets, as a consequence of the differences between grocery retailing in different market areas. However, the research methodology, together with the findings and efficiency indicators, establishes a model for research in other markets using local parameters. Being able to relate the findings to the literature increases their external validity. On this basis it is argued that the external validity of the research is satisfactory.

There are various types of geographical statistics available in Finland. The population, number of households, household income and numerous other facts are collected on 500 metres by 500 metres squares nation wide. This data could be used to estimate the potential cost level at which electronic grocery shopping can be built in different geographical areas. The nature of the road network, size, density and buying power of the households could be used to determine the potential market for the new service. This is a vast area of further research, which will require assessing the links between household income and grocery consumption as well as identifying the parameters for a typical EGS customer.

Reliability means that the results of the research will be the same if the research is repeated. Furthermore, the reliability is increased if the results can be verified with empirical evidence. The models used in this research for the distribution and LDC operations are likely to give the same results if the study is repeated. The empirical evidence given by the piloting supports the research findings, even if the amount of households in the pilot study is small.

The reliability of the study based on interviews is the least satisfactory, because the results are formed from opinions that are not directly supported by any quantitative analysis. The reliability has been improved by letting another set of experts review the analyses made on the basis of interviews with different experts. For example, the cost of waste disposal was underestimated in the first analysis of the Local Distribution Centre and corrected after a review by supermarket retailing specialists. Quantitative estimates of possible changes in cost structure were made by some experts but they have neither been used nor presented in this dissertation. For example, the saving in packaging material costs was estimate to be 10 to 20 percent in dairy industry, but these kind of quantitative analyses are left for further research. It is argued that the conclusions in Chapter Four are reliable at the level of accuracy at which they have been presented.

In summary, it is pointed out that there are weaknesses in the construct validity and external validity as well as in the reliability of this research. However, these weaknesses need to be accepted, because of the fact that the area of research is new and there is very limited data available. It is argued that the general validity and reliability of this dissertation are sufficient for the results to be presented in the form in which they have been presented.

8 Conclusions and Further Research

This chapter will summarise the research contribution of this dissertation and discuss further the structural options for an electronic grocery shopping service. One of the major reasons for not starting to build the services in Finland is the high investment and high risk involved. The structural options will emphasise the possibilities of creating an efficient service at a lower investment level, thus making the service economically feasible for a wider range of customers in a country with a very low density of population. Finally, this chapter will discuss directions for further research, which will extend from pure EGS to electronic commerce in general and specialty merchandise.

8.1 Summary of Results

This section will summarise the research findings and evaluate the research contribution of this dissertation. Furthermore, it will relate the results and findings to the body of knowledge by comparing the results and findings to the existing literature. Finally, the following section will discuss the wider potential implications of the research findings for society and the environment.

The most important research findings of this dissertation are:

The operational costs of a Local Distribution Centre can be lower than the operational costs of a supermarket.

This seems to be true with sales volumes of more than €3 million, even with less than optimal operation. However, the LDC has to be purpose-built for shopping basket assembly and have a reasonably stable workload so as to avoid unnecessarily high resource allocation that has been measured to be able to cope with demand peaks.

Home delivery can be made efficient with a moderate market share

There seems to be a possibility of achieving real economy of scale in home delivery, but not with the service models used by the early practitioners. If the consumer is at liberty to decide the delivery time, the production cost of the service is going to be high, even with high customer density. With service models that give flexibility in route planning and optimisation, the service can be provided efficiently, even with a moderate market share. The pricing strategy of the EGS company can be used to direct the consumers to choose service models that will lead to efficient home delivery operation.

Costs in the middle and upstream of the supply chain will not increase as a result of changing supermarkets to Local Distribution Centres

A Local Distribution Centre with home delivery cannot work efficiently without consolidating the customer orders of the logistically largest product groups into direct overnight orders to suppliers. This will require investments in better and more detailed order handling and fulfilment in some food industries, such as breweries. However, there are many positive aspects, for instance increased demand predictability and cost reductions in deliveries, which will more than offset the negative aspects. The middle and upstream of the grocery supply chain have the potential to make cost savings in the chain structure.

Electronic grocery shopping with home delivery can be made cheaper to operate than supermarket retailing handling a similar volume of sales

On the basis of the three earlier findings, the main finding of this dissertation is that electronic grocery shopping with home delivery service can be made more efficient than today’s supermarkets. This requires a restructuring of the supply chain and, most importantly, consumer co-operation. A service that is efficient from the consumer’s point of view cannot be created without the consumer’s co-operation. The service requires loyalty, forward planning, and delivery times optimised by the service provider, not dictated by the customer on impulse. With more than €200,000 worth of annual sales per square kilometre a Local Distribution Centre-based home delivery service seems to have the potential to become more cost-effective than running supermarkets. This comparison takes into account only the direct running costs of the store and not the fact that the consumers come to the supermarkets to pick and pack their groceries and pay for the cost of home delivery themselves. Stable grocery delivery activity with unattended optimised routes with annual sales of €200,000 can be achieved with 25 four-person households per square kilometre purchasing 90 percent of their groceries from the service.

New efficiency indicators will be needed to measure electronic grocery shopping

In addition to the results and findings gained from studying the research questions the study gave a better understanding of the inherent characteristics of electronic grocery shopping. On the basis of this understanding it is suggested that the EGS environment should be measured with new performance indicators. The indicators used for the store-based supply chain, sales per store area and sales per employee, will not work well in the EGS supply chain. Sales per Local Distribution Centre and sales per square kilometre appear to be much better ways of characterising the efficiency potential of the service. As discussed earlier the sales per LDC floor space will loose importance and total sales per outlet will better characterise the efficiency. These indicators will show better which home delivery service models can be used and what cost level can be achieved in different geographical areas.

When comparing the results to earlier literature, they are very different from what has been published before. This is by no means to be understood as suggesting that the findings of earlier research are wrong. The main reason is that the earlier research did not look at EGS as a purpose-built supply chain from suppliers to households. The findings of this dissertation support the view of Kalakota (1997), who suggests that retailers are re-evaluating every aspect of their operations, from customer service to advertising, merchandising to store design, and logistics to order fulfilment. The difference is that in grocery retailing there is no sign of this kind of general activity. However, the findings suggest that it should be happening in order to create more efficient services.

Macht (1996) estimates that electronic grocery shopping might capture more than 20 percent of the total market in the USA. The findings clearly support this and even more. However, it seems to be a much slower process than the early practitioners anticipated. The development will not happen without customers changing their shopping habits and this change will be slow. This supports the opinion of the Forrester research expert (Dagher, 1998). However, it has to be noted that the most active grocery buyers are families with children. This means that the biggest markets for the new type of service are consumers from the age of 25 to maybe 50. This group of people will automatically and completely be replaced every 25 years.

The findings are not in conflict with the analysis of Laseter et al (2000), even if the service models analysed by them are not recommended as a basis for electronic grocery shopping. When analysing the commercial dot com home delivery services they have realised that some of the services will never be profitable, regardless of customer density. The companies are claiming that the service will become profitable with a larger number of customers. This dissertation supports their finding, that providing home delivery efficiently at very low cost is not possible with occasional customers randomly controlling the production parameters of the service.

This research partly supports Ring and Tigert’s (2001) analysis of early practitioners. They are of the opinion that the line between Internet retailers and brick-and-mortar retailers will disappear and customers will be served the way they desire. It appears logical that the current grocery retailers are in the best position to create the new services, but the supply chain in efficient EGS retailing must be different from that of a grocery store-based operation. Furthermore, the costs of picking and home delivery quoted by Ring and Tigert are very far from the cost structure presented on the basis of this research.

The statement of Rosen and Howard (2000) that "the online grocery sales model is intuitively questionable" seems to be very true for the early pure play Internet grocers and their service models. It also shows how the limited research published has been concentrating on the operations of the early practitioners and especially the mistakes they have made. However, it should not be understood from this that electronic grocery shopping is a 'mission impossible'. The research findings of this dissertation have links to much earlier general supply chain-related research.

The findings of Fisher (1997) suggest that demand characteristics are important when deciding the structure of a supply chain for a certain product. In the EGS environment this appears to be very important for a well-functioning and efficient operation. On the other hand, by reducing time delays in the flow of information and goods (Stalk, 1998), it is possible to lower inventory levels and improve overall efficiency (Levy, 1997). Efficiency in the EGS environment is based on direct demand information from consumers that is immediately available to all parties in the supply chain. This information is not distorted by intermediaries who will modify it on the basis of their own estimates of real demand. Furthermore, demand forecasting possibilities improve with a shorter supply chain.

All this can be related to the analyses of Forrester (1961) and Burbidge (1989) and, further, to Lee et al (1997) and Towill (1991), showing that distortion in the information flow in any supply chain causes higher inventory, larger production capacity requirements, and other inefficiencies in the supply chain. When we compare the store-based multi-level supply chain to the EGS environment, this inefficiency can be seen. The store-based supply chain creates much less value than EGS by only having the groceries available for consumers to pick and deliver at their own cost. When the information flow is direct and without distortion it is possible to build a supply chain all the way to households at the same cost or one less than is the case with a store-based operation.

Wider potential implications

The research findings suggest that with certain conditions in place it could be cheaper to deliver groceries directly to people's homes instead of running supermarkets. Changes in the supply chain of groceries in this way, however, will happen slowly, if at all. As has been discussed earlier in the research philosophy section, the research results of applied science are not necessarily carried out in practice, even if they were to support changing the way something is done. In addition to this, grocery retailers who have made heavy investments in current structure and building a new, parallel but separate supply chain, might not be attracted despite the potential cost benefit.

Tesco’s example in the United Kingdom shows that electronic grocery shopping will gain at least some of the market share. This gives a reason to explore the potential wider implications of large scale EGS. We have identified three areas where direct implications are likely: legislation, the environment and employment. Further implications will follow indirectly in transportation systems and perhaps the increased personal free time will have wider implications than expected. These implications are discussed in this section in order to identify other areas which are also outside engineering sciences that have potential for further research in this field.

Legislators are expected to have some difficulties in adjusting to trade made on an electronic basis. This area was identified in early stages of the Intertrade project and a study under the title “Legal Issues of Electronic Grocery Shopping” was initiated by the project group. This study was made by Ms. Miia

Maunula from the Law School of the University of Helsinki and was later expanded to a Master’s Thesis in 2000.

The findings of this study clearly confirmed that there are numerous areas of legislation that have to be adjusted to keep them up to date with the new trading environment. The policy for returns and cancellations of orders in consumer legislation includes some references to perishable products, but they are not clear enough to be able to govern the electronic grocery shopping environment without problems. Instead of returns of perishable products the legislation should perhaps start defining more practical approaches such as policies that allow for compensation. Achieving sufficient consumer protection does not necessarily mean a completely new set of laws, indeed some companies have started self regulation in those areas where the Internet has brought change. This self regulation with the concomitant adoption of generally accepted operating principles could be at least a temporary solution.

The other area of legislation that is very important are the regulations in respect of hygiene and preservation temperatures. There are very strict regulations for the in store and transportation operations of groceries. The home delivery distribution and reception and delivery boxes that enable unattended reception are not well covered in these provisions. The responsibility issues in particular can be very complicated. For example, in a situation where the reception box has a power failure and all frozen products melt before they are removed from the box by the consumer. Furthermore, building regulations do not necessarily have provisions for reception boxes and in some cases might be unclear as to who is in a position to give permission for installation.

The study tried to cover the general provisions in the legislation that potentially need to be modified and did not try to find extreme examples of what might happen. The general conclusion of the study was that while there are difficulties in the current legislation the problems should not be exaggerated. The legislation covers some of the problem areas well and with a degree of interpretation most situations can be handled reasonably. The companies offering services in this field should take their responsibilities seriously and make operating policies that cover the holes in the legislation.

The other area where EGS could have wider implications is the environment. The author and other research group members attended a two step survey study of the dematerialization potential of EGS made by Anna Kärnä at the Department of Management of the Helsinki School of Economics. The study was based on two step interviews of 40 people believed to be experts in the area of EGS, as well as the published research work, including Intertrade. It will be published as a part of the research report Heiskanen, E., Halme, M., Jalas, M., Kärnä, A. & Lovio, R.: *Dematerialization: the potential of ICT and services*. Forthcoming in the publication series the Finnish Environment, the Ministry of the Environment.

According to this study EGS will not significantly reduce the materials or energy consumed in grocery shopping and deliveries as long as the scale of electronic grocery shopping remains small. The @ Your Home report (Retail Logistics Task Force, 2001b) by the Foresight Retail Logistics Task Force in the United Kingdom estimates that home shopping in general seems to have a tendency to increase packaging and paper use, especially in deliveries of small single items. There is no separate comment for groceries, but according to the report delivering several items at the same time will help to reduce packaging requirements. This is normally the case in grocery home delivery. The report also points out that the need to build new fulfilment centres will lead to more energy use, which is also likely to be the case for groceries. EGS will have both direct as well as indirect effects on the environment, but both are still very difficult to quantify, except in terms of what could potentially be best or worst case scenarios. More research will be needed before, for example, the impact on consumer behaviour and consumption habits, or on retail trade structure, can be evaluated.

Some of the direct effects of EGS on traffic can already be identified. Simulations have shown that replacing car trips to supermarkets by centralised home deliveries can lead to considerable savings in mileage, energy use and emissions. These results are a side product of the home delivery simulations in the Intertrade project (Punakivi et Holmström, 2001). National Economic Research Associates support these calculations by forecasting that electronic home shopping will reduce car travel in the UK by 5 % by 2005 and 10 % by 2010 (NERA, 2000). This would only require an addition of 0.25% by 2005 and 0.5% by 2010 to delivery vehicle traffic. In the Netherlands there are fears that home delivery will replace shopping trips carried out by foot or bicycle, thus increasing delivery vehicle traffic without a decreasing effect on car travel (Transport en Logistiek Nederland, 2000). The research estimates a 17 % increase in road vehicle traffic in case online sales reach 11.5% share of all retail sales by 2005. In the grocery home shopping it is important to find out the future shopping patterns to be able to see the impact on road traffic. What proportion of consumers will purchase all groceries on line and what is the proportion of consumers that use the on line service only for heavy and bulky products, while shopping all the rest in person (Retail Logistics Task Force, 2001b).

When operative models of EGS in order processing, delivery and reception become more established and the business volume grows other effects will become more visible. It seems that EGS could lead to reduced warehousing needs and more co-ordinated traffic flows with higher volumes. The reduction potential in energy use is easier to estimate than the impacts of EGS on material use. This includes issues such as how EGS influences product packaging and spoilage.

According to Kärnä: “When estimating the net environmental impacts due to EGS, *the indirect effects of EGS adoption become even more significant than the way in which the EGS shopping process is organized.* These indirect effects include, among other things, how many regular users EGS will attract (the penetration rate), to what extent it replaces traditional grocery shopping, and what kind of other activities it potentially substitutes or generates (such as impacts on recreational traffic). It is time to start focusing more research on these impact-creating mechanisms before EGS becomes an everyday activity."

The employment aspect has been a very sensitive issue in all technological changes in society. EGS in this sense appears to be more good news than bad, if widely adopted. The results of the Intertrade research project include the calculations for potential implications in employment as a side product. The proportion of labour costs in a traditional grocery store was estimated by analysing five medium size supermarkets of the S-group. The proportion was calculated as percentage of sales without administration and management costs. This was compared to the proportion of labour cost in a Local Distribution Centre, which varies depending on the efficiency of the LDC (see attachment 3). The comparison suggested that in the EGS environment the labour cost addition is from 0.1 up to 2.4 percent of the sales. A high degree of automation would naturally affect these figures. Handling groceries seems to be very difficult to automate. If it were easier, there would probably be much more automation in grocery stores today.

Home delivery will additionally increase the need for labour. The home delivery cost with a large customer base and high drop density will be from 2 up to 4 percent of the sales, depending on the service model. Unattended reception will result in a decrease in distribution costs. Based on Statistics Finland, the proportion of labour costs in small truck and van transportation was 59 percent in April 2002. This means that the labour need for distribution is roughly 1.2 up to 2.4 percent of the sales.

If EGS were to gain a 30 percent market share, the value of the additional labour needed for it would be from 1.3 up to 4.8 percent of the sales. From annual total sales of €10 billion in Finland this would mean an extra work cost of between €39 million and €144 million annually (with an annual total cost of employees of €20,000). The number of extra employees would be from 2,000 up to 7,200. The purpose of this exercise is not to make an accurate prediction of the number of extra jobs created potentially by EGS. It is merely to show the scale of the implications.

The valuation of personal time is going to be critical for the growth of electronic grocery shopping. One can make calculation after calculation about how EGS is cheaper than shopping in a supermarket based on different valuations. These calculations are not likely to convince consumers of the benefits of the new service. The results show that it is possible in certain circumstances to create a service which is cheaper than running an average supermarket, but the difference is not very big. The savings are hardly going to be sufficient to enable EGS operators to offer much cheaper prices to the extent that pricing alone could be used to attract new customers. The valuation of the personal time of the customers by the customers themselves will be the most important issue when trying to assess the potential and growth of the market share of the electronic channel.

People in the USA are prepared to pay USD 1.50 for a saving of 15 minutes in travelling time (Hogarty, 2000). This valuation of USD 6 per hour for personal time would convert to an annual cost of grocery shopping of € 1,200 to €1,500 for an average household, depending on the amount of direct travelling cost involved. This is approximately 200 hours in time, four to five full weeks of work. A rational reaction from consumers would be to start to use the new services immediately and even be prepared to pay for them. However, the issue is not that simple. Consumers do not like change and take up for the use of the new services will require a major change in everyday life. Another issue that makes the start of the new service more difficult is the complexity of grocery shopping. Choosing between a slow road with traffic lights and a fast toll road is easy. Learning to shop for groceries online will take time and effort. On the other hand, creating a user interface that makes shopping easy and convenient will take time and effort, too. The facts seem to suggest that EGS with home delivery is eventually going to gain a substantial market share. It may be a long and slow process and the valuation of personal time will become a more important issue when the services have been developed sufficiently to really give substantial time savings for home shoppers.

EGS will have wide implications if it succeeds and grows, winning a market share from traditional grocery retailing. It is difficult to make accurate predictions of the size of the implications at the bottom line. As mentioned in chapter 6 the cost of one shopping visit made by a municipal home nurse for the elderly is over €13. The value of the groceries bought during one visit is, on average, €10 (Salmela, 2002). This is just the monetary side of the transaction. When analysing the working time of the municipal home nurse, approximately half of the working time was spent on grocery shopping. If the groceries were home delivered it would not necessarily save money, because the saved time would be used to the actual home care and social contact with the disabled or elderly. This way the benefits of EGS would materialise as improved quality of home nursing (Tuunainen, 1999).

There are many more parameters other than monetary ones that can be used to judge the nature of the implications. Is the potentially increased personal free time going to produce happier families, spending more time together and enjoying a better quality of life in a cleaner environment? It can also be argued that EGS will create unhappy people losing their last social contact with other people by eliminating grocery shopping. It seems unlikely that one of these extremes will happen. If EGS attracts enough consumers to reach large scale profitability, there will be changes in the transportation infrastructure and also to the current grocery supply chain. However, most likely it will become an additional channel for some consumers, while stores remain as the alternative way of shopping for groceries. The social inclusion of home shopping has also been pointed out as an important aspect in the research in the UK

8.2 Feasibility and growth potential of e-grocery in Finland

This section will discuss the alternatives that Finnish grocery retailers have concerning EGS. The different options for building new services are compared and some guidelines are given as to how the research results can be used. Unfortunately, there is no knowledge of current consumer expectations that could be used as a basis for assessing the potential market for EGS services and their growth. The best way to make any market predictions is maybe to look at the development of the market in the UK (Retail Logistics Task Force, 2001b).

As discussed at the very beginning, the Finnish grocery market is divided between four companies, and it is believed to be a reasonably stable market. Hostile market penetration by a complete outsider seems to be difficult. Because of the market's small size, the investments that are sensible for this kind of operation are limited. Lidl is currently trying to penetrate the market with its special business model, which is based on selling cheaply whatever it is able to buy cheaply, whenever it is able to do so, without any guarantees of availability. This kind of special business model might work and take a share of the market, but for a full service retailer market entry would probably be more logical through the acquisition of one of the existing players. This gives the grocery retailers the luxury of being able to go slowly with development and to avoid big risks – or do nothing at all for a long time.

As discussed in Section 2.1, EGS seems to be a slow-developing business. The market develops slowly, but unfortunately learning how to operate the new services is a slow process, too. It has taken Tesco (Business Week, 2001) some five years to learn how to pick from a store. Even if part of the information is publicly available, it does not seem possible to copy the operational capabilities overnight. If it were easy there would be others having copied Tesco's EGS operation by now and making profits, too.

If the learning process is as long as seems to be the case with EGS, it makes sense to start practising sooner rather than later. It does not necessarily mean losing a lot of money. In a steady market like Finland EGS can be practised with a very limited geographical scope without too much worry about the reactions of the competition. As shown in the home distribution analyses, EGS is a very local business and trying to create a nation wide service straight away would not be advisable. A store based picking provides a possibility to much faster roll-out across the country as seen in Tesco's case. The LDC based approach is slower and needs a lot of investments. Whatever service model is targeted, it should first be made to work in a fairly compact geographical area and then copied to new areas. This has been Tesco's strategy, too (Business Week, 2001).

The initial studies and analysis of EGS with direct home delivery give us positive signals that the Hybrid Model could also be a platform for gradual low-risk growth for EGS. When we look at trade-off figures given out by Streamline, stating that 1600 households is the minimum for one local distribution centre to break even (Macht, 1996), we really would like to find alternative solutions for full-service EGS. It might well be that the Hybrid Model is not able to give cost structure figures as lucrative as a fully dedicated EGS supply chain. The Hybrid Model will most likely lower the break-even number of households served by one centre. If the number of households needed for profitable operation can be considerably lowered, the Hybrid Model will serve as a low-risk evolutionary model for the starting of EGS by current traders in addition to the store based picking model. The Hybrid Model might also be suitable for smaller cities, where a large-scale store is needed for the low price image and the number of households interested in EGS is not sufficient to justify a dedicated outlet.

The other alternative is to concentrate marketing efforts on a limited geographical area with a high population density and get the necessary amount of households to use the service. The amount of loyal households needed for an operation to be as efficient as a supermarket ranges from 1400 up to 2100.

The household numbers are based on four-member households with annual purchases worth €6000 (90 percent loyalty) and the average and pessimistic scenarios presented in Section 6.3.2. It is most likely that this approach will require investment and time and effort, but it is has the best growth rate potential should the market start growing rapidly.

The other aspect that needs consideration is the service models for home delivery. Attended delivery does not need large investments but the value to the customer is usually lower. Investments in the possibility of unattended delivery can be made by several parties. Some customers are willing to invest in the unattended delivery infrastructure themselves, especially when building a new house, where an inbuilt reception box with two-way doors can efficiently be used as an additional fridge and freezer in the household. However, it will take many years until these customers are in the majority. The other options are collective reception locker systems in office buildings or residential areas. Discussions with some Finnish business executives seem to indicate that there is some willingness in companies to make their employees' lives easier by providing the reception infrastructure, for example, in the office building car park.

One option for financing the reception lockers is somebody making a business out of it. By sharing the cost between several e-grocers and e-tailers of general and specialty merchandise there might be the possibility of creating a similar system as banks have done with their cash dispensers. The banks started with proprietary machines but soon realised that these were not a means of competing as everybody had them. So they created a company to administer and maintain the network with transaction-based earning logic. It is possible that there are some aspects of this development that are worth copying.

Unattended delivery will give flexibility and lower cost to the home delivery operation. In addition it will give more flexibility to the picking activity. This has not been quantified in this dissertation and will be a matter for further research to study. However, even with high customer density and a good picking solution, one could end up in trouble if the customers can freely control the production of the service. This happens if the service is completely based on customer-given time windows for delivery. That will lead to accumulations in order picking and home delivery which will lead to an increased need for transportation capacity, as shown in Section 6.2. Furthermore, the resources at the picking facility have to be arranged so as to cope with the peak work loads, leading to additional costs.

If there are not enough unattended reception facilities there are still other ways to create the same flexibility with attended delivery. EGS is a loyalty business and must be based on frequent customers (Tanskanen et al, 2002). There are two service models that work almost as well as unattended reception from the service provider's point of view. The first example is fixed routes with single scheduled drops. This service model resembles a bus route. The route is fixed and there is an approximate schedule for each drop. The exact time can vary as a result of the amount of stops, the weather, and traffic. The other example is the van sales service model of a company selling ice cream directly to households. The van has a fixed route with scheduled stops in places with easy access to numerous households, such as in front of a block of flats or in the middle of a housing area. The van signals that it has arrived and households wishing to buy ice cream buy it directly from the van driver. Some people might be happy with this type of delivery if it can be arranged at low cost.

One important aspect of home delivery is that there should be no administration included in the delivery procedure. EGS is very hard to create on the basis of casual customers, so payment for goods should be made separate from their delivery. In this respect EGS resembles electricity supply or rubbish collection. The customer does not pay for every single transaction; there is a monthly or quarterly charge for services rendered. This requires that the customer has a credit arrangement with the service provider. If the service provider does not want to have a credit risk, this can be handled with advance payment.

Tanskanen et al (2002) have summarised the lessons learned during the three years of this research project and those six pieces of advice can be used as guidelines on the way to a profitable EGS.

1. Focus on customer density and build operative systems locally – copy and paste the working system to make it big.

2. e-grocery is loyalty business – build and maintain trust.

3. The buying power should be at least as strong as the supermarkets have.

4. Take care of operational efficiency and provide a high service level – utilise reception boxes and start with a store-based service – switch to a hybrid model and build dedicated fulfilment centres when the local business volume justifies it.

5. A good ordering interface and the availability of product information are basic requirements – eDemand and eCategory management are powerful new opportunities.

6. Enlarge the product range you offer to include high margin non-grocery items when an effective logistics system to households has been built and there is a base of loyal customers.

Following these pieces of advice is no guarantee for automatic success but it will prevent the making of the same costly mistakes that most of the early practitioners have made.

The other important aspect when trying to implement the new EGS service is the nature of the residential area. It seems to be impossible to use the same service model for all types of residential areas. Additionally, there will be areas where the new services will be very difficult to create due to low population density. Figure 8.1 illustrates the estimated feasibility of the basic alternatives for the service model in different residential areas. The residential areas in the five categories can be taken to be representative of most areas in Finland. It is believed that the density of the population and the nature of the residential area are more important for the feasibility of the services than the buying power of the households. Groceries are necessities, especially for households with children. Further, the net income of the household does not directly correlate with the amount of money used for grocery purchases.

Service model	Type of residential area: City centre	Urban	Suburban	Rural village	Rural
Attended, time window	+-	+-	+-	+-	-
Reception box, customer specific	+-	+	++	+	-
Shared reception box, Multiple units	++	+	+	+	+-
Attended, fixed routes	-	+-	+	++	+

++	feasible
+	feasible with reservations
+-	possible, but expensive
-	not likely

Figure 8.1 The feasibility of different service models by type of residential area

In city centres the only feasible service model is thought to be the unattended delivery to shared reception boxes. The density of population is high and a reasonable business volume can be created with a moderate market share. Home delivery, however, will be difficult without reception facilities. Traffic, limited parking facilities and high-rise housing make the attended reception options expensive and unreliable. The shared reception facilities will need investment and space, which may not necessarily be available in old houses. One option to service the city centre population is to have the shared reception facilities at the place of work.

The difference between urban and suburban areas is in the nature of the housing. What is meant by suburban area here is an area of mostly small houses, where households have direct access to the ground level. Urban areas mainly have larger buildings, with tens of flats sharing the same access to the ground level. Suburban areas have more flexibility in arranging different types of reception for deliveries. Furthermore, access to the households and parking is easier. Even when the density of population is higher in urban areas, the difficulties related to reception of deliveries will make most service models less feasible. Over time new houses being built in urban areas could have inbuilt reception facilities, which will make the service more feasible. Unfortunately, it could take tens of years for enough houses to be built to make any real difference.

Rural villages have a reasonable local density of population situated in the middle of the countryside. The nature of the housing is comparable to suburban areas, but the total number of households is smaller. This would require a much larger market share to reach the same efficiency for services such as those in suburban areas. An option for these areas could be the time tabled fixed routes service, but household co-operation and flexibility would be required to make it work efficiently. A negative aspect of the EGS services in this type of residential area would be that it could make supermarkets disappear completely, thus making the services for some people very limited. Using a hybrid model would remove this disadvantage.

Finally, it seems that there are very limited possibilities for creating any EGS services with the same cost levels as in other areas in rural areas with a very low density of population. The most feasible solution seems to be a copy of the shop-in-the-bus concept that is already widely used in these areas. There are rarely any stores or supermarkets in these areas, so grocery shopping requires a long trip to the store or a lot of flexibility. A delivery vehicle making scheduled stops once or twice a week in rural areas delivering ordered groceries to pre-set places could be reasonably efficient. The deliveries would not be made all the way up to the people’s homes, but they would, nonetheless, be much nearer than the nearest store. The advantage of the local collection points would be distribution efficiency, which could keep the prices of groceries down even in the areas of very low density of population. The disadvantage is the co-operation needed from the consumer’s side.

To conclude, it can be summarised that a reasonably sized area with a large density of population will create the best environment in which to create EGS services in the near future. With time, the difficulties in delivering to areas with a very high population density can be overcome with investments in reception facilities. In areas with a very low density of population the opportunities to create this new type of service will be limited. They will require either a high willingness to pay for the service, or a high degree of flexibility and co-operation.

8.3 Directions for further research

The purpose of this section is to identify areas for further research. The research project has been long and extensive, but the area for research is new and complicated. Even if this research has been able to quantify the main cost elements of EGS with certain accuracy, another important contribution has been enhancing the understanding of the inherent characteristics of EGS as a new system (Forrester, 1961) and how its efficiency could be measured.

There are numerous areas for future research in the area of EGS; those suggested here are most closely linked to logistics. The Retail Logistics Task

Force in the UK has summarised the extent to which existing research and literature provide information on various home delivery subjects and characteristics. The report presents an extensive list of research priorities (Retail Logistics Task Force, 2001b). Because of the lack of relevant literature and the novelty of the research area, this section should be considered partly as a summary of the author's opinions, which are based only on four years of personal involvement in the research project. Five areas for future research will be discussed in more detail: home delivery, the Local Distribution Centre, the implications for suppliers, consolidation with other merchandise, and the user interface.

Home delivery and reception models. This research has been able to quantify the differences between attended and unattended delivery service models in their simplest form. New potential reception models have been introduced at the idea level but in order to be able to quantify the cost implications new research will be needed. The most interesting models are shared facilities. It appears likely that making more drops at one stop will reduce distribution costs considerably. How much reduction can be expected and what kind of investments can be justified on its basis? Furthermore, reception facilities have been introduced inbuilt into new homes (Siemens, 2001). What kind of applications can be built to multi-family houses? Is an intelligent lift with refrigerated boxes, working, for example, on the paternoster principle, feasible for multi-storey houses with dozens of apartments?

Attended delivery will be a quick alternative when starting a home delivery service because it will not require investment. Are there further ways of making it more efficient? How much cost saving would the service models presented in Section 6.2 create in comparison to other service models? Are there other models that will be even more efficient and still acceptable to a sufficient amount of consumers?

Local distribution centre efficiency. This research has constructed one model of a local distribution centre on the basis of best practice from the early practitioners and general warehousing theories. The construction uses very little automation and is based on low investment. With larger volumes investment will probably make the centre more efficient but it is not just a question of picking speed. The pay-back on investments made purely to increase picking speed has already been researched by Kämäräinen et al (2001a). A question that needs more attention in further research is the interconnection between picking and home delivery.

This research has not taken into consideration the possibility that bottlenecks in picking might increase the costs of home delivery. On the other hand, home delivery capacity problems increase the need to store assembled shopping baskets at the LDC and, at a certain point, start adding to the cost of the picking procedures. When volumes increase and investment in increased picking speed becomes financially justified, the controlling of picking and home delivery might become a problem. It might be that the home delivery should control the picking and not the other way around. This area should be further researched, at least on the level where one can see the nature of problems to be expected. Without a working environment there might be too many parameters to be guessed at to really give any reliable evidence, but even a small LDC could give useful data to provide a basis for this research.

Implications for suppliers. This research includes a small case study on the implications of downstream changes for suppliers and middle stream distribution. However, the purpose of the case study was only to find evidence of the direction of the implications, not to quantify them. The study revealed significant potential opportunities for change, for example in the operation of the dairy and brewery industries. For both industries the question of packaging is going to be a big issue in the future. In addition to cost implications, a substantial environmental impact is also possible. A preliminary study of this has been made by Kärnä at the Helsinki School of Economics Department of Management (Heiskanen, 2002).

The change to LDCs with home delivery in the downstream will gradually have an impact on most of the activities of the suppliers of the logistically most intensive products. It appears from the pilot data that the changes will also affect demand and demand characteristics. The potential changes and their cost and other implications should be further researched by industry in order to be able to quantify their impact. Furthermore, the distribution of products from industry to LDCs and large direct customers could be made more efficient by outsourcing all distribution on a smaller-than-truckload scale. Small direct customer deliveries could potentially be made by the home delivery operators. The larger direct deliveries could perhaps be consolidated with other product deliveries.

The implications for suppliers and the middle stream distribution represent a large area of research and the suppliers should exercise caution when assessing new long-term investments. The research could bring at least some understanding of the implications of the potential changes, thus helping to avoid bad investment decisions.

Consolidation with other merchandise. The home delivery of groceries on a larger scale will create a new logistical infrastructure (Yrjölä, 2000). That, especially when combined with unattended reception infrastructure at the household, will be a logistical stream that could potentially serve as a carrier of other merchandise purchased over the Internet. What is the density of customers needed to create a market in which the consolidation of all home deliveries would create savings? This would probably include the traditional mail, as well.

This maybe slightly futuristic research should not be limited to logistical streams from suppliers to households. The consolidation could include other small deliveries, especially in urban areas, such as office supplies, local courier services, local business mail, and so on. The decisions made in community planning have an impact on businesses and the residential environment for many years. Long-term plans should take into account possible changes in urban logistical streams.

User Interface. Electronic commerce started by being very much technology-driven. The first-phase dot com companies offered the possibility of ordering over the Internet, thinking it created added value for the consumer. Some of the companies invested in creating a website that really offered some added value in comparison to catalogue sales by showing the products in 3D, such as BOO.COM, or other features not possible in print media. Unfortunately, the technology as a whole did not work properly. The telecommunication infrastructure of most users does not allow for complicated websites with extensive graphic capabilities, simply because of low data transfer speed. Furthermore, most sites were (and still are) so difficult to use that an average consumer had difficulties in buying products (Vaalisto, 2001).

The development of the user interface should start from user needs. The need for communication and spending time on a website should be minimised, not maximised. The user interface of an EGS service should take into account the fact that most products should not be ordered. The purchase, or rather supply, decision can be made for the time being and the flow of products can be controlled, if necessary, with very simple user interfaces. The user interface is probably the hardest area to research, because consumers have no way of knowing what they will want in the future. Thus, asking them will not help in this case. The possible development will include trial and error, piloting, creating added value services, testing and improving them, adding and reducing technology, and so on.

In the development of and further research into EGS there are two findings in this dissertation that summarise it and can work as a general roadmap to the future:

Electronic grocery shopping is not a supermarket in digital form – it is a completely new supply chain for groceries from the supplier all the way to the final destination, the household – **and it is possible!**

9 Appendices

Appendix 1 The Grocery retailing in Finland

K-Group is the market leader with turnover of 35 629 million FIM (EUR 6 000 million) in 1998. The share of groceries was 52,2 % (EUR 3 100 million). The K-group dominates the grocery market with a market share of 38,2 % of the total grocery market (Kesko,1999; A C Nielsen,1999).

S-Group is a co-operative retail chain with a regional and national organisation. The total retail business of the S-Group in 1998 was 31 444 million FIM (EUR 5 300 million). The share of groceries was 46,9 % thereof (EUR 2 500 million) (SOK, 1999).

The procurement has been organised as a joint venture with a competitor Tradeka. Inex Partners Oy is owned half and half owned by both organisations and all grocery procurement is done jointly (SOK, 1999). The shareholders agreement is valid until year 2007 (Nurmi, 1996).

Tradeka and **Elanto** are joint owners of most of their grocery retailing. They can be seen as one interest group in the market. The grocery sales of retail chains and stores owned by Tradeka and Elanto in 1998 was 6 836 million FIM (EUR 1 150 million) (Tradeka, 1999; Elanto, 1999; A C Nielsen 1999).

Elanto and Tradeka have concentrated their procurement to Inex Partners, fifty percent owned by Tradeka.

Spar is the largest consortium of independent retailers in the world. Spar Finland plc’s majority shareholder is Axfood AB, belonging to the Swedish Axel Johnson Group. Axfood AB has 40 per cent of the shares and 66 per cent of the votes of Spar Finland plc. Axfood AB is one of the largest food retail companies in the Nordic countries and listed on the Stockholm Stock Exchange.

The grocery sales in year 1998 was 5 861 million FIM (EUR 1 000 million).

Spar Finland is a co-owner of Tuko Logistics Oy, formerly TukoSpar Oy. The other owners are Wihuri Oy (44 %), Oy Stockmann Ab (14 %) ja Heinon tukku Oy (7 %).

Wihuri Oy's grocery chain Ruokamarkkinat Oy is the largest privately held grocery retailer in the Finnish market. The retailing is organised in two store brands, Ruokavarasto and Eurospar. In year 1998 the value of sales was 2 660 million FIM (EUR 450 million) (A C Nielsen 1999; Wihuri 1999). In November 1999 the Sesto grocery chain owned by Stockmann plc was sold to Wihuri (Tiilikainen 1999).

Stockmann plc continues grocery retailing in its department stores. The combined grocery volume of the Sesto chain and departments store sales in 1998 was 1 606 million FIM (EUR 270 million) (Stockmann 1999; A C Nielsen 1999).

Table 9.1 shows that S-Group has grown and become a major player in the grocery retailing with K-Group (Kesko). These two together hold over 60 percent market share. Even if there has been concentration in the market the disintegretion of Tuko (T-group) has changed the competition setting by increasing the market shares of the smaller players.

Table 9.1 Market shares by interest groups 1980-1998 (A C Nielsen 1999)

Group	1980 MFIM %	1985 MFIM %	1990 MFIM %	1996 MFIM %	1997 MFIM %	1998 MFIM %
K-Group	8019 37.8	14256 39.8	19599 40.5	20615 39.6	20498 38.1	21427 38.2
T-Group	4141 19.5	7706 21.5	11505 23.8	10227 19.6		
Spar				6249 12.0	6077 11.3	5861 10.5
Wihuri				2674 5.1	2790 5.2	2660 4.7
Stockmann				1462 2.8	1496 2.8	1606 2.9
S-Group	4234 19.9	6286 17.5	7719 15.9	12129 23.3	13486 25.1	14729 26.3
Tradeka	3045 14.3	4630 12.9	5357 11.1	6362 12.2	6721 12.5	6836 12.2
Elanto	Incl.in Tradeka	Incl. in Tradeka	1614 3.3	Incl. in Tradeka	Incl. in Tradeka	Incl. in Tradeka
Others	1790 8.5	2983 8.3	2632 5.4	2782 5.3	2728 5.1	2891 5.2

Appendix 2 Limited price comparison of the Finnish e-grocers

Prices as at 8.-15.11.1999 (Ruokavarasto,1999; Y-Halli, 1999; Ruokanet, 1999; Eurospar, 1999)

SUPPEA VERTAILU OSTOSKORIEN KESKEN ILMAN KULJETUSTA

TUOTE	KPL	RUOKAVARASTO	Y-HALLI	RUOKANET	EUROSPAR
VALIO Kevytmaito 1,5 L	2	5,93	5,90	6,75	4,30
HK PRINSSINNAKKI	1	15,90	16,90	16,90	15,90
Broilerin rintaleike 1 kg	1	26,90	29,90	38,43	29,90
Flora 400 g	1	6,50	6,90	8,20	6,90
Emmental punal. 1 kg	0,4	49,90	52,90	62,40	44,90
Kurkku (ulkom.) 1 kg	0,5	12,98	9,90	9,80	23,90
Tomaatti (ulkom.) 1 kg	0,5	14,90	13,90	14,46	9,90
Jälkiuunileipä 300 g	1	4,90	6,50	7,10	4,95
Kananmunat 10 kpl	1	7,67	8,90	9,60	6,90
Juhla-Mokka kahvi 500 g	1	16,90	17,90	20,90	14,90
		162,48	169,60	194,54	162,45
Indeksi		**100,00**	**104,39**	**114,71**	**99,98**
Kuljetettuna		108,21	112,59	125,89	112,29

TUOTE	KPL	RUOKAVARASTO	Y-HALLI	RUOKANET	
VALIO Kevytmaito 1,5 L	2	11,85	11,80	13,50	8,60
HK PRINSSINNAKKI	1	15,90	16,90	16,90	15,90
Broilerin rintaleike 1 kg	1	26,90	29,90	38,43	29,90
Flora 400 g	1	6,50	6,90	8,20	6,90
Emmental punal. 1 kg	0,4	19,96	21,16	24,96	17,96
Kurkku (ulkom.) 1 kg	0,5	6,49	4,95	4,90	11,95
Tomaatti (ulkom.) 1 kg	0,5	7,45	6,95	7,23	4,95
Jälkiuunileipä 300 g	1	4,90	6,50	7,10	4,95
Kananmunat 10 kpl	1	7,67	8,90	9,60	6,90
Juhla-Mokka kahvi 500 g	1	16,90	17,90	20,90	14,90
		124,52	131,86	151,72	122,91
Indeksi		**100,00**	**105,89**	**115,06**	**98,71**
Kuljetettuna (1/4 osa kertakulj.)		108,03	113,93	127,87	110,75

Appendix 3 Parameters, benchmarks and model details

Cost Analysis for the LDC:	maximum values	minimum values
Premises:		
Floor space	1 200 m2	1 200 m
Rental cost	120 FIM/m2/month	35 FIM/m2/month
	€20.17	€5.88
Total rent per annum	€290,420	€84,706
Cost of equipment:		
Refrigerating equipment	€70,588	€70,588
(40 m2 frozen, 200 m2 cooled)		
Shelves		
(250m*300mk/m)		
(200m*2000mk/m)		
including installation	€100,840	€72,269
Warehouse management and other systems:		
	€760,336	€478,992
Total equipment and systems:	€931,765	€621,849
(5 year amortisation)	€186,353	€124,370
Cost of labour:		
Salary and personnel costs	€2,521	€2,521
(per month and per person)		

Picking speed, order lines per hour	170	230
Efficient picking time per person per day	5	5
Average price of order line	€1.68	€1.68
Working days per year	250	250

Pessimistic scenario curve points

Estimated sales	**1 000 000**	**mk/year**	172,8 %	rent as % of sales
lines to pick	100 000	order lines	110,9 %	equipment as % of sales
lines to pick per day	400	lines per day		
personnel needed	0,5	persons		
personnel cost per month	7 059	FIM		
personnel cost per year	84 706	FIM	Total:	
% of sales	8,5 %		**292,2 %**	

Estimated sales	**5 000 000**	**mk/year**	34,6 %	rent as % of sales
lines to pick	500 000	order lines	22,2 %	equipment as % of sales
lines to pick per day	2 000	lines per day		
personnel needed	2,4	persons		
personnel cost per month	35 294	FIM		
personnel cost per year	423 529	FIM	Total:	
% of sales	8,5 %		**65,2 %**	

Estimated sales	**10 000 000**	**mk/year**	17,3 %	rent as % of sales
lines to pick	1 000 000	order lines	11,1 %	equipment as % of sales
lines to pick per day	4 000	lines per day		
personnel needed	4,7	persons		
personnel cost per month	70 588	FIM		
personnel cost per year	847 059	FIM	Total:	
% of sales	8,5 %		**36,8 %**	

Estimated sales	**20 000 000**	**mk/year**	8,6 %	rent as % of sales
lines to pick	2 000 000	order lines	5,5 %	equipment as % of sales
lines to pick per day	8 000	lines per day		
personnel needed	9,4	persons		
personnel cost per month	141 176	FIM		
personnel cost per year	1 694 118	FIM	Total:	
% of sales	8,5 %		**22,7 %**	

Estimated sales	**30 000 000**	**mk/year**	5,8 %	rent as % of sales
lines to pick	3 000 000	order lines	3,7 %	equipment as % of sales
lines to pick per day	12 000	lines per day		
personnel needed	14,1	persons		
personnel cost per month	211 765	FIM		
personnel cost per year	2 541 176	FIM	Total:	
% of sales	8,5 %		**17,9 %**	

Estimated sales	**50 000 000**	**mk/year**	3,5 %	rent as % of sales
lines to pick	5 000 000	order lines	2,2 %	equipment as % of sales
lines to pick per day	20 000	lines per day		
personnel needed	23,5	persons		
personnel cost per month	352 941	FIM		
personnel cost per year	4 235 294	FIM	Total:	
% of sales	8,5 %		**14,1 %**	

Estimated sales	**70 000 000**	**mk/year**	2,5 %	rent as % of sales
lines to pick	7 000 000	order lines	1,6 %	equipment as % of sales
lines to pick per day	28 000	lines per day		
personnel needed	32,9	persons		
personnel cost per month	494 118	FIM		
personnel cost per year	5 929 412	FIM	Total:	
% of sales	8,5 %		**12,5 %**	

Estimated sales	**100 000 000**	**mk/year**	1,7 %	rent as % of sales
lines to pick	10 000 000	order lines	1,1 %	equipment as % of sales
lines to pick per day	40 000	lines per day		
personnel needed	47,1	persons		
personnel cost per month	705 882	FIM		
personnel cost per year	8 470 588	FIM	Total:	
% of sales	8,5 %		**11,3 %**	

Optimistic scenario curve points

Estimated sales	**1 000 000**	**mk/year**	50,4 %	rent as % of sales
lines to pick	100 000	order lines	74,0 %	equipment as % of sales
lines to pick per day	400	lines per day		
personnel needed	0,3	persons		
personnel cost per month	5 217	FIM		
personnel cost per year	62 609	FIM	Total:	
% of sales	6,3 %		**130,7 %**	

Estimated sales	**5 000 000**	**mk/year**	10,1 %	rent as % of sales
lines to pick	500 000	order lines	14,8 %	equipment as % of sales
lines to pick per day	2 000	lines per day		
personnel needed	1,7	persons		
personnel cost per month	26 087	FIM		
personnel cost per year	313 043	FIM	Total:	
% of sales	6,3 %		**31,1 %**	

Estimated sales	**10 000 000**	**mk/year**	5,0 %	rent as % of sales
lines to pick	1 000 000	order lines	7,4 %	equipment as % of sales
lines to pick per day	4 000	lines per day		
personnel needed	3,5	persons		
personnel cost per month	52 174	FIM		
personnel cost per year	626 087	FIM	Total:	
% of sales	6,3 %		**18,7 %**	

Estimated sales	**20 000 000**	**mk/year**	2,5 %	rent as % of sales
lines to pick	2 000 000	order lines	3,7 %	equipment as % of sales
lines to pick per day	8 000	lines per day		
personnel needed	7,0	persons		
personnel cost per month	104 348	FIM		
personnel cost per year	1 252 174	FIM	Total:	
% of sales	6,3 %		**12,5 %**	

Estimated sales	**30 000 000**	**mk/year**	1,7 %	rent as % of sales
lines to pick	3 000 000	order lines	2,5 %	equipment as % of sales
lines to pick per day	12 000	lines per day		
personnel needed	10,4	persons		
personnel cost per month	156 522	FIM		
personnel cost per year	1 878 261	FIM	Total:	
% of sales	6,3 %		**10,4 %**	

Estimated sales	**50 000 000**	**mk/year**	1,0 %	rent as % of sales
lines to pick	5 000 000	order lines	1,5 %	equipment as % of sales
lines to pick per day	20 000	lines per day		
personnel needed	17,4	persons		
personnel cost per month	260 870	FIM		
personnel cost per year	3 130 435	FIM	Total:	
% of sales	6,3 %		**8,7 %**	

Estimated sales	**70 000 000**	**mk/year**	0,7 %	rent as % of sales
lines to pick	7 000 000	order lines	1,1 %	equipment as % of sales
lines to pick per day	28 000	lines per day		
personnel needed	24,3	persons		
personnel cost per month	365 217	FIM		
personnel cost per year	4 382 609	FIM	Total:	
% of sales	6,3 %		**8,0 %**	

Estimated sales	**100 000 000**	**mk/year**	0,5 %	rent as % of sales
lines to pick	10 000 000	order lines	0,7 %	equipment as % of sales
lines to pick per day	40 000	lines per day		
personnel needed	34,8	persons		
personnel cost per month	521 739	FIM		
personnel cost per year	6 260 870	FIM	Total:	
% of sales	6,3 %		**7,5 %**	

Benchmark on all different operations and organisations for the most important parameters

Picking speed Order lines per person per hour; description of operation

100	S-group; from a normal store, no automation
100	Y-halli; from a normal store, no automation
200	Matomera; Local Distribution Centre, no automation
450	Webvan, Local Distribution Centre, highly automated

135 in average up to 300 Atria, Logistics Centre, highly automated meat distribution centre. Not directly comparable, because the weight of an average order line is 3,5 kilograms and picking temperature +2 decrees Celcius.

LDC floor area / Claimed space efficiency ratio to a supermarket

Matomera,	1,040 m2 / 2,5 to 3
Streamline,	5,175 m2 / 3 to 4
Webvan,	30,500 m2 / 2,5

Rental costs in Helsinki Rent per month €/m2; description

€5.90	Warm warehouse, low end (Sponda)
€16.00	Typical supermarket in Helsinki area (S-Group)
€11.50	Low end supermarket cost in Helsinki (Merita-Kiinteistöt)

Home delivery cost €/ drop; description

€3.70	Y-halli, A supermarket delivering with own van, attended
€4.20	Pilot with S-Group, unattended
€9.90	Tesco, attended delivery, based on Business Week average figures
€1.80	Rubbish collection in the pilot area, unattended

Home delivery computer model (Punakivi et Saranen, 2001)

We built a computer model to study the various home delivery concepts used generally. The framework of the model is presented in Figure A3.1. Each scenario results in two performance measures. The cost estimate is calculated using the fleet required to meet 100-per cent on-time delivery performance within the model. The associated mileage is used for calculating the environmental effects of the scenarios.

Each service concept examined is defined by:

The product range offered
The type of reception,(i.e. own reception box or customer present at home)
The delivery hours
The length of the delivery time window
The delivery lead time, i.e. the minimum time difference between order and delivery
Minimum order or delivery surcharge

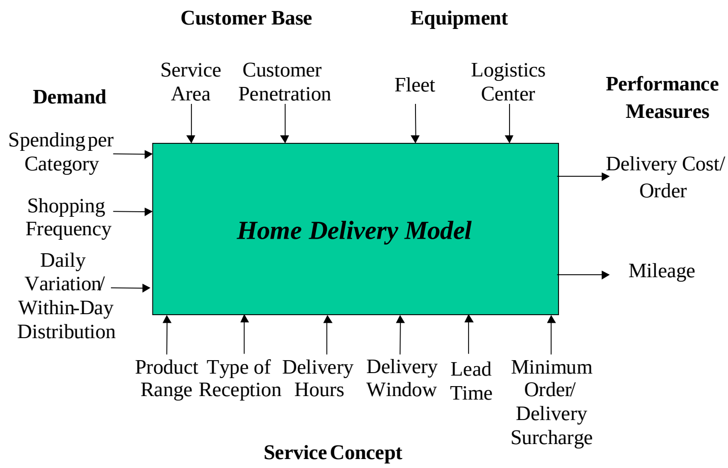

Figure A3.1 Home delivery framework

In the computer model, each scenario is constructed in two steps. First orders are generated and then they are routed using RoutePro, a routing software from CAPS Logistics. The logic of the order generation process depends on the availability of data.

The order file format presented in Table A3.2 is determined by the requirements of RoutePro. In addition to the volume of the order and the vehicle, the routing is limited by the two time windows included in the order file. The delivery time window, specified by Drop off start[1] and Drop off end[2], depends on the type of reception. If there is a reception box in the household, the delivery time window equals the delivery hours. Otherwise the delivery hours are divided into time windows defined by the service concept selected. The delivery time frame of each order is defined using a distribution, which shape describes when the customers want their deliveries to arrive. In our study the distribution is based on the real POS -data i.e. the actual shopping time of the "order". The pick up time window, which describes when the orders have to be loaded into the vehicle at the logistics centre, is determined in the order file by using Pick up start[3] and Pick up end[4]. The delivery is assumed to be available for pick up at the last possible ordering time for the respective delivery time window.

Table A3.2 Example order file (transpose)

ID	36	37	38
FromID	Depot	Depot	Depot
ToID	Cust3345	Cust1185	Cust7789
Quantity1	11.673	27.191	16.677
Type	Custorder	Custorder	Custorder
PickAvlDT[3]	10/6/99 7:00 AM	10/6/99 7:00 AM	10/6/99 7:00 AM
PickByDT[4]	10/6/99 11:59 PM	10/6/99 11:59 PM	10/6/99 11:59 PM
DropAvlDT[1]	10/6/99 1:00 PM	10/6/99 8:00 AM	10/6/99 1:00 PM
DropByDT[2]	10/6/99 2:00 PM	10/6/99 8:00 PM	10/6/99 2:00 PM

Figure A3.3 presents an example of the relationship between the time windows in the order file. As noted above the delivery time specification is based on a distribution. The service concept specifies last possible order arrival time for each delivery time. This is used as the starting point of the pick up time window. The pick up time ends as the delivery time ends.

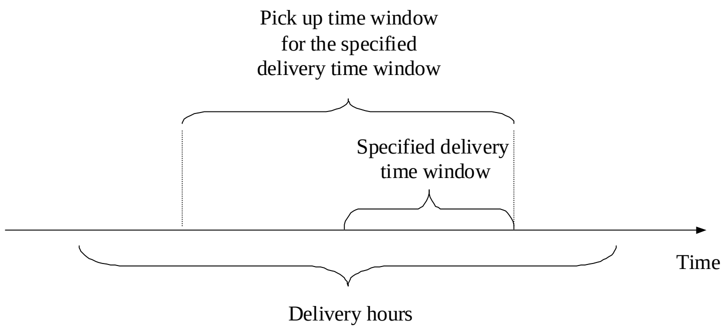

Figure A3.3 Order file time windows

Structure of semi-structured interviews

Impact of Electronic Grocery Shopping to first tier Suppliers

1. General data collection of the supplier
 -Business volume, market share, position in the market
-Description of the operations today
-Most important business partners, competition
-Other relevant data

2. Description of possible structural options for EGS downstream operations
 -LDC instead of supermarket
 -Hybrid Model
 -Alternatives for home delivery

3. Possible requirements of the new structure to the supplier
 -Changes to order entry systems
 -Lead-time requirements
 -Changes to deliveries and mid-stream transportation

4. Possible changes to internal operations of the supplier
 -Production planning and sourcing
 -Manufacturing
 -Packaging and picking

5. Other possible changes
 -Potential negative impacts
 -Potential positive impacts

6. Other relevant issues and comments

Appendix 4 The interviewed persons and interactive presentations

The experts evaluating the LDC parameters and operational costs and fuctionality:

Time and place: 5.1. 2000, S-Centre

Pauli Hinkkanen, Inex Partners
Harri Mönkkönen, Director, Logistics and IT, S-Group
Juhani Suni, S-Group
Jari Lohi, e-grocery manager, S-Group
Visa Palonen, e-commerce manager,SOK
Matti Niemi, S-Group
Kari Heikkinen, S-Group

The interviewed persons and interactive presentations and workshops where the potential changes in upstream operations have been presented and discussed

Breweries

Initial Interviews and analysis:
Time & Place: 1.9.1999, Hartwall production plant and logistics centre, Lahti
Harri Matikainen, Logistics Manager, Hartwall
Eino Lemmetty, Hartwall

Presentation of results:
Time & Place: Brewery Union technical committee meeting, Iisalmi 06.04.2000.
Attendees:

Rolf Therman, Technical Director,Harwall
Peter Hartwall, Brewery Master, Hartwall
Tommy Hoffström, Development Manager, Hartwall
Harri Matikainen, Logistics Manager, Hartwall
Risto Saarinen, Managing Director, Brewery Union
Seppo Laalo, Logistics Director, Sinebrychoff
Janne Jantunen, Managing Director, Pirkanmaan Uusi Panimo
Pentti Pelttari, Brewery Master, Olvi
Pentti Karppanen, Director, Production and Logistics, Olvi

Dairy Industry (Valio Plc)

Initial Interviews and analysis:
Time & Place: 11.1.2000, Valio Plc Headquarters, Helsinki
Tapani Sievänen, Development Manager
Kalevi Hilden, Logistics Manager

Presentation 15.02.2000 at Valio middle management

Workshop for management 24.10.2001 at Valio Plc Headquarters, Helsinki
Participants:
Rauno Hiltunen, Development Director
Timo Kärnä, Sales Director
Juha Lyytinen, Development Manager
Kalevi Hilden, Logistics Manager
Additionally 8 executives and managers from different parts of the organisation

Meat Industry (Atria Plc)

Initial Interview and analysis:
Time & Place: 13.10.1999, HUT, Espoo
Pekka Kuussaari, Senior Consultant, EP-Logistics

Further discussion:
Time & Place: 15.5.2000, EP-Logistics, Helsinki
Erkki Muilu, Logistics Director, Atria Plc
Pekka Kuussaari, Senior Consultant, EP-Logistics
Additionally three consultants of EP-Logistics

Further analysis and discussion:
Time & Place: 21.1.2002, Atria production plant and logistics centre, Nurmo
Participants:
Erkki Muilu, Logistics Director, Atria Plc
Ville Ruuskanen, Logistics Development Manager, Atria Plc

Appendix 5 Research project and research questions

Research environment and individual contributions

The cornerstone of the research methodology was the organisation of the Ecomlog research project. The initial project initiative was to research the grocery business. The actual project was expanded to cover other aspects of electronic commerce and electronic business, as described in Section 1.4. Even if the original project initiative was part of Ecomlog, it was carried out as an autonomous sub-project, with the original name ‘Intertrade’. The author’s responsibility was to manage Intertrade as project manager and be the main link between the participating companies and the project group. The project management task included planning, participating and instructing the research work carried out by the other researchers in the group: Tomi Jaakola, Mikko Punakivi, and Juha Saranen. Mikko Punakivi started later his more independent research work on home delivery. Furthermore, in addition to the author’s own individual research activities, liaison between other Ecomlog sub-projects and the co-ordination of research activities were also the author’s responsibility. For example, Vesa Kämäräinen from the Ecomlog project group were very closely linked to the Intertrade project during the research work connected with this dissertation. The following section will explain the personal research contribution of the author and how the Intertrade project developed into three interlinked but independent research areas.

In the Intertrade project the initial problem definition and planning was carried out mainly by Hannu Yrjölä, starting in 1997 and resulted in the commencement of the actual Ecomlog research programme in April 1999. Vesa Kämäräinen also participated in this initial phase during the summer of 1998. Yrjölä & Tanskanen (1999) and Yrjölä et al. (2000) were published soon after starting the Intertrade project, providing guidelines for the research work. These research papers are attached as appendix 6 to give more detailed picture of the early stages of the research project. The paper by Holmström et al (1999) was published also at the early stages of the project with different research emphasis.

Based on the problem area definition and pre-understanding of the problem area the main research question in the Intertrade project, What are the essential issues in achieving cost-efficient supply chain operations in the e-grocery business?, was formulated. Then the relevant research topics were identified and selected for research. The Home deliveries including analysis of various models and the cost effects of attended vs. unattended reception, was seen as an important research topic. Another important topic to be analysed was the order assembly system, including comparing the picking operations in a dedicated DC and store and analysis of appropriate levels of automation in the picking operations. The third area of interest was the possible impacts on upstream operations in the grocery supply chain, including an analysis from the first tier supplier's point of view.

Hannu Yrjölä took responsibility for studying the main research question and making the synthesis of the research topics. Since the main question was found to be very complex and included several essential sub-questions, the research work was carried out as a joint effort. During the research process the main responsibilities were divided in the following way:

What is the impact of alternative goods reception models on cost of home delivery? (main responsibility: Mikko Punakivi)
What is the impact of alternative order assembly systems on the effectiveness of the e-grocery supply chain? (main responsibility: Vesa Kämäräinen)
What are the implications of changing from conventional shopping to EGS on the grocers’ first tier suppliers? (main responsibility: Hannu Yrjölä)

In the main research phase these topics were then analysed partly together by the authors and partly individually. During the research process the focus was set in topics 1 and 2, since greater development potential was identified there, topic one being the most important. During the main research process, several more specific questions were revealed and selected for further research, which was then conducted individually.

This dissertation concentrates on finding out under which conditions e-grocery business could be cost competitive when compared to conventional grocery retailing. This also includes analysing the feasibility of the hybrid model that combines DC and the supermarket. The viewpoint is one of supply chain cost efficiency and identifying the major cost elements in the business case on e-grocery.

The work in progress dissertation by Punakivi (2002) focuses on detailed comparisons of the cost efficiency of the alternative solutions in home delivery operations by modelling. In the modelling, the cost levels of home delivery operations are also compared to the current costs of a household customer visiting a supermarket using their own car. In addition to the cost efficiency analysis, the environmental effects of the alternative home delivery models are also analysed.

The licentiate thesis by Kämäräinen (2002) concentrates on identifying the biggest logistical challenges when developing operations for the e-grocery supply chain at the consumer end, and describes the basic principles of how to develop cost-efficient supply chain solutions. The work in progress dissertation by Kämäräinen is to be enlarged based on the licentiate thesis. The viewpoint of Kämäräinen is systemic and focuses on the solutions and links between components in e-grocery.

This thesis of Yrjölä builds on the results of the pre-understanding phase and joint research work of the authors, Mikko Punakivi and Vesa Kämäräinen. Following section gives a detailed overview of the research scope and contributions.

Research Questions

I Current state analysis (Yrjölä assisted by Kämäräinen)

The goal of the first phase is the identification of the essential supply chain issues involved in the emerging e-grocery business.

0. What are the essential issues in supply chain operations for the e-grocery business?

0.1 What are the market prospects and trends in grocery retailing?
0.1.1 What are the market prospects for grocery retailing and electronic grocery shopping internationally?
0.1.2 What are the market prospects for grocery retailing and electronic grocery shopping in Finland?
0.1.2.1 What consumer groups have the biggest needs for home delivery service?
0.1.2.2 How does the current laws regulating retailing affect electronic grocery shopping in Finland?

0.2 What is the different supply chain structures and transport volumes for major product groups in Finnish grocery retailing? (Breweries, Dairies, Meat industry)

0.3 What different solutions exist in early EGS operations?
0.3.1 Solutions for goods reception for the customer?
0.3.2 Solutions for order assembly?
0.3.3 What are the different combinations of solutions?

0.4 What is the cost structure of early EGS operators?

0.4.1 What is the cost structure for order assembly in a supermarket?

0.4.2 What is the cost structure for order assembly in a local distribution centre?

0.4.3 What is the cost structure for home delivery?

II Constructive phase

The results from phase I indicated that to gain insight into the operation and potential effectiveness of EGS detailed constructive research on the following issues was necessary:

1. What is the effective supply chain for electronic grocery shopping?

1.1 What is the impact of alternative goods reception modes (attended, reception box, delivery box, shared reception box) on home delivery effectiveness?

1.1.1 What is the impact of alternative goods reception modes on home delivery cost-effectiveness?

1.1.1.1 What is the impact of attended goods reception vs. reception box on home delivery cost? (Punakivi and Yrjölä)

1.1.1.2 What is the impact of other unattended goods reception modes on operational costs of home delivery? (Punakivi)

1.1.1.3 What is the impact of the alternative unattended goods reception modes on required investments? (Punakivi)

1.1.1.4 Can the operational savings in home delivery transportation justify the investments for unattended reception? (Punakivi and Yrjölä)

1.1.2 What is the impact of alternative goods reception modes on customer service? (Kämäräinen and Punakivi)?

1.1.2.1 In which situations is each alternative goods reception mode feasible?

1.2 What is the impact of alternative order assembly systems on the effectiveness of the e-grocery supply chain?

1.2.1 What is the effectiveness of order assembly in local distribution centre (LDC) compared to order assembly in the store?

1.2.1.1 What is the supermarket cost-structure? (Kämäräinen)

1.2.1.2 What are the cost differences between supermarket and LDC? (Kämäräinen)

1.2.1.3 How should order assembly in LDC be organised? (Kämäräinen and Yrjölä)

1.2.1.4 How should automation be used in LDC? (Kämäräinen)

1.3 What are the implications of changing from conventional shopping to EGS on the grocers' first tier suppliers? (Yrjölä)

1.3.1 What are the implications of changing from conventional shopping to EGS on breweries?

1.3.2 What are the implications of changing from conventional shopping to EGS on dairies?

1.3.3 What are the implications of changing from conventional shopping to EGS on meat industry?

III Focused research and strategic implications

2. What is the cost structure of EGS? (Yrjölä)

2.1 What is the cost structure for order assembly for EGS?

2.1.1 What is the cost structure for order assembly in a supermarket?

2.1.2 What is the cost structure for order assembly in a local distribution centre?

2.1.3 What is the feasibility of the hybrid model that combines LDC and supermarket?

2.2 What is the cost structure for home delivery?

2.2.1 What is the impact of customer density?

2.2.2 What is the impact of attended vs. unattended?

2.3 What is the cost impact of EGS on first tier suppliers?

2.4. Can e-grocery supply chain with home delivery be more efficient than conventional grocery supply chain?

2.5 What are the key performance indicators for EGS?

3. What is the required growth and customer acquisition strategy for EGS from operational efficiency viewpoint? (Yrjölä)

4. What are the wider implications in society of large scale EGS?

4.1 What are the potential implications on the environment

4.1.1 What are the environmental effects of alternative goods reception modes? (Punakivi)

4.1.1.1 What is the impact of alternative goods reception modes on mileage driven in urban traffic?

4.1.1.2 What is the impact of alternative goods reception modes on greenhouse gas emissions?

4.1.2 What is the impact on packaging and recycling? (Yrjölä)

4.2 What are the potential implications on employment? (Yrjölä)

4.3.What are the potential implications on legislation? (Yrjölä)

5. What is the market potential for supplying unattended reception solutions? (Kämäräinen and Punakivi)

5.1 What are possible revenue models for unattended reception? (Kämäräinen)

5.2 What are the most potential revenue models for a box supplier? (Kämäräinen)

5.3 How do consumers experience unattended reception? (Kämäräinen)

5.4 How do potential B2B customers experience unattended reception? (Kämäräinen and Punakivi)

6. How best implement EGS using reception boxes (Kämäräinen)

6.1 What kinds of service models are needed?

6.2 What are customer experiences and needs for the ordering interface?

6.3 What are customer experiences of using the reception boxes?

6.4 How reception box service should be priced? (Kämäräinen and Punakivi)

7. What is the basic requirements for the reception box? (Kämäräinen, Punakivi and Yrjölä)

7.1 Temperature requirements and size requirement based on shopping basket analysis? (Punakivi)

7.2 What are the possible other requirements?

8. How can grocery manufacturer's role be changed due to the EGS? (Kämäräinen)

8.1 What are alternatives for the grocery manufacturer?

8.1 What kind of marketing solutions can be adapted?

8.3 How grocery manufacturer can take a more active role in the grocery business?

Appendix 6 Research papers

An Evolutionary Approach for Developing Physical Distribution in Electronic Grocery Shopping

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Summary

Electronic commerce is growing rapidly hand in hand with people and businesses getting more and more connected to the Internet. Electronic Grocery Shopping (EGS) with direct home delivery is gradually starting to become an option for busy families who do not want to spend their leisure time in grocery shops. The early EGS operators offer service built on top of the traditional grocery shop and the Internet is only used as a communication tool to transmit the customer order. To become a viable option for consumers the EGS has to be based on completely new logistics structure where the Internet is used to connect all parties in the supply chain to the same real time flow of information. The supply chain all the way from the supplier to the household will be rebuilt.

In the USA this development has started already and so called dedicated EGS companies have entered the marketplace with investors backing them up. Huge losses are made in the battle against the traditional players. In smaller markets the funds needed for this kind of revolutionary action are not easy to come up with. This paper describes an evolutionary model for traditional grocery traders to start EGS gradually based mainly on investments made already. The gradual market driven growth of EGS will possibly save the traders from huge front up losses and speed up the development.

Keywords: E-commerce, Grocery Shopping, Logistics, Supply Chains

1. Introduction

More and more supermarkets are being built to enable people to park their cars near by while shopping for heavy and bulky daily consumer products. According to studies made in Finland (LTT, 1995) households visit shops on average 4,3 times a week spending on average 48 minutes time on weekdays and 58 minutes on weekends. 57% of the time is spent in cars and the rest in shops picking and paying for the goods. Altogether we are looking at a total of some 450 million hours spent to this pick-up activity. Based on these facts we argue that the downstream operations in the logistics chain of grocery goods, from the shop to the household, are currently very expensive and ineffective from the point of the consumer.

The order processing can now be moved to Internet and order information can be made available in real time to all parties in the supply chain. The whole distribution can be rebuilt to by-pass most of the current structure. In the last couple of years new companies have entered into the marketplace and started to invest in building dedicated Electronic Grocery Shopping systems. Companies like Streamline and Shoplink are building the whole supply chain from producers to households from scratch creating a new cost structure for daily consumer products trade. However, this approach requires significant investments and involves big risks. Therefore it does not fit to smaller markets where reaching the break-even volume is much more difficult.
There are some 4200 grocery retail outlets in Finland and the number has been decreasing for years. Currently approximately 400 biggest stores and supermarkets do 50 percent of the trade. Smaller shops are suffering and a new threat for them is the growing trade volumes of grocery products at petrol stations and kiosks. They can offer more flexible opening hours than grocery stores due to current legislation.

In the USA the companies building dedicated Electronic Grocery Shopping chains are all making still huge losses. Peapod reported an operational loss of 15 million dollars with 57 million-dollar sales volume. Streamline made a 10 million-dollar loss with only 7 million-dollar total revenues. Their expectations are based on estimates claiming that 10 to 12 percent of the 500 billion dollar grocery market is going to turn internet-driven in the next 5 to 7 years. On the other hand, 60 percent of adult Americans do not like grocery shopping and 67 percent of double income households have a PC. This gives support to estimates for rapid growth of Electronic Grocery Shopping. (Sources: Peapod, Shoplink, Streamline)

2. Framework

The key issue in servicing customers is how to meet or exceed their expectations at an affordable cost in relation to competition or the customer's willingness to pay for the service. In the grocery supply chain traditionally the "service" has been limited to put the merchandise on display in the shop for customer pick up. The aim of the supply chain is to keep all products available at all times. For perishable products there is an extra effort to avoid passing "best before" dates. The cost-to-serve for different products and product groups consists for the biggest part of in-store handling cost, space and equipment cost and cost of capital. It is simple to calculate and reasonably easy to optimize at the desired level of service.

When the value offering point is moved forward up to the household the whole picture will change and the amount of possibilities for supply chain design increases dramatically. Based on general supply chain principles the cost must be balanced against service. However, an organization should take a process view rather than a functional view to supply chain planning. Thus, it should work across functional boundaries to integrate business processes needed to create the supply chain. This way an organization can in some cases compress its lead-times and raise quality and accuracy at all stages and at the same time improve service and lower the costs (Braithwaite, Samakh 1998).

Applied to Electronic Grocery Shopping with direct home delivery this implies that the supply chain has to be designed as an integrated process. The process can be very different for various products in order to achieve best overall efficiency. It is essential that the cost-to-serve is known for each product group for the whole supply chain for all feasible service level options. The supply chain will include all steps from original source up to the household.

Another aspect to supply chain redesign for Electronic Grocery Shopping is the variance in demand predictability. The general principles suggest that products with predictable demand should have supply chain focused on minimizing physical cost (Fisher, 1997). These “functional” products typically have large volume and low profit margin. In the grocery environment good examples for this product category are milk and bread. The supply chain for products with unpredictable demand should be responsive. These high margin, low volume “innovative” products have high product variety within each category. The margin of error in the demand forecast is often up to 100 percent. Good examples in the grocery world for this kind of product are West Indian Chili Sauce or insect repellent. Just optimizing the physical efficiency of the supply chain for these products will not increase overall profitability due to the negative impact of the optimization. The primary purpose of supply chain design for functional products is to supply predictable demand efficiently at the lowest possible cost. For innovative products the design purpose is to respond quickly to unpredictable demand in order to minimize stockouts, forced markdowns, and obsolete inventory.

When designing logistics model to support Electronic Grocery Shopping there is one more important issue to consider. The positioning of the customer order decoupling point (CODP). It defines the stage in the supply process, where the product is linked to a specific customer order. In the traditional grocery shop the

COPD is normally in the store when the customer picks up the product himself. In the Electronic Grocery shopping the COPD can be shifted backwards and in some cases forward in the supply chain. The positive and negative effects of backwards and forward shifting generally are (Olhager, 1994):

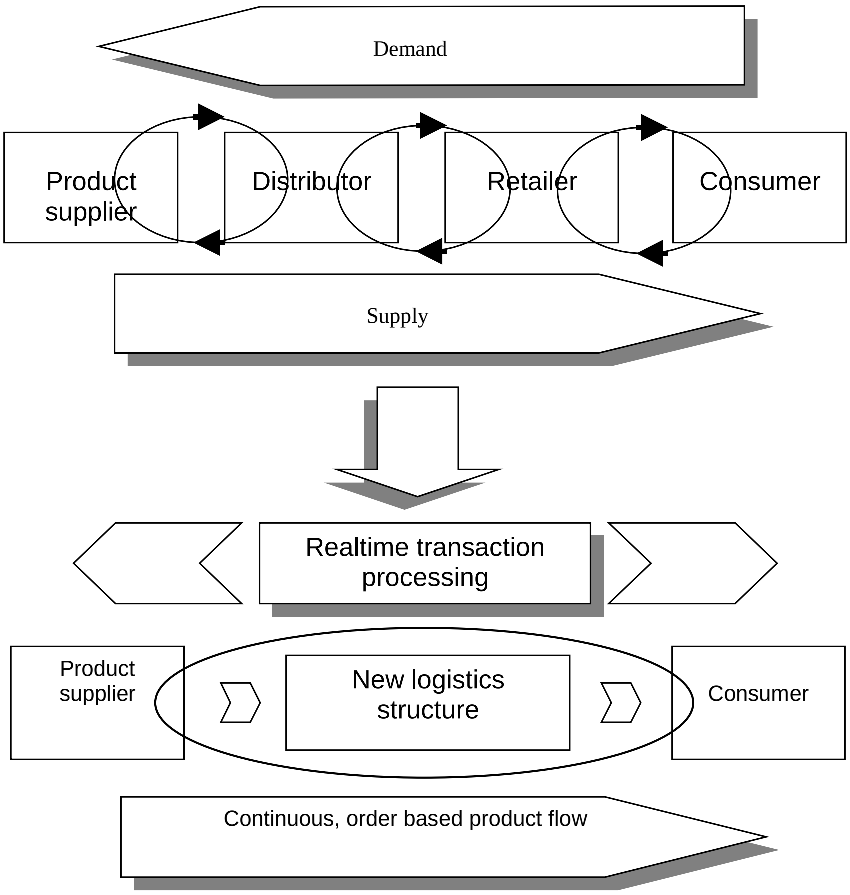
	Backward	Forward
Reason for shifting	Reduce the reliance on forecasts Reduce or eliminate buffer inventories Reduce the risk of obsolescence of inventories	Reduce the customer lead time Process optimization
Negative effects	Longer delivery lead times and reduced delivery reliability Reduced process efficiency due to reduced possibilities for optimization Increase products-in-process	Rely more on forecasts and higher risk of obsolescence Reduce the product range

Table 1: Positive and negative effects of shifting the CODP

These general supply chain issues form the framework for constructing the elements for Electronic Grocery Shopping supply chain.

3. The new approach to grocery shopping

We are still in the early stages of electronic commerce and Internet is quite commonly seen only as an electronic communication media to pass customer orders to service providers. Even if Internet was commercially born in the middle 1990s it does not increase the efficiency of electronic trading substantially compared to a telephone, 1876 invented technology, if used only in this capacity. Internet is doing the same to the whole society what minicomputers did in1980s to companies. Connect everybody to a common real time transaction processing system. This enables everybody involved in any process to get all information needed for his task in real time. Companies redesigned their processes and successful ones improved their overall efficiency and were able to cut overhead costs at the same time. It was not unusual that the efficiency in information processing within a process was improved by a factor of ten.

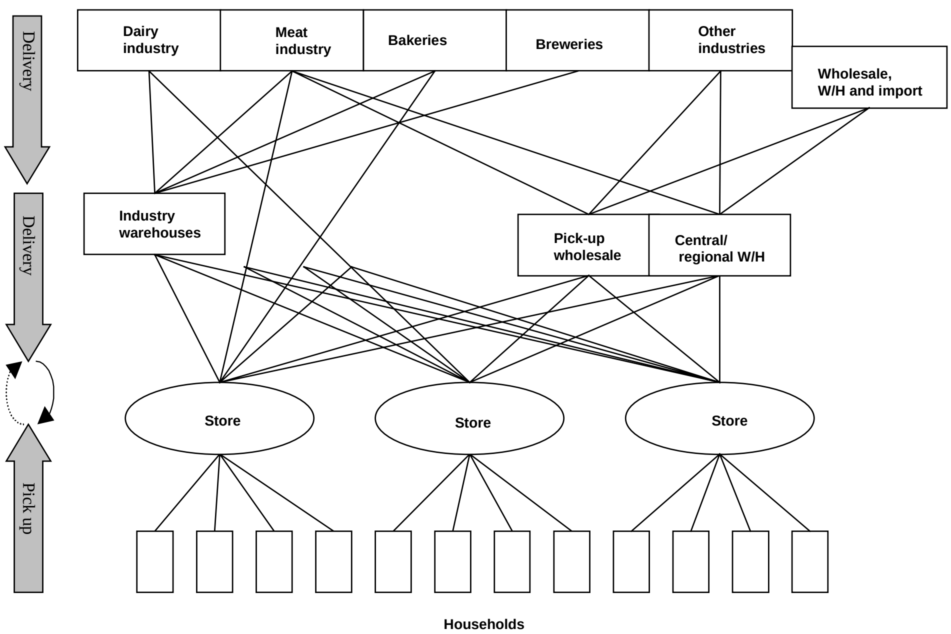


Picture 2. The change of the Structure of the Grocery Trade (Upper part source: : KSA 1993)

Picture 2 illustrates the change of the structure of grocery shopping as a process starting from product supplier and ending at consumer location in today's ICT environment (Information and Communication Technology). It looks quite obvious that the whole logistics structure needs a complete redesign to be competitive.

3.1. Cost structure of grocery distribution today

Based on detailed studies of consumer behavior in Finland (LTT, 1995) we have calculated that the collection task made by the consumer himself represents 20 percent of the grocery products value at shop check-out point. The total value of the trade in Finland is approximately 10 billion EURO annually. This 2 billion EURO annual cost is based on the previously mentioned 450 million hours spent for shopping and travelling to and from a shop. The hourly rate used here is only 3.25 EURO, which is the “leisure time”-rate used by the Ministry of Transport for assessing road network investments. Over half a billion EURO the consumers spend on private car transportation to shopping. These cost are due to the fact that the last arrow describing the goods flow in Picture 3 is wrong way round.



Picture 3. Today’s Grocery distribution

Table 4 gives a comparison of modern supermarket internal cost structure in the USA and gives an idea what the cost structure for high volume dedicated Electronic Grocery Supply Chain could be.

Streamline Versus Supermarkets: More Net Per Revenue Dollar

	TYPICAL SUPERMARKET*	STREAMLINE
Cost of Goods Sold	$0,75	$0,72
Operating Costs	$0,17	$0,13
Distribution	$0,04	$0,06
Corporate Overhead	$0,03	$0,03
Net Profit	$0,01	$0,06

*Figures compiled by Smart Store, a research-and-development initiative at Andersen Consulting.

Table 4 Modern Supermarket vs. EGS

The figures above were presented by Streamline, Inc. and cannot be regarded as neutral scientific estimates. However, based on this profit and cost calculations companies like General Electric, Intel and SAP America have invested millions of dollars in the new venture. If the modern supermarket figures are topped with the 20 percent mark-up for the do-it-yourself logistics made by the consumer, the future of the modern supermarket does not seem very bright.

3.2. The hybrid model

The recent development in Electronic Grocery Shopping in the USA shows quite clearly the trend. Dedicated new EGS companies are entering the marketplace with huge investments making huge front-up losses. Some of the old players are changing their business model and joining the battle for the EGS market shares. The other old players are trying to make the best out of their current position and monitor the development but do not join the race.

In smaller markets like Finland the early EGS applications are based on offering "We shop for you"-service for households tired of "do-it-yourself"-logistics. There are always people who are desperate enough to pay an arm and a leg to get groceries home delivered.
In addition to being extremely inefficient this service requires somebody to stay at home to receive the goods. To be cost efficient the EGS has to be based on a new logistics structure. The supply chains for various product groups have to be redesigned and the processes have to be re-engineered. Furthermore, an efficient home delivery operation today requires that the home has to be able to receive the merchandise unattended.

The hybrid model is constructed for true EGS with smaller volumes and based mostly on investments already made. The operation can be done by current supermarkets that are redesigned so that they can more effectively start direct home delivery while still keeping also the conventional store. The overall supply chain costs will be reduced by bypassing most of the current structure for part of the products. This is done using dedicated supply chains from the supplier directly to the Local Distribution Center. Figure 5 illustrates a typical Pareto curve for grocery products.

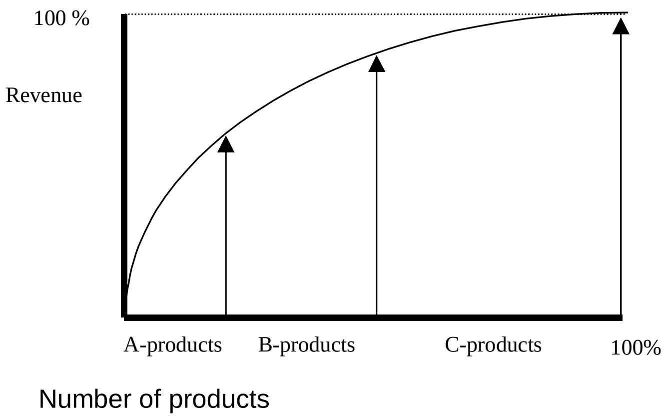


FIGURE 5 Pareto curve for grocery products

The grocery products are initially divided into three categories based on the position on the curve. For adjustments the product and product categories can be analyzed for their suitability to the standard supply chain structure suggested to each type. The characteristics of the supply chain for A, B and C-products are:

	A	B	C
Cost-to-serve	very important	important	not so important
Supply chain focus	cost	efficiency	responsiveness
CODP	adjustable	adj./fixed	fixed
Inventories	no	automated	manual

The largest area of cost in conventional supply chain from the supplier to the store checkout register is the operational costs within a store. This is 17 pct of the value of the goods based on the SmartStore figures (Page 5). In the initial design of the Hybrid Model the emphasis has been on eliminating the store costs for the biggest part of the logistics stream. The elimination of cost gives room for the extra costs for the home delivery. On the other hand, the today's supermarket carries a huge number of products with very low purchase frequency. The consumers expect these products to be available in any attractive shopping environment in the future. Using the store for inventory of products with low purchase frequency lowers the start-up investments for the EGS service.

In the basic design the A-products have no inventory. A-products come straight from the industry to the LDC based on accumulated customer orders. In the LDC the products are sorted to the home delivery boxes. For some A-products an optimal operation can be based on estimated demand in stead of customer orders e.g. to enable the transportation from the supplier to the LDC in full truckloads. Typical products of the A-category are brewery and dairy products.

B-products have an automated or manual inventory, where the emphasis is on efficient picking. In today's supermarket the construction and lay out is not meant to support efficiency. Quite contrary the design makes the consumer to spend as much time as possible in the store to make maximum amount purchase on impulse. The delivery boxes with the A-products get the ordered B-products either automatically or manually from the B-product inventory. Typical B-products have medium purchase frequency and are not heavy or bulky. Canned food, meat products, rice and pasta are good candidates for the B-group.

For C-category products the store is used as an inventory and picking is done manually. A good planning and control system can make the picking more efficient than in the "We shop for you"-services where one customer order is picked at a time. The picking from the store can be controlled by the home delivery routing system. When a full home delivery vehicle is getting completed with A- and B-products the needed C-products from the store can be grouped to make a couple efficient pick-up runs trough the store to complete all orders ready to go. A typical C-product is a small bottle of West Indian Chili Sauce. The store naturally carries all A- and B-products but the quantities and space allocation for these products are just a fraction of the one in the conventional store. Figure 6 illustrates the proposed solution.

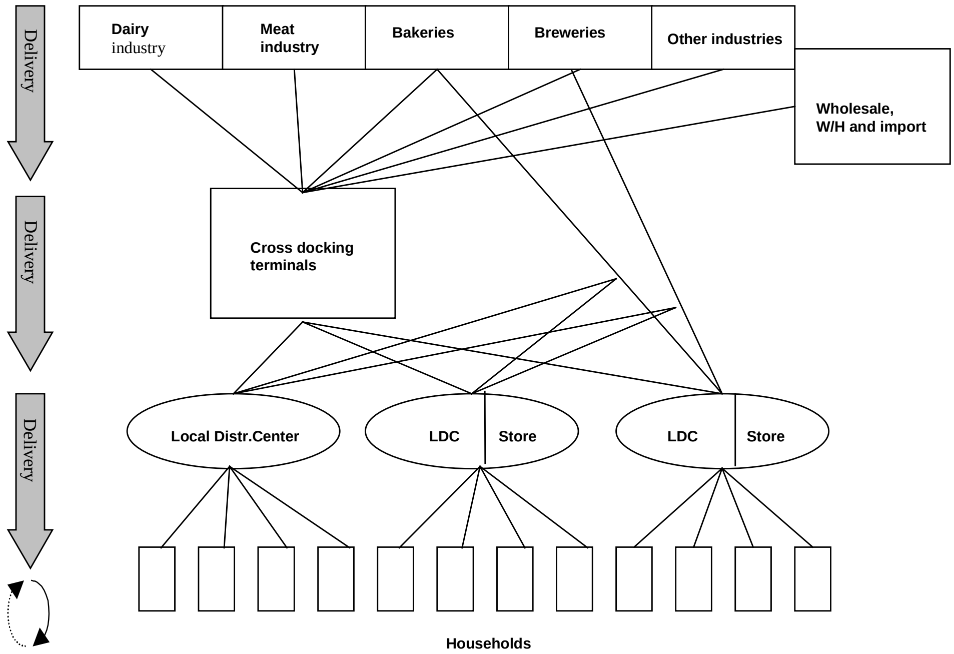


Figure 6. The Hybrid Model

3.3. Initial analysis for some product groups

We made a direct home distribution model of brewery products in Helsinki area and analyzed the total cost of home delivery and the model sensitivity to various parameters. The purpose of this exercise was not to give the industry final cost figures to make investment plans. We wanted to understand better the cost drivers of direct home delivery and collect information to help us to build the actual simulation model for more detailed analysis.

To make it simple we only accepted home deliveries in full cases, which made it very easy to make profit with the home distribution by just taking the store sales margin. However, the handling and storing brewery products in the store for consumer pick-up is not by any means cheap so bypassing the store completely gives room for quite a bit of extra cost for home delivery. We also assumed the households to receive the goods unattended Streamline style. On the other hand, we were only analyzing one product group without the synergy of one delivery cost for all grocery products.

The total sales volume of medium strength beer in Finland is 250 million liters per annum making the consumption 50 liters per capita. In the Helsinki Metropolitan area there are close to one million people buying 50 million liters of beer every year. We made calculations for distributing 25 per cent of this amount directly to households with mediums size vans carrying 150 cases of beer. In the base calculation we used 70 pct load factor and four minutes for one drop-off allowing 70 minutes per trip for loading, administration and driver breaks. We tried to take all possible cost items involved into consideration and connected the model to a profit and loss statement and a balance sheet. We finally ended up with 10 distribution centers with six vans each to look most efficient for the area covered. Also, we ended up with a handsome profit taking only the same sales margin as the supermarket today takes. With a small delivery charge it looked almost impossible not to make profit no matter how we changed the basic parameters.

Even if this exercise cannot be considered as a true and fair profit analysis for store versus home delivery it gave some interested results on the sensitivity. It was no surprise that the model was extremely sensitive to a delivery charge. Even a small transaction based delivery charge on top of the sales margin made the home delivery to fly. The possible variation in the sales margin did not have any comparable effect on the profitability. The capacity utilization of delivery vans had surprisingly low impact on the overall profit. So did the size of average order and driver salary. The most critical factor for the home delivery cost structure was by far the time per drop-off. The factor was not a surprise but how dominating factor it is, certainly surprised us. This implies that the business we are dealing with is very analytical to garbage collection.

4. Conclusions

The initial studies and analysis of EGS with direct home delivery give us positive signals that the hybrid model could be a platform for gradual low risk growth for EGS. When we look at trade-off figures given out by Streamline stating that 1600 households is minimum for one local distribution center to break even we really like to find an alternate solution for full service EGS. It might well be that the hybrid model is not able to give as lucrative cost structure figures than a dedicated full bloodied EGS Supply Chain machine making six times more money than a traditional supermarket with superior service. However, it serves as a research tool for analyzing the cost structure of grocery home distribution with detailed simulation models. Furthermore, we would like to be able to prove that the Hybrid Model will lower the break even number of households served by one center considerably. The further research with detailed simulation models with true data will give us more evidence. If the number of households needed for profitable operation can be considerably lowered the Hybrid Model will serve as a low risk evolutionary model to start EGS by current traders. This will hopefully speed up the evident development without large number of casualties.

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An Agenda for Electronic Grocery Shopping Supply Chain Research

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Abstract:

Electronic Grocery Shopping (EGS) has emerged as a challenger to traditional grocery business during the last few years. However, it has not yet achieved remarkable marketing share. One reason is inefficient supply chain of the e-grocery business. Especially the home delivery adds extra costs. This paper introduces a new supply chain configuration called Hybrid model for the EGS with the purpose of increased operating efficiency and lower investment costs. It also launches a research agenda for the Hybrid model. The Hybrid model is studied in terms of costs and service and compared to current business models.

Keywords: E-commerce, Grocery Shopping, Logistics, Simulation, Supply Chains

1. Introduction

More and more supermarkets are being built to enable people to park their cars near by while shopping for heavy and bulky daily consumer products. In fact, supermarkets have increased their share in Finland from 21,9 % to 43,2 % of daily consumer goods sales from 1991 to 1998 (A.C. Nielsen, 1999). According to study made in Finland households visit shops on average 4,3 times a week spending on average 48 minutes time on weekdays and 58 minutes on weekends (LTT,1995). If this is converted to costs using the average worker salary as the calculation basis, the total annual cost is 34 billion FIM (€ 6 billion), which is about 50 % of the total value of the grocery business in Finland. Of this time, 57% is spent in cars while the rest in shops picking and paying the goods. Based on these figures it is the downstream operations in the logistics chain of grocery goods, the self-service pickup from the shop to the household, that is currently the most expensive and ineffective part.

At present electronic commerce is growing rapidly hand in hand with people and businesses getting more and more connected to the Internet. Electronic Grocery Shopping (EGS) with direct home delivery is gradually starting to become a viable option for busy families who do not want to spend their leisure time in grocery shops. The early EGS operators, like early Peapod (www.peapod.com) business model, offer service built on top of the traditional grocery shop where the Internet is only used as a communication tool to transmit the customer order. We claim that in order to become a cost competitive alternative for consumers, the EGS needs to be based on completely new business model, where the Internet is used to connect all parties in the supply chain to the same flow of information in real time. This means that the entire grocery supply chain, all the way from the suppliers to the household needs to be reengineered.

In the USA the development towards a new supply chain configuration has started already as the so called dedicated EGS companies, like Streamline, have entered the marketplace with investors backing them up. At the same time huge losses are made in the battle against the traditional players. In smaller markets the funds needed for this kind of revolutionary action are not easy to come up with. In this case a gradual market driven growth of EGS will possibly save the traders from huge front up losses and speed up the development.

There are already a few publications and some literature on e-commerce in general. However, the logistics of e-commerce is a new line of research. In the literature search we found very little relevant scientific literature on the use of Internet in the grocery logistics and applications. The about only sources of public data are a few Internet pages. Therefore the literature review concentrates on generic theories of supply chains that are applicable to this new field of research.

The existing inefficiency in the final stage of the grocery supply chain as well as the new possibilities opened by the increased household penetration for Internet builds the motivation for setting up a research agenda for this purposes as well as for this article. Specifically, the objectives of this article are
to outline one specific EGS supply chain configuration alternative, the Hybrid model
to propose a research agenda for the Hybrid model in terms of cost and service performance as such and in comparison to alternative configurations.
The research is focused to the Hybrid model, which is a development path model for traditional grocery traders enabling them to set up an EGS piecewise by utilising as much as possible existing facilities and other investments already made. In terms of studying cost and performance of supply chain configurations, the article expresses a normative view on how simulation should be used to research the cost structure of direct home delivery of groceries.

2. Framework

2.1 Electronic Grocery Shopping

Electronic Grocery Shopping can be regarded merely as electronic order processing of household grocery shopping accompanied by the ensuring home delivery. The order processing is an important part of the process but it is not as important a part of the entire supply chain structure. Even if the ordering would be done e.g. by telephone and the order transformation to bits and bytes would take place elsewhere in the ordering process, this would not have a significant impact on the total cost structure.

Another common tendency is to think EGS as a supermarket copied to an electronic form. However, we think that it is highly unlikely that the concept of supermarket will survive in EGS. The digital copy of a supermarket can offer only the possibility to buy products. When the value offering point i.e. the point where the consumer receives the groceries (Holmström et.al 2000), is shifted forward in the supply chain up to the household, the operation should be designed to meet the household needs. A much more interesting aspect is a continuous supply of products offered to the consumer, which could be realised, for example, as a VMI of groceries in the household (Småros & Holmström 2000). This is an example of a possible new value adding services that can be realised in the EGS environment. Therefore it is important to understand that EGS is not only a traditional shop in electronic form. It is a paradigm shift that enables completely new approaches for building a demand and supply chain of grocery products from suppliers to the household.

2.2 Postulation of Research Agenda Scope

When we look at the supply chain from the producer to the household as an integrated process, it is quite clear that there must be different types of supply chain designs depending on the product or product group in question. It is essential that the cost-to-serve is known for each product group for the whole supply chain for all feasible service level options in order to make informed decisions on service offering and pricing. However, an organisation should take a process view rather than a functional view to supply chain planning. Thus, it should work across functional boundaries to integrate business processes needed to create the supply chain. This way an organisation can in some cases compress its lead-times and raise quality and accuracy at all stages and at the same time improve service and lower the costs (Braithwaite & Samakh 1998).

According to the basic warehouse management theory (e.g. Bowersox et al, 1986) the products in the warehouse should be classified to volume or other groups and each group be controlled accordingly. Fisher (1997) extends this classification from warehouse to cover all parts of the supply chain. Fisher suggests that products with predictable demand should have an efficient supply chain focused on minimising physical cost. These stable demand products that he calls “functional”, typically have large volume and low profit margin. In the grocery environment good examples for this product category are milk and beverages. The supply chain for products with unpredictable demand should be responsive. These high margin, low volume “innovative” products have high product variety within each category. The margin of error in the demand forecast according to Fisher is often up to 100 percent. Good examples in the grocery world for this kind of product are West Indian Chilli Sauce or insect repellent. Just (concentrating on) the physical efficiency of the supply chain for these products will not increase overall profitability. This is due to the negative impact of other factors like lost sale that can have more impact on the overall profitability. The primary purpose of supply chain design for functional products is to supply predictable demand efficiently at the lowest possible cost. For innovative products the design purpose is to respond quickly to unpredictable demand in order to minimise stockouts, forced markdowns, and obsolete inventory. The aspect of supply chain redesign for EGS that needs to be included in the scope of research agenda is demand predictability i.e. forecast accuracy.

When designing supply chain to support EGS there is another important issue to consider. The positioning of the customer order decoupling point (CODP). It defines the stage in the supply process, where the product is linked to a specific customer order. The positive and negative effects of backwards and forward shifting generally are in table 1 (Olhager 1994).

Table 1. Reasons and Negative effects of a CODP shift

	Backward	**Foreward**
Positive effects	• Reduce the reliance on forecasts • Reduce or eliminate buffer inventories • Reduce the risk of obsolescence of inventories	• Reduce the customer lead time • Process optimization
Negative effects	• Longer delivery lead times • Reduced delivery reliability • Reduced process efficiency due to reduced possibilities for optimization	• Rely more on forecasts • higher risk of obsolescence • Reduce the product range • Increase products-in-process

In the traditional grocery shop the COPD is normally in the store when the customer walks in the store and picks up all the products he wishes to purchase by himself. In the EGS, however, the COPD can be shifted backwards and in some cases forward in the supply chain providing more degrees of freedom in supply chain design.

These general supply chain issues of cost-to-serve, product classification and CODP form the framework for constructing the elements for Electronic Grocery Shopping supply chain.

2.3 Description of the Hybrid model

The Hybrid Model is based on current supermarkets that are redesigned so that they can more effectively start direct home delivery at the same time still keeping also the conventional store. The hybrid model is an evolutionary model for developing physical distribution in the electronic grocery shopping. It enables a stepwise development of the physical distribution structure towards more Internet shopping dedicated solution so that the risks and investment costs are decreased. The overall supply chain costs will be reduced by by-passing most of the current structure for part of the products. The hybrid model is illustrated in figure 1

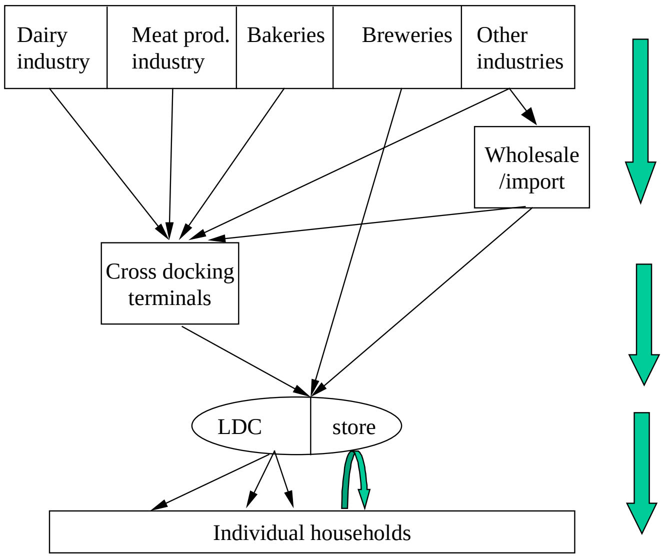

Figure 1. The Hybrid Model

This paper will describe how simulation model will be used to research the total supply chain cost structure from supplier up to the final delivery to the household. The model should accommodate different levels/views as the research focus will to vary by the volume of households served. As the volume of households served grows, it opens new opportunities also for the configuration of the upstream supply chain, thereby shifting the research focus nearer the industry while the home delivery details can be researched with lower number of households.

The hybrid model is constructed for true EGS with smaller volumes and based mostly on investments already made. The operation can be done by current supermarkets that are redesigned direct home delivery while still keeping also the conventional store. That the overall supply chain costs will be reduced by bypassing most of the current structure, e.g. in-store operations, for part of the products serves as the working hypothesis. This is done by using dedicated supply chains from the supplier directly to the LDC.

The grocery products are initially divided into three categories based on the sales volume. For adjustments the product and product categories can be analysed for their suitability to the standard supply chain structure suggested to each type

Table 2. The characteristics of the supply chain for A, B and C-products

Category	A	B	C
Cost-to-serve	very important	Important	not so important
Supply chain focus	cost	Efficiency	responsiveness
CODP	Supplier/LDC	Store/LDC	Store
Inventories	At the supplier	Automated	manual

In the basic design of the hybrid model the A-products have no inventory. A-products come directly from the industry to the LDC based on accumulated customer orders. In the LDC the products are sorted to the home delivery boxes. For some A-products an optimal operation can be based on estimated demand in stead of customer orders e.g. to enable the transportation from the supplier to the LDC in full truckloads. In Finland, typical products of the A-category are brewery and dairy products.

B-products have an automated or manual inventory. For this category, the emphasis is on efficient picking. In today's supermarket the construction and lay out are not designed to support picking efficiency. Quite contrary, the design makes the consumer to spend as much time as possible in the store to make maximum amount purchase on impulse. The delivery boxes with the A-products get the ordered B-products either automatically or manually from the B-product inventory. Typical B-products have medium purchase frequency and are not heavy or bulky. Canned food, meat products, rice and pasta are good candidates for the B-group in Finland.

For C-category products the store is used as an inventory and picking is done manually. A good planning and control system can make the picking more efficient than in the "We shop for you"-services where one customer order is picked at a time. The picking from the store can be controlled by the home delivery routing system. When a full home delivery vehicle is getting completed with A- and B-products the needed C-products from the store can be grouped to make a couple efficient pick-up runs trough the store to complete all orders ready to go. A typical C-product is a small bottle of West Indian Chilli Sauce. The store naturally carries all A- and B-products but the quantities and space allocation for these products are just a fraction of the one in the conventional store.

The largest area of cost in conventional supply chain from the supplier to the store checkout register is the operational costs within a store. This is 17 % of the value of the goods based on the SmartStore figures (Table 3). In the initial design of the Hybrid Model the emphasis has been on eliminating the store handling as well as some inventory costs for the volume part of the logistics stream. The elimination of the store cost gives room for the extra costs for the home delivery. On the other hand, the today's supermarket can carry even over 15 000 products with very low purchase frequency. The consumers expect these products to be available in any attractive shopping environment in the future. Using the store for inventory of products with low purchase frequency lowers the start-up investments for the EGS service while still enabling fast home delivery.

Table 3. Example of cost structure of one EGS versus typical supermarket, figures compiled by Smart Store, a research-and-development initiative at Andersen Consulting (INC 1999)

	Typical Supermarket	Streamline
Cost of goods sold	$ 0.75	$ 0.72
Operating costs	$ 0.17	$ 0.13
Distribution	$ 0.04	$ 0.06
Corporate overhead	$ 0.03	$ 0.03
Net profit $	$ 0.01	$ 0.06

3. Research agenda for the Hybrid model

The second objective for the research agenda was to find out the overall feasibility of the suggested Hybrid model and compare it to alternative business models. The alternative business models are the conventional store with multilevel supply chain and the dedicated e-grocery without any physical store.

The research agenda needs to accommodate multiple research approaches. There will be a need for both case qualitative studies and quantitative modelling research. The most significant expected result of the case studies is to identify products, product groups and manufacturing industries capable of operating with the A-type supply chain.

3.1. Research questions

The qualitative case research is expected to give answers to questions:

What specific products can use A-type supply chain?
What changes and adjustments will be needed (to what)?
What investments are needed and where?
What service models can be offered to consumers?
What service level can be achieved?

The qualitative approach research will study different food producing industries as cases using the suggested model. The various products and product groups will be investigated first as separate flows having no interaction with product flows of other industries. This phase will specify the characteristics of an A-type product and identify the industries and product suppliers capable of using the (again A-type) supply chain. The next step is to define the differences between B- and C-products

The main focus of the modelling research is to determine of the cost structure of the Hybrid model. The research questions in this area include:

What is the cost difference of attended and unattended receipt of goods in home delivery?
What is the effect of service level to home delivery cost?
What cost benefit can be achieved with dynamic routing?
What is the break-even volume for having a dedicated local distribution centre?
What is the effect of service level to middle stream transportation cost?
Are there middle stream product flows that can be combined to achieve better efficiency?

We are at this stage only interested in the larger scope of cost structure so we have decided to use simulation for the transportation and distribution parts of the supply chain and we have excluded the handling and order picking as well as ordering and payment. The cost structure of operations in local distribution centres and cross-docking terminals will be calculated without simulation.

The questions concerning the areas near the household require much less volume than the questions up the stream. This implies a multiple model approach where questions emerging at different levels of volume should be simulated with models focusing on each level separately.
Figure 2 illustrates the suggested approach.

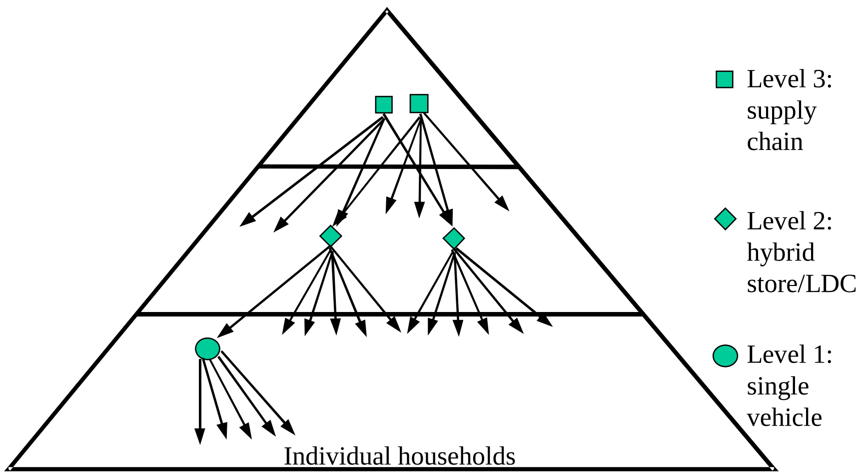

Figure 2: Multiple model approach for the EGS research

3.2. The multiple model approach

The first level of research questions near the household can be answered by using just one delivery vehicle in simulation. Using several vehicles will just give the same result several times. The typical Finnish household expenditure on groceries per person is about € 1 680 per annum per person (A.C. Nielsen, 1999). The prime customer group for home delivery groceries according to

Streamline, Inc is a suburban double income household preferably with three or more children. Their service model includes one weekly delivery as standard and extra deliveries at extra charge. Streamline customers buy more almost 90 pct of all groceries trough the service (Dagher 1998). The goods are delivered unattended to a delivery box at the household.

Average Finnish household visits a grocery shop 4,3 times a week (LTT,1995). Based on this we assume that it is more realistic to investigate a slightly modified service model in Finland. We have taken two weekly deliveries as standard service. The average customer household size of four people is used as a starting point. When we use the 90 pct purchase ratio through the service we can calculate that our defined target customer family purchases groceries for € 6 050 annually and get them delivered twice a week to their home in 48 weeks of the year.

We estimate that these parameters selected tend to give higher transportation cost than the actual costs will be. The early experience in Finland and Sweden shows higher value per delivery than we end up with these parameters (€ 63 per delivery). However, we feel that it is better to start with parameters that are highly unlikely to give too optimistic picture of the new logistics structure. Models in each level needs to be easily updateable to new parameter values when more reliable benchmark figures from the early EGS operators become available.

The first level of simulation will include 300 households. This figure is the estimated capacity of one delivery vehicle making 120 drops a day five days a week. The total 600 drops a week will give a twice-a-week service to the households. The research question on this level will be: What is the influence of attended or unattended receipt of goods on transportation costs. The simulation will be done in real area using real household locations randomly picked from data coming from a grocery chain operating in the area with 5 stores.

The density of households will affect to the transportation costs so it can be adjusted by picking the 300 households from smaller or larger area. Furthermore, the unattended and attended receipt can be combined. Thus, we can test how much attended receipt can be mixed with unattended base delivery load before the costs will start to soar.

The second level includes 3000 households and we will be using the same base area of 25 square kilometres of Helsinki suburbs. The area totals slightly over 200,000 inhabitants and they form 89,000 households. The reasons for this scale selection is that it is the smallest amount of households that can be served profitably with two local distribution centres based on Streamline's experience. So on the other hand we want to limit the number of households to the minimum while still having a maximum possibility to combine delivery routing options. The purpose for this level simulations is to understand the impact of dynamics in routing to home delivery costs. By running simulations with 12 delivery vehicle and two LDCs in slightly overlapping areas gives an environment where the cost of flexibility can be studied with different service models and their combinations.

The third level includes 30,000 households and it is not expected to give better understanding of the pure home delivery part of the costs. This amount of households as customers in the earlier selected needs to be tested to see the implications of 33 % local market share to the transportation costs but the density of households is so big that it will most likely offer new possibilities to upstream supply chain configuration. The main purpose of simulations with this amount of households is expected to get answers to questions concerning the middle and upper stream operations of the A-category products. Selecting different areas with local market shares ranging from 1 to 20 pct will enable cost calculations for different distribution strategies for the A-product manufacturers.

Finally, the distribution strategies for B- and C- category products will be tested on the forth level with some 300,000 households. Table 4 summarises the objectives of the research by simulation.

Table 4. Research scope and questions at different modelling levels

Level	Number of households	Research questions	Model focus	Expected results
1. Van	300	Attended vs. unattended reception of deliveries	Households	Impact to distribution cost structure
2. Suburb	3 000	Static vs. dynamic routing	Local distribution	Cost trade-offs Operational aspects
3. Metropol	30 000	Middle and upper stream flows of A-products Recycling	Middle stream and local distribution	New cost structure for supplier distribution Improvement potential
4. Nation	300 000	B- and C-product distribution costs	Upper and middle stream distribution	New cost structure Operational aspects

4. Discussion

This paper sets out a proposal for a research agenda for EGS supply chain research. The line of research is entering into new grounds, as evidenced by the virtual non-existence of scientific literature, thereby filling a gap in the scientific body of knowledge. At this initial stage, three contributions (Yrjölä

1999; Småros et.al. 2000, Kämäräinen 2000) have already been made public. At the same time, the importance of EGS field needs not questioning and the research agenda is expected to give results that have clear implications for the practitioners on the viability of the Hybrid model. The multiple methods of case and modelling research increase the validity of findings produced by the research agenda by the principle of methodological triangulation**,** as recommend for logistics research by Menzer and Flint (1997). Menzer and Flint (1997) point out that the lack of realism and external validity are problems of modelling approach whereas statistical generalisability in turn is a problem in case research approach (e.g. Yin, 1993, by Menzer and Flint, 1997). The multiple model approach to simulation modelling enables research in many levels of accuracy, much like the zooming and focusing method advocated by Eloranta and Räisänen (1984), and enables addressing a wide variety questions at different levels of detail as shown in table 4.

The research agenda at present still excludes some potentially important topics in the EGS Hybrid model environment. For example, the effects of campaigns and promotions are not included, nor is marketing in EGS environment in general. Solutions to increase order picking efficiency especially at the LDC are similarly left outside the scope of this agenda. Another important issue is that once the paradigm shift from today's supermarkets to EGS occurs, it is likely to bring about further benefits in terms of EGS adapted product packaging that supports home delivery and picking efficiency instead of shelving ease which are not tackled in this research agenda.

It is expected that the research findings produced by the agenda can be readily generalised to different geographical areas in Finland as well as other grocery markets outside Finland with the reservation that the particular parameter choices, like customer density and the household average purchase value, must be comparable. In the model, the parameters can of course be changed and sensitivity analyses for parameter values needs to be carried out, but in terms of generalising the published results, the correspondence of parameter choices must be considered carefully. Generalising to other areas and countries applies to the viability of the Hybrid model as such as well as its viability as a function of households, service levels and costs. The concept of choosing the supply chain according to product class seems readily applicable to other countries, while the actual division of products into these classes does not. To some extent, the results may be applied to the problem of a hostile market entry situation, but the key questions are likely to be different in those cases.

The research agenda proposed by this paper is at the present being carried out in Helsinki University of Technology with industrial partners including a daily consumer goods supplier, food industry manufacturers, a grocery chain, commercial refrigeration manufacturer and a teleoperator as a three-year, national Finnish research initiative ECOMLOG.

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