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The impact of investments on e-grocery logistics operations

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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 Auditorium Luna, Spektri at Helsinki University of Technology, Industrial Engineering and Management (Espoo, Finland) on the 13th of June, 2003 at 13 o'clock.

ABSTRACT

In recent years, various business models have been implemented in e-grocery retailing, however, in most cases, without success. The biggest stumbling block has been logistics, and some inefficient operation has frequently led to capital being used up on operating expenses. Therefore, improving overall logistical efficiency can be seen as one of the most important steps towards profitability. This dissertation aims at understanding different e-grocery logistics system implementation alternatives. The main objective is to study how best to implement an e-grocery business from the logistical point of view so as to ensure profitability. The second objective is to identify, model, and evaluate different logistical solutions that can be used in e-grocery retailing. Solutions for achieving greater picking efficiency are presented and modelled. Special attention is paid to investments in the automation of picking. Different unattended reception solutions and revenue models are identified and examined. The potential of the revenue models is evaluated with modelling and concrete examples. The last objective is to find and evaluate cost-effective combinations of logistical solutions in different market situations so as to enable the successful implementation of an e-grocery business.

According to the results, the general rule that cost savings in picking cannot be realised with automation if demand and capacity utilisation varies significantly applies also to the e-grocery business. Therefore, the focus should be more on creating a flexible distribution centre with manual solutions. Another result suggests that shared reception boxes with an open system have the potential to be profitable as a part of the e-grocery logistics system. However, customer demand is currently uncertain and therefore capacity utilisation is crucial. Finally, the way in which the order of implementing logistical solutions affects e-grocery business investment is presented. The flexibility of individual solutions and solutions' inter-dependencies when choosing an investment strategy are discussed.

Keywords: e-grocery business, electronic grocery shopping (EGS), home shopping, home delivery, automation, picking efficiency, unattended reception, reception box, shared reception box, e-fulfilment, investment, capacity utilisation

FOREWORD

This dissertation was carried out during the ECOMLOG research programme at the TAI Research Centre at Helsinki University of Technology during 1999-2002. This inspiring and cooperative working environment made it possible to complete this research process successfully.

Numerous organisations and people - my colleagues, fellow-students, company representatives, friends, and family - have given me support during the research programme and after it, when I was finalising the dissertation. There is no possibility to name all of them here. However, without their help and criticism I would not have been able to complete this learning process with the required amount of work, critical thinking, and creativity. Therefore, I wish to express my appreciation to all of them.

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Vesa Kämäräinen

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DEFINITIONS

Terms and their meanings as used in this dissertation.

Attended reception	Traditional way to receive the order; the customer has to be at the delivery address to receive the order at the given time or time window.
Automated order picking	Automated picking means that part or all the products are picked by using automation. For example, items can be manually removed from the picking location and then transported to the packing and/or shipping area by a conveyor. Devices such as the pick car concept and carousels are used to decrease the amount of manual work. Picking is often controlled by a computer.
Delivery box	The delivery box is an insulated and secured box that can be left on the customer's doorstep. It can be equipped with a secure docking mechanism. Pick-up of the delivery boxes is carried out at the next delivery time or separately on the day after delivery.
Delivery window	The e-grocer's operating hours are divided into delivery windows as defined by the service concept. Attended reception usually means two- or three-hour delivery windows for the customer.
Distribution centre (DC)	A distribution centre can be used as an alternative place for store picking. It requires higher picking volume than a supermarket and aims to cut picking costs as a result of the increased picking speed, lower labour costs, and more efficient space utilisation. Picking can be based on manual or automated solutions.
E-grocery business	Customers order groceries mainly by using electronic channels such as the Internet. Orders are picked and delivered to customers. Also referred to as electronic grocery shopping (EGS) and e-grocery retailing.
Home shopping	Customers order products using the Internet, catalogues, or mobile phones. Orders are picked and delivered to customers. Also includes non-food items.
Just-in-time (JIT)	JIT is a management philosophy which involves providing the right items of the right quality and in the right quantity at the right place and at the right time.

Logistics system	A logistics system consists of operational elements of logistics such as picking, home delivery, and reception of the orders.
Order assembly	Order assembly includes picking, packing, and shipping operations at the supermarket or distribution centre. In addition, it includes check-out operations when using a supermarket.
Reception box	Reception boxes are usually refrigerated (they can also contain separate lockers at different temperatures); customer-specific boxes are located in the customer's garage or yard and can be locked. Reception boxes can be customer-specific or shared.
Shared reception box	Shared reception box units may have various amounts of separate lockers, each of which contains a freezer, chilled, and room temperature compartments. The separate lockers have electronic locks with a changing opening code to enable shared usage of the lockers using a mobile phone. The shared reception box units may be placed, for example, in bus or underground stations, petrol stations, tobacconists', newsagents, and office car parks or wherever the retailer believes it to be convenient for consumers. The shared reception box concept may also be called the automated Collection and Delivery Point (CDP) concept.
Traditional grocery retailing	Store-based shopping i.e. customers do their shopping at some physical location, for example in a supermarket, hypermarket or corner store.
Unattended reception	Customers become independent of the delivery timetable (i.e. they do not need to be at home waiting for the delivery) by receiving orders in the reception box (their own or shared) or delivery box.
Vendor-managed inventory (VMI)	Suppliers actively participate in the customer's inventory management and send replenishments when needed. For example, the e-grocer takes care of the consumer's grocery replenishment.

PAPERS

Paper I Kämäräinen, V., Småros, J., Holmström, J., Jaakola, T. (2001), "Cost effectiveness in the e-grocery business", *International Journal of Retail and Distribution Management*, Vol. 29, Number 1, 2001, pp. 41-48

Paper II Kämäräinen, V., Saranen, J., Holmström, J. (2001), "The reception box impact on home delivery efficiency in the e-grocery business", *International Journal of Physical Distribution and Logistics* Management, Vol. 31, Number 6, 2001, pp. 414-426

Paper III Kämäräinen, V., Punakivi, M. (2002), "'Unattended reception – a business opportunity?", forthcoming in the *International Journal of Services Technology and Management*

Paper IV Kämäräinen, V., Punakivi, M. (2002), "Developing cost-effective operations for the e-grocery supply chain", *International Journal of Logistics: Research & Applications*, Vol. 5, Number 3, 2002, pp. 285-298

Paper V Småros, J., Holmström, J., Kämäräinen, V. (2000), "New service opportunities in the e-grocery business", *International Journal of Logistics Management*, Vol. 11, Number 1, 2000, pp. 61-73

1 INTRODUCTION

1.1 Background

The home delivery of groceries is not a particularly new service concept in the grocery business. Many grocery retailers and even manufacturers have offered delivery services to consumers for decades (Papiernik 2000). However, the potential of the home delivery business was not remarkable until the mid-1990s, when Internet-based ordering gave the market a great boost.

From the customer's point of view, home shopping should mean convenience. Early e-grocers offered services such as videos, dry cleaning, and film processing in addition to groceries (Reda 1998). These services make customers' lives easier by obviating the need to stand in the checkout queue or drive to the supermarket. In particular, an e-grocer can offer a good service to those people who have difficulties in getting to the supermarket or who have a lack of time, such as disabled persons or busy urban families (Tuunainen 1999; Morgansky and Cude 2000). However, e-grocers are still too expensive for many consumers, mainly due to their high consumer prices and home delivery charges.

In spite of the low-margin nature of the grocery business, market opportunity in the grocery business is remarkable. In Finland, the size of the grocery market is about 10 billion euros (Nielsen 1999). Globally, the grocery business is not growing very fast, but the e-grocery business is estimated to be one of the fastest-growing areas in e-commerce (Rowland 2001). In recent years, in addition to the pure start-up companies, various supermarkets have started e-grocery businesses. E-grocers around the world have used hundreds of millions of dollars to win market share from traditional grocery retailers. However, most of the players have failed. The focus has been on rapid growth, while the principles of logistics design have been a minor object of the e-grocery business. As a result, rapid growth and inefficient logistical operations have used up capital on operating expenses without a remarkable market share in grocery retailing being gained. For example, the e-grocery market is estimated to represent only about 0.2% of total retail grocery sales in the USA, 0.3-0.7% in the UK, and 0.1% in Finland (IDC 2000; Finch 2001; @ Your Home 2001; Päivittäistavarakauppa 2001). In other words, the value of the e-grocery market is approximately $900 million in the USA, 450–1,000 million euros in

the UK, and 10 million euros in Finland. The grocery retailing giants Tesco and Ahold are major players in the e-grocery business. Tesco.com is the world's biggest e-store, with a turnover of approximately 340 million euros in 2000. Other noteworthy e-grocers in 2000 were Peapod (owned by Ahold, $120 turnover), Sainsbury ($65 million) and Asda Wal-Mart ($60 million) in the UK, and Safeway ($65 million) and Albertson's ($50 million) in the USA (Van Gelder 2002a). However, the size of the e-grocery market has grown fast and it is likely that the value of the market has even doubled since 2001.

In spite of general interest and the implementation of various service concepts, only a small amount of research has been carried out in the area of e-grocery logistics. However, the need for such research is obvious (Auramo et al 2002). The development of the e-grocery business is challenging, but on the other hand there are a lot of opportunities. Firstly, many rules and regulations have to be followed in the grocery supply chain. When practical logistical solutions are developed for the e-grocery business, it is possible to apply these solutions to other supply chains. Secondly, in the grocery business, the product range is wide and material flows are massive, even from the individual consumer's point of view. For example, the consumption of groceries in Finland is almost 1,000 kg per person yearly (Finfood 1999). Most of these groceries are consumed at home and currently "home deliveries" are made by consumers themselves. Thirdly, market potential in the e-grocery business is remarkable and demand is not very sensitive to economic fluctuations. People need groceries on a regular basis and this means that there is a chance to develop a service system that covers a wide range of households. From the companies' point of view, groceries are the best hope for reaching profitability in the home delivery business (Bovet and Martha 2000).

Compared to traditional grocery retailing, home delivery and order picking are new operations and additional costs in e-grocery retailing (Himelstein 1999; Reda 1998; Ring and Tigert 2001). Currently, the most common home delivery model is that customers select a time window when the groceries are delivered. This means that the customers have to be at home to receive the order. Another alternative is to use so-called unattended reception. It means that customers become independent of the delivery timetable (i.e. they do not need to be at home waiting for the delivery) by receiving orders in a reception or delivery box. Unattended reception gives more freedom to the e-grocer, who can thus use

more flexible and efficient route optimisation (Punakivi 2003). Order picking is another big cost driver (Kämäräinen et al 2001a). Picking can be done in an existing supermarket or a specialised distribution centre. Currently, the most common way is to pick orders in supermarkets. However, some players, such as Peapod in the USA and Telemarket in France, also use distribution centres in order to be more efficient in picking. In some cases, picking speed is improved by using automated distribution centres. From the logistical point of view, existing operational models can be divided into four main combinations (Tanskanen 2000):

- attended reception with store-based picking
- attended reception with distribution centre-based picking
- unattended reception with store-based picking
- unattended reception with distribution centre-based picking

In spite of various logistical solutions and alternative combinations, knowledge of success factors has remained uncovered (Punakivi 2003; Yrjölä 2003). Hitherto, customer demand has been low and e-grocers have operated mainly by using store-based picking and attended reception. However, competitive prices and new services are needed to create a wider customer base.

To increase market share, e-grocers need to implement logistics systems that enable the cutting of costs. In this dissertation, the term logistics system means operational elements included in e-grocery retailing. Many solutions aimed at cutting operational costs have been introduced, but nobody has pointed out the optimal logistical solutions and their right combinations from the point of view of implementation. However, knowledge about how best to implement an e-grocery logistics system is one of the most critical factors when starting a business.

1.2 Objectives and scope of the Dissertation

In spite of all the effort and money put into developing e-grocery businesses around the world, there are only a few e-grocers that have made improvements that have successfully led to profitable operations. Usually, e-grocers have concentrated on improving some specific element or logistical solution, while overall effectiveness has remained poor. A good example is the former Webvan, who radically increased the speed of picking in their distribution centres but could not make their other operations efficient. Therefore, the main objective of this dissertation is to study how best to implement e-grocery systems so that businesses can become profitable. A successful implementation process also requires understanding different logistical solutions. Therefore, the second objective is to identify, model, and evaluate different logistical solutions that can be used in an e-grocery retailing. The focus is on issues of picking and goods reception, because these are essential operations for an efficient e-grocery logistics system. These operations have required huge investments and have also been stumbling blocks for most e-grocers. It has been proved that unattended reception enables a more efficient operational model than attended (Punakivi 2003), but implementation and revenue issues are still unsolved. The last objective is to find out cost-effective combinations of solutions in different market situations and give guidelines for a successful implementation process.

The study aims at understanding what is needed for e-grocery logistics system implementation by formulating answers to the following research questions:

I How best can an e-grocery logistics system be implemented?

- *What logistical solutions have the greatest potential in different market situations?*
- *What is the right combination of logistical solutions?*
- *How do different logistical solutions and implementation orders affect the overall behaviour of a logistics system?*

To find answers to these research questions, some additional research questions need to be formulated and answered, in addition to results from earlier research that have to be

utilised. Focused research questions concern picking and reception problems that are still uncovered but important from the point of view of the whole logistics system.

II How should order picking be carried out in the specialised distribution centre?

- *What is the potential of manual picking of customer orders?*
- *How should automation be used in picking?*

III What is the feasibility of providing unattended reception solutions?

- *What are possible revenue models for unattended reception?*
- *What is the impact of alternative goods reception modes on customer service?*

Logistics is not the only focus of concern when trying to cut costs and make an e-commerce business profitable, but it is one of the major issues (Peters 2000). However, the focus of this study is on logistics implementation issues, including different operational solutions and their inter-dependencies in the downstream of the supply chain.

The scope of this dissertation covers the e-grocery retail logistics. It is very challenging because many rules and regulations on temperature and hygiene have to be followed in the grocery supply chain. Potential material flows in the e-grocery retailing are massive, but current volumes are still small. Furthermore, consumer expectations are high.

1.3 Research environment

This study was carried out at the TAI Research Centre, which is an independent unit of Helsinki University of Technology. Ten company partners were involved in the ECOMLOG research programme during 1999-2002, in addition to Tekes, the national technology agency. The names of the company partners can be found in Appendix I.

The ECOMLOG research programme focused on logistics and supply chain management for e-commerce. The main objectives of the research programme were:

1) to develop B2C e-commerce models for changing the supply chain from passive product delivery into proactive service to the consumer or business customer, and
2) develop B2B e-commerce models that both increase transactional values and reduce transaction costs in the supply chain.

At the beginning of the research programme, there were four different projects, called: 1) Intertrade; 2) simulation and modelling; 3) C-VOP (Consumer Value Offering Point), and 4) e–collaboration. The Intertrade project merged with the simulation and modelling project in the autumn of 2000. The e-collaboration project developed and piloted collaborative supply chain planning and control models using web-based applications. Later, the e-collaboration and C-VOP projects also merged. In the autumn of 2001, a new project was established to commercialise the results of the research programme. In the end, the research programme consisted of the three different projects as described in Figure 1.

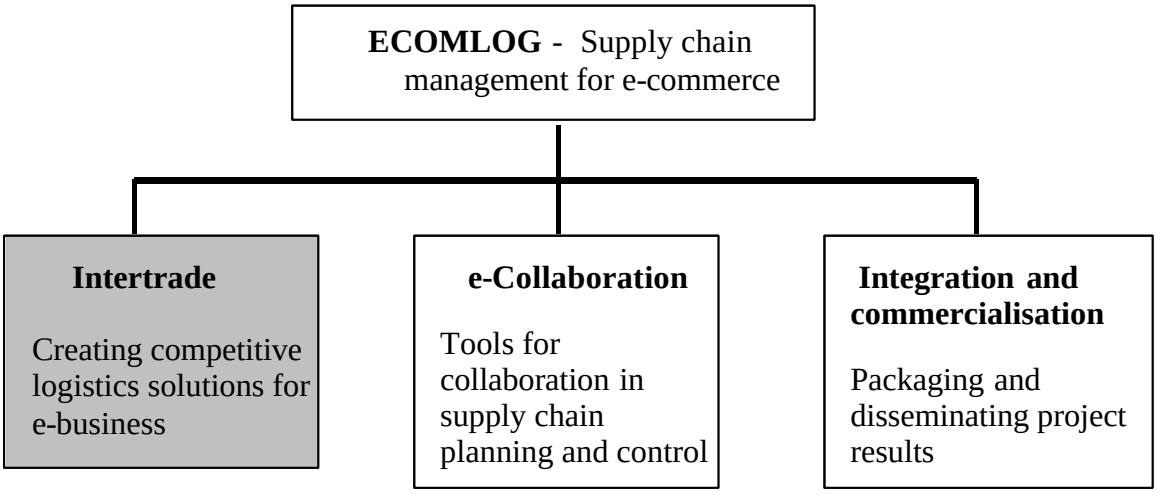


Figure 1. The structure of the ECOMLOG research programme.

This dissertation is closely related to the Intertrade project. The preliminary work of the Intertrade project started in 1997 and was mainly carried out by Hannu Yrjölä. The author first became involved in the project in the pre-study phase in the summer of 1998. The Intertrade project was first launched as a part of the ECOMLOG research programme in April 1999. The first guidelines for the research programme were soon published by Yrjölä

and Tanskanen (1999), Holmström et al (1999), and Yrjölä et al (2000). During 1999-2002, the author took part in the project as a researcher and a project manager.

The focus of Intertrade was mainly on the e-grocery supply chain and especially on the physical distribution of groceries. On the basis of early research, the main research question of the Intertrade project was formulated. *"What are the essential issues in achieving cost-effective supply chain operations in the e-grocery business?"* Three different research topics identified for this project were home deliveries, order assembly systems, and e-grocers' impacts on operations in the supply chain upstream. During the research, the major emphasis was on home deliveries, including the reception of the goods, as a result of the observation that the reception mode used has a strong influence on the overall cost-effectiveness of the e-grocery business. Order assembly systems, including the comparison of picking operations in a store and in a specialised distribution centre and analysing the impact of automation, were seen as another important area of research. Upstream operations, including an analysis from the first-tier supplier's point of view, were the third research topic.

Hannu Yrjölä managed the Intertrade project for the first two years and took responsibility for the main research question. During the research process, the main question was divided into three sub-questions, and responsibilities were divided as follows:

- *What is the impact of alternative goods reception models on the 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 addition, all the authors had their own specific research questions under the three main topics. However, during the research process it was decided to give more weight to some research topics than others. Also, strong inter-dependencies between the topics were observed. Therefore, the authors studied these topics partly individually and partly

together. The responsibilities and individual research questions in the Intertrade project are given in Appendix II.

This dissertation is restricted to the study of e-grocery logistics implementation issues. The focus is on e-grocery logistics system implementation in the downstream of the supply chain, starting from picking operations and ending with the reception of orders at the customer's end (Kämäräinen et al 2001a; Kämäräinen et al 2001b; Kämäräinen and Punakivi 2002a, Kämäräinen and Punakivi 2002b, Småros et al 2000).

Other related studies in the Intertrade project consist mainly of the studies of Mikko Punakivi and Hannu Yrjölä. Punakivi focused on home delivery and route optimisation issues, studying also the impacts of different reception alternatives on home delivery efficiency (Punakivi 2003; Punakivi et al 2001a; Punakivi et al 2001b; Punakivi and Saranen 2001; Punakivi and Tanskanen 2001; Punakivi 2000; Punakivi and Holmström 2001a). In addition, Punakivi studied environmental issues in the home delivery business (Punakivi and Holmström 2001b). Punakivi has also published the results of some research together with the author of this study (Kämäräinen and Punakivi 2001; Kämäräinen and Punakivi 2002a; Kämäräinen and Punakivi 2002b).

The dissertation of Yrjölä is a monograph. He studied overall cost-effectiveness in the e-grocery supply chain and tried to find out what constitutes an efficient e-grocery supply chain structure. The focus of his dissertation is on finding an answer to the question whether an e-grocery business cost structure can take over a traditional grocery business cost structure (Yrjölä 2003; Yrjölä et al 2002; Yrjölä 2001; Yrjölä 2000; Yrjölä and Tanskanen 1999). Yrjölä has published some research together with the author of this study (Yrjölä et al 2000; Kämäräinen and Yrjölä 2001) as well. However, these studies mainly concern the logistics of general merchandise retailing. The dissertations of Punakivi and Yrjölä are studied more closely in the literature chapter. Table 1 summarises the main research areas in the dissertations of Kämäräinen, Punakivi, and Yrjölä.

Table 1. The main research areas in the dissertations involved in the Intertrade project.

Main research areas	Kämäräinen	Punakivi	Yrjölä
E-grocery business cost structure versus traditional grocery business cost structure.			X
The efficiency of different home delivery operation models in the e-grocery business.		X	
Feasibility for supplying unattended reception solutions.	X		
Automation investments in picking efficiency.	X		
Implications of the e-grocery business for the middle and and upstream of the supply chain.			X
Efficiency indicators in the e-grocery business.			X
Environmental issues in the e-grocery business.		X	
Terms for e-grocery logistics system implementation.	X		

1.4 Structure of the Dissertation

This dissertation consists of five papers and a binding story that includes six chapters. In the first chapter, an introduction to the e-grocery business and the main challenges in the development of logistics are presented. This chapter also contains the objectives and scope of the study. Furthermore, the first chapter introduces the research environment.

Chapter 2 is a literature review. In this chapter, an overview of logistics, e-grocery markets, and earlier research is given. In addition, relevant theories and concepts connected with the research problem are studied and their applicability to the answering of the research questions are discussed. In Chapter 3, the hypotheses of this dissertation are formulated. In addition, the contributions of the separate papers included in the study are presented in this chapter.

Chapter 4 presents the research approaches and the research methods used in this dissertation. Chapter 5 reviews the results of the dissertation. It also shows how the binding story links together the papers and the research questions. Chapter 6 presents the contribution of the dissertation. The managerial implications, validity, reliability, and relevance of the dissertation are discussed in this chapter. In addition, this chapter outlines the limitations of the study and indicates some directions for future research.

2 LITERATURE REVIEW

In order better to understand the e-grocery business and implementation process from the logistics point of view, a short overview of logistics is given in this chapter. Logistics is studied from the points of view of marketing, operations and systems. The second part of this chapter provides an overview of the e-grocery market and models, in addition to mentioning earlier research in the field. These are needed to provide an understanding of the mistakes and, on the other hand, the success factors of the early players.

2.1 Logistics

The term logistics first appeared in the early 1900s. However, it did not become well known until the Second World War, when military operations demonstrated how distribution activities could be integrated into a single system (Lambert and Stock 1992). In practice, the Second World War also represented a starting-point for the development of logistics in the business environment. Soon, physical distribution was being discussed in relation to marketing, and logistics was linked to customer service.

The Council of Logistic Management (CLM 2001) describe logistics as "that part of the supply chain process that plans, implements and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements". Christopher (1998) has a more strategic approach to logistics. He states that "logistics is the process of strategically managing the procurement, movement and 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 maximized through the cost-effective fulfilment of orders".

The differences between logistics and supply chain management (SCM) definitions are very small (Lambert et al 1998). According to Vokurka and Lummus (2000), SCM is more than logistics. It is the integration of all the processes involved in SCM and it changes the roles of other functional areas such as marketing, sales and financing (Vokurka and

Lummus 2000). Supply Chain Management (SCM) first appeared in the early 1980s, when Oliver and Webber (1982) discussed the potential benefits of integrating the internal business functions of purchasing, manufacturing, sales, and distribution. However, nowadays logistics and supply chain management are often referred to as essentially the same thing (Lambert and Stock 1992).

Logistics has always played an important role in the retailing business. According to Fisher et al (2000), forecasting, supply chain speed, inventory planning and gathering accurate, available data are critical areas in achieving efficient retailing operations. Fernie et al (2000) studied the development of grocery logistics in the UK. They state that changes in supplier control, centralisation, the just-in-time principle and supplier-retailer relationships have been important development areas during recent decades. Until the 1980s, the supplier provided most logistical support to stores. However, nowadays third party contractors often undertake store deliveries. The need to shorten lead times and reduce inventories led to the centralisation boom in which regional distribution centres (DC) replaced direct store deliveries in the late 1980s and early 1990s. This created a retail-controlled distribution network and simultaneously opened up new markets for third party companies.

This centralisation, combined with advances in information handling, such as point-of-sales data (POS) and electronic data interchange (EDI), was the starting point for the application of JIT principles in logistics operations (Fernie et al 2000). In practice, this meant more frequent store deliveries and smaller order sizes. This also increased the importance of IT and information sharing. In the mid- and late 1990s, the grocery business received a new impulse for information sharing through the efficient consumer response (ECR) and collaborative planning, forecasting, and replenishment (CPFR) approaches (ECR 2001; CPFR 2002). ECR is about "increasing consumer value while optimising the supply chain, and so generating profitable growth for the trading partners involved" (ECR 2001). In practice, the focus is on sales forecasting and the statistical management of safety stocks. CPFR focuses on "the process of forecasting supply and demand by bringing various plans and projections from both the supplier and the customer into synchronisation" (Harrison and van Hoek 2002). In the grocery business, various CPFR projects that have been successful from both the retailer's and supplier's points of view

have been introduced during recent years. In grocery retailing, the world-wide concentration of retailers, the increase of own-label products, the need to develop common industry standards, customer analyses enabled by IT, the growing number of supermarkets and home shopping are also seen as important categories of development (Vorst 2000; Fernie et al 2000).

Increased logistical requirements have created possibilities for specialised logistics companies. In fact, the increase of third party (3PL) and fourth party (4PL? [1]) providers can be seen as an important trend in logistics. Factors such as a focus on core competencies, increased customer service requirements, capital requirements, supply chain costs and simplifying the industrial relations environment have opened up opportunities for those 3PL providers whose main purpose is to take care of customers' logistics operations (Gattorna 1998). However, typically no single 3 PL provider is able to satisfy all logistical requirements. The concept of 4PL is an extension of the 3PL concept. Typically, 4PL providers are interfaces between the client and multiple logistics service providers taking care (ideally) of all the aspects of the client's supply chain management (Gattorna 1998).

The overall target of logistics is to achieve the chosen customer service level at the lowest possible total cost (Boversox and Closs 1996). Logistics has an important role in long-term profitability. In Figure 2, it can be seen how logistics affects long-term profitability through better customer service, a long-term customer relationship, and retention. Logistics can also be described as a concept that tries to integrate a company's different activities in such a way that the efficiency of the overall system increases. The logic of Figure 2 applies especially well to e-grocery retailing, where various possible services can be created and offered to customers, depending on customer needs and willingness to pay for the service.

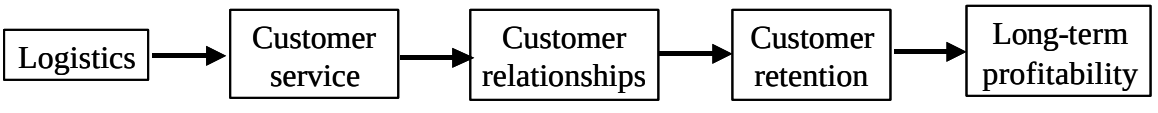


Figure 2. The linkages between logistics and profitability (Christopher 1998).

[1] trademark introduced and owned by Andersen Consulting

Customer service and total costs have a strong trade-off in e-grocery retailing, where picking and home deliveries are additional costs compared to traditional grocery retailing. Therefore, a well-integrated and efficient logistics system is especially important in the e-grocery business. According to McKinnon (1989), logistics can help integrate a company's activities by:

1) mirroring the marketing "mission" of the company
2) improving the efficiency of material and information flows
3) bringing sub-systems together

These views are also used in this dissertation to examine logistics systems and their importance in e-grocery retailing.

2.1.1 Marketing view

Logistics is marketing-oriented and therefore has an important role in satisfying customer needs and achieving a profit for the company (Lambert and Stock 1992). A long-term relationship with the customer means improved retention rates and hence greater profitability. Therefore, greater profitability requires superior customer service. Customer service can also be seen as a link between logistics and marketing.

Product availability in the marketplace at low cost is the key advantage provided by logistics (Harrison and van Hoek 2002). Lambert (1976) has shown the cost trade-offs required in marketing and logistics, as shown in Figure 3. In marketing, the 4P model (product, price, promotion, place) is traditionally used in making decisions about the implementation of a positioning strategy and achieving the associated marketing and financial goals (Harrison and van Hoek 2002). Logistics is mainly involved in the place component, which also considers the firm's channels of distribution as shown in Figure 3 (Lambert and Stock 1992). However, logistics supports product and promotion decisions as well.

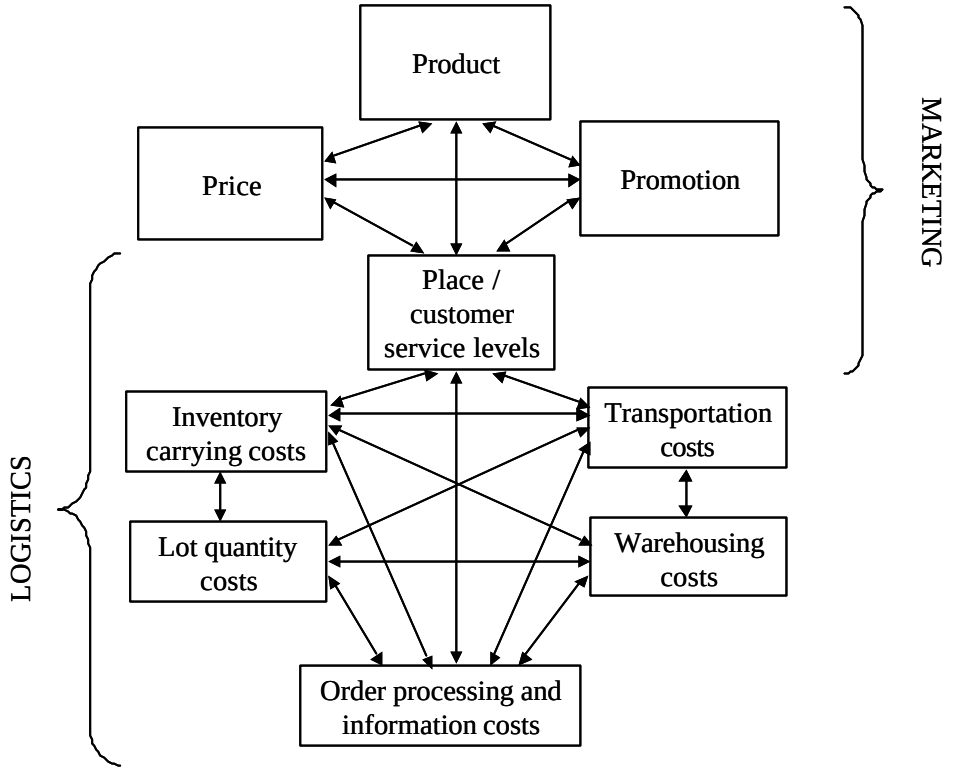


Figure 3. Cost trade-offs required in marketing and logistics (Lambert 1976).

To guarantee the right product at the right place at the right time, the logistics system and processes must be designed to support products in the marketplace (Harrison and van Hoek 2002). The marketing objective is to allocate resources to the marketing mix so as to maximise the long-run profitability of the company, whereas the objective of logistics is to minimise total costs, given the customer service objective (Lambert 1976). The link between marketing and logistics is especially important in grocery retailing, where customers usually have many shopping options and therefore low barriers to changing retailers.

2.1.2 Operational view

In grocery retailing, the trend in logistics strategy is to reduce the number of levels in the supply chain (Cooper 1990). This tendency has also been seen lately in the case of e-tailers, who have tried to change channel structures by bypassing some levels of the supply chain. On the other hand, by delivering products to the end customers, e-tailers have also taken account of customers as an essential part of the supply chain. Examples of different retailing channel structures are seen in Figure 4.

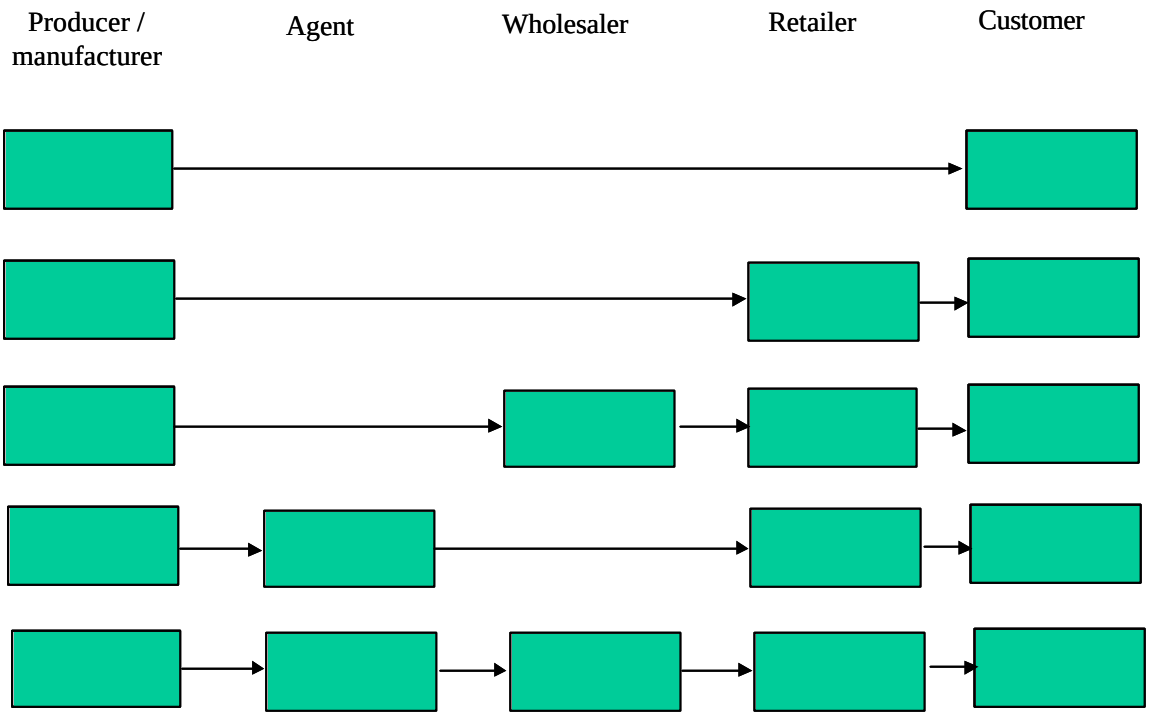


Figure 4. Different channel structures (Gustafsson and Mannermaa 1979).

Logistics strategy (cost-leader, product differentiation, service), product type (functional, innovative), time-based distribution (centralised, decentralised), product life cycle, and customer requirements (customer density, need of support) can be used as heuristics when choosing the distribution strategy (Inkiläinen 1988). Regardless of the structure chosen, the development of operations is one of the biggest challenges when trying to improve supply chain efficiency. Customer service, transportation, warehousing, inventory management, order processing and information systems, forecasting, and production planning are important areas of development when improving logistics productivity (Lambert and Stock

1992) The role of warehouse management and transportation has increased in the grocery business during recent years as retailers have gained more power in the supply chain. For example, in Finland about half of the retailers' purchases are concentrated on two main organisations.

In e-grocery retailing, picking and home deliveries are challenging operations. To understand these operations better, warehouse management and vehicle routing problems are studied in the following section.

Improving warehouse efficiency

Nowadays, it is mainly traditional supermarkets that are used for e-grocery order picking. However, their main concern is to display the products in an appealing way for consumers, which often means slow picking speed, poor space utilisation, and high costs when placing items on to shelves. In addition, consumers doing their daily shopping obstruct picking staff and the use of a cashier adds checkout costs. On the other hand, supermarket picking does not require big investments. The second alternative, a specialised distribution centre, requires considerable investment, but also offers opportunities to improve picking efficiency and space utilisation in addition to reducing losses caused by pilferage and spoilage (Kämäräinen 2000; Jaakola 1999; Holmström et al 1999). In order better to understand the requirements of an efficient e-grocery distribution centre, some basic principles of warehouse management theory are studied in the following paragraphs.

Warehouse management is an underlying methodology that affects the industrial success of a distribution organisation (Gunasekaran et al 1999). The two main objectives of a warehouse and distribution facility are maintaining improved profitability and better customer service (Mulcahy 1994). Traditionally, the issue of improving warehouses' operational efficiency is discussed from such perspectives as Material Requirement Planning (MRP), Just-In-Time (JIT), and Total Quality Management (TQM). The JIT philosophy can also be used when designing a distribution centre for e-grocery retailing. The aim is the reduction of non-value-adding activities and increasing lead time through the supply chain.

JIT first appeared in the literature in the early 1970s. Originally, it is a Japanese manufacturing technique implemented first by Toyota (McLachlin 1997). In particular, an ongoing elimination of waste and a consistent improvement in productivity are often seen as the main goals of the JIT philosophy (Wallance 1990; Crawford and Cox 1990; Fullerton and McWatters 2000). In the e-grocery business, the picking process is linked directly to home delivery operations as well as the further-upstream operations of the supply chain. This means that flexibility and right timing are extremely important when designing e-grocery operations. The goal of JIT, together with supply chain management and related concepts, is also seen as providing customers with the right products (goods or services) in the right quantities at the right time and place while minimising the costs by eliminating waste in the supply chain (Sakakibara et al 1993; Hanfield 1993; Christopher 1994). In warehousing, it means focusing on demand pull, minimal economic quantity, reducing work-in-progress (WIP), supplier reliability, preventive maintenance, and the elimination of buffers (Gunasekaran et al 1999). The goal is to schedule operations, reduce lead times, and improve on-time deliveries.

Warehouse activities typically comprise receiving, transfer, storing, picking, packing, and shipping operations. Typical warehousing activities and their order are presented in Figure 5. Order picking is an essential operation in the warehouse. Estimates of the cost of labour in picking operations vary from 30 to 65 percent (Gross 1981; Oxley 1988; Coyle et al 1996). Therefore, order picking is seen as the number one area for improvement in warehousing (WERC 1986). A critical issue in order picking is simultaneously reducing the costs and increasing the speed of the order picking activity (Petersen 1999). Information processing has also an important role in warehousing.

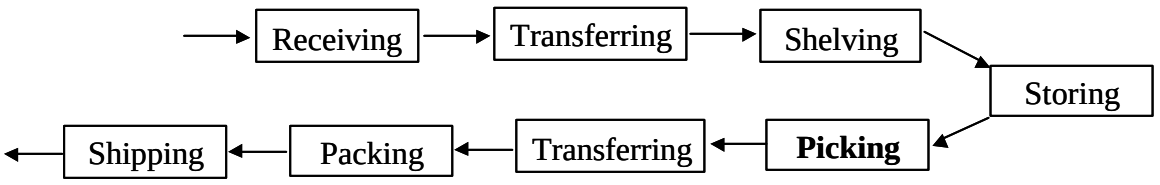


Figure 5. Activities in warehousing operations.

An e-grocery distribution centre can be based on either manual or automated solutions. Factors such as the demand pattern of the items, the configuration of the warehouse, the location of the items in the warehouse, and the picking method greatly affect the performance and efficiency of the picking operation (Petersen 1999). Traditionally, order-picking methods can be divided into manual order-picking methods, mechanised order-picking methods, and automated order-picking methods (Mulcahy 1994).

A manual order-picking method means that an employee goes to the SKU picking position, removes the appropriate items from the picking location, and transfers them to the packing and/or shipping area. Travel time is often about 50 per cent of an order picker's time (Tompkins et al 1996). Travel routes can be studied by using different heuristics. Actually, picking routing is a special case of the travelling salesman problem (TSP). Transversal strategy, return strategy, largest gap strategy, composite strategy, and optimal routing are commonly used heuristics (Petersen 1997; Petersen 1999). These strategies are described in Appendix III.

A mechanised order-picking method means that items are manually removed from the picking location and then transported to the packing and/or shipping area by using a conveyor. Devices such as the pick car concep and carousels are used to decrease the amount of manual work (Mulcahy 1994). These kinds of order-picking methods are also used in e-grocery distribution centres (Cuglielmo 2000).

Automatic order picking means that order picking is controlled by a computer. Items are removed from the shelves using robotics and automation. A conveyor network transfers items to the packing and/or shipping area. Devices such as itematic concept, automatic order picking machines, and the automatic item dispenser concept are used (Mulcahy 1994). In addition, innovations in data capture technology, such as bar codes, RFID, and voice recognition make picking easier and reduce the amount of errors. The recent growth of e-commerce has forced many companies to develop new picking solutions in order to fulfil orders efficiently. Typically, orders in e-commerce are small and volumes high compared to traditional warehouses. In order to meet demand additional space and equipment are often needed. These, together with fast growth, have caused additional costs in picking. According to Carter (2000), traditional distribution facilities typically use from

25% to 33% of their employees in the picking function, whereas a distribution centre designed for e-commerce may utilise up to 90% of the workforce in the picking process alone. This increases the potential for automation and robotics. However, it is important to ensure operational efficiency before implementing automation.

An optimal mix of manual and automated handling systems is vital for warehouse operation (Lambert and Stock 1992). However, operational efficiency in the distribution centre can also be improved by paying attention to the basic principles of layout design. In e-grocery retailing, temperature and hygiene requirements, durability, a wide product range, and demand patterns in particular have to be taken into account when designing the layout of the distribution centre. Basically, those items with the highest turnover should be located nearest to the shipping area. Pareto analysis (ABC analysis) is a good tool for volume analysis when designing layouts (Harmon 1993). Expiry dates are a challenge when dealing with products such as perishables. Therefore, first-in first-out (fifo) is an important picking principle in the e-grocery distribution centre. Cross-docking and flow-through warehousing are good strategies to reduce the amount of spoiled products and improve the efficiency of e-grocery material handling (Jaakola and Kämäräinen 1999). In these strategies, the main idea is to divide a bulk into smaller batches and assemble a shipment for the customer in the minimum time. A former e-grocer, Matomera in Sweden, used this kind of strategy (Johnsson 1999).

Home deliveries and goods reception

Using reception boxes means that the customer becomes independent of the delivery timetable, i.e. he/she does not need to be at home waiting for the delivery. On the other hand, reception boxes give more freedom to the e-grocer, which can be used for more flexible and efficient route optimisation. In the case of reception boxes, there is a deadline for home deliveries, meaning the latest time when the customers have to be served. This gives freedom for routing. In practice, the deadline for home deliveries is, for example, 6 p.m., while the deadline for orders is 11 p.m. the day before. This means one wide delivery window for picking and home delivery, regardless of the customers' timetables. This makes more flexible and efficient route optimisation possible. The home delivery problem is illustrated in Figure 6.

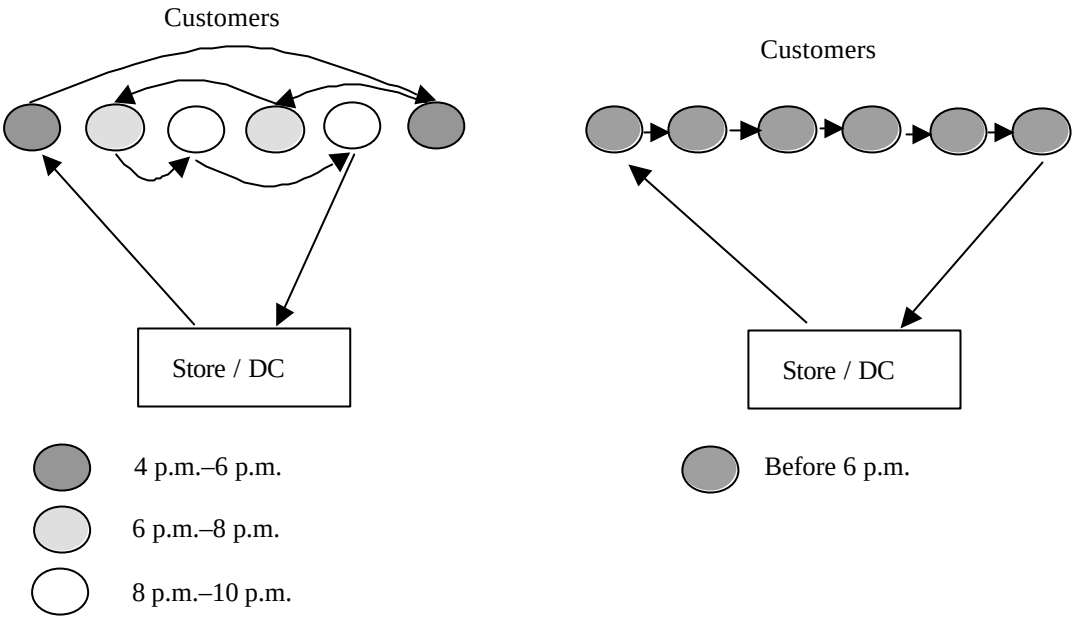


Figure 6. Home delivery with delivery windows and with reception boxes (Kämäräinen 2002).

In Figure 6, a simple example of the home delivery problem is presented. On the left-hand side, there is the general model used in the e-grocery business. There are six customers selecting a time for home delivery from three different time windows. Because the customer has the freedom to choose any of the time windows, it is unlikely that an optimal route can be reached. On the right-hand side, there is a model where reception boxes are used. In this case, the deadline for the reception of the items is at 6 p.m. for all the customers. This means that the e-grocer can optimise routes inside one wide delivery window.

The home delivery problem is equal to the vehicle routing problem with time window constraints (VRPTW) (Solomon and Desrosiers 1988; Desrosiers et al 1988). It is also known as the time-constrained vehicle routing problem (TCVRP)(Kolen et al 1988). The VRPTW problem is a generalisation of the better-known vehicle routing problem (VRP) with time windows or delivery deadlines added (Desrochers et al 1992). The VRP is a special case of the travelling salesman problem (TSP), whereas the TSP is one of the most widely-studied problems in the transportation science literature (Onan et al 1996). In spite of the VRPTW with tight time windows being a considerable problem in practice, it was for a long time of little interest to academic researchers (Bodin 1990). Early approaches to

the VRPTW were mainly developed through case studies (Pullen and Webb 1967; Knight and Hofer 1968).

The goal of the VRPTW is to find the route for a vehicle to serve all the customers at the lowest cost, taking account of the capacity and travel time constraints of the delivery vehicle and the time window the customer has chosen. One of the most impressive changes when solving vehicle routing and scheduling problems has been the introduction of the computer environment with algorithms in the past 20 years (Bodin 1990). Despite the existence of many techniques and methods, the number of constraints and the large size of the simulation environment impose many restrictions on the simulations and so produce inexact results. In the e-grocery business, the costs of home deliveries seem to be heavily dependent on the delivery time required. In this case, it can be said that the VRP is a time-constrained problem.

In addition to the time used for home deliveries, the flexibility of home deliveries may also influence other operations in the e-grocery business. According to Bodin (1990) "chancing the way routes and schedules are created forces the organization to alter how it carries out its other operations, such as how it creates and maintains customer lists and databases, bills for services, provides maintenance, emergency services, and order entry, manufactures products and locates plants and warehouses". In the e-grocery business, routing and scheduling also have a strong link to picking operations.

2.1.3 System view

One of the main challenges in the implementation of an e-grocery logistics system is to find all the success factors and get them to the right places in the right order. Vehicle routing and warehouse management are good approaches to building an understanding of individual logistical solutions but cannot be used to explain the behaviour of the whole e-grocery logistics system. Therefore, this section focuses on understanding e-grocery logistics as a large system consisting of various different logistical solutions.

What is, then, a good definition of a system? Wilson (1993) defines a system as "a structured set of objectives and/or attributes together with the relationships between them in its environment". According to Skyttner (2001), "a system cannot be understood by analysis of the parts because of their complex interactions and because purpose or meaning can only be immanent in the whole" An opposite definition is given by the biologist Weiss (1985): "a system is anything unitary enough to deserve a name". Boulding (1985) has the same kind of broad-minded definition: "a system is anything that is not chaos". According to Ackoff (1981), a system includes two or more elements that satisfy the following conditions:

1) the behaviour of each element has an effect on the behaviour of the whole system;
2) the behaviour of the elements and their effects on the whole system are interdependent;
3) however, subgroups of the elements are formed; all have an effect on the behaviour of the whole system, but none has an independent effect on it.

Customer service, transportation, warehouse management, and other areas of logistics are only part of the logistical system. It should be taken into account that a positive impact on one part can still have a negative impact on the whole system. Therefore, the main emphasis of the logistics concept is on systems. Logistics dynamics involves various players and can be examined as the behaviour of a very complex system. In this system, the behaviour of individual players or elements can have a dramatic effect on the behaviour of the whole system. The structure of a system is often described as an arrangement of different subsystems and components. Therefore, systems differ from each other "in the way they are organized, in the particular mechanisms and dynamics of the interrelations among the parts and environments" (Skyttner 2001). This may also be expressed as an order in the relationship among the components which make up a system.

Individual players usually have their own preferences that conflict with common goals. However, in management as well in engineering, interconnections and interactions between the components of the system are often more important than the separate components themselves (Forrester 1961). Linking operations seamlessly together can be

even more important than the effectiveness of individual operations as well (Kämäräinen and Punakivi 2002b). Therefore, game theory is seen as an alternative approach for the e-grocery logistics system. Game theory is a systematic approach to understanding the behaviour of different players when their fortunes are different (Brandenburger and Nalebuff 1996). It first appeared in the modern mathematical approach to interest conflict in the 1920s (Luce and Raiffa 1957). The game can be rule-based or freewheeling, without any external constraints. A business system can be seen as a complex mix of both types of games. The elements of the game are players, added values, rules, tactics, and scope (Brandenburger and Nalebuff 1996). To change the game, at least one of the elements has to be changed. In the business system or game, the problem for each player is to make the choice that benefits him most.

2.2 E-grocery logistics

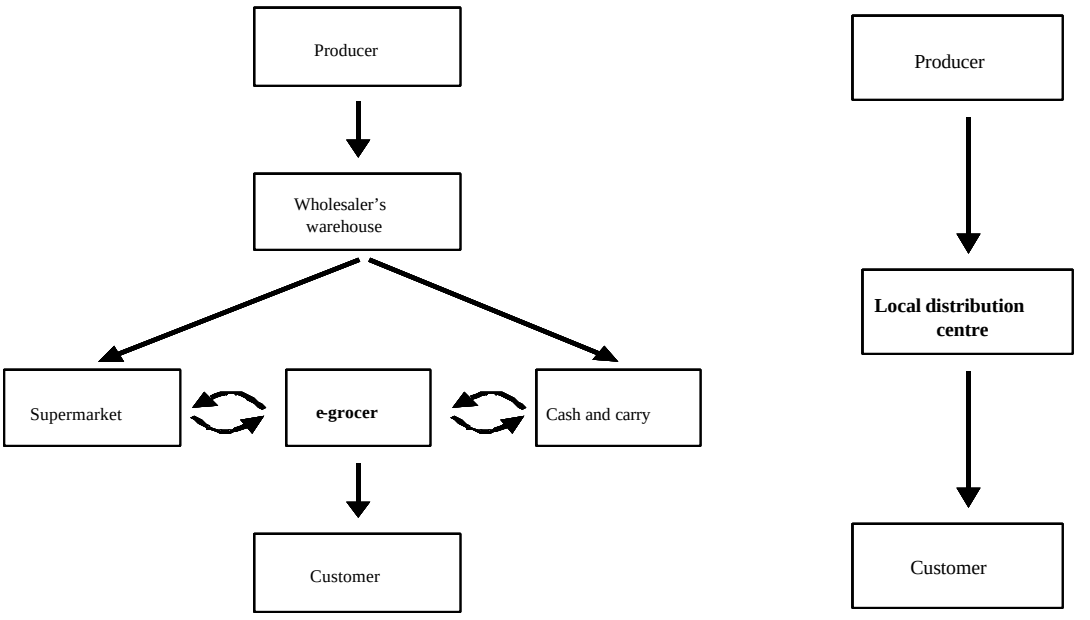
Improvement of supply chain performance is one of the biggest management challenges today (Davis 1993; Towill 1997; Beamon 1998; Lambert et al 1998). In business-to-consumer (B2C) electronic commerce, logistics, especially in the downstream of the supply chain, is a major challenge (Tanskanen 2000). However, the development of logistics for e-commerce involves some big differences compared to traditional business. Major differences occur in the order picking and home delivery operations. In traditional grocery retailing, customers do their own picking free of charge, from the retailer's point of view. The e-grocer, however, has to do this work in addition to the home deliveries. In the e-grocery business, achieving more efficient operations – and thus reducing costs - is one of the biggest challenges (Lewis 2000; Lee and Whang 2001; Kämäräinen 2002, Punakivi 2003; Ring and Tigert 2001; Yrjölä 2003).

2.2.1 Different models of e-grocery retailing

From the supply chain perspective, there exist two different e-grocery models (Dagher 1998; Heikkilä et al 1998b; Holmström et al 1999; Kämäräinen 2000). Figure 7 presents two different supply chains for e-grocery retailing. The first alternative is to operate as an intermediary in the supply chain, picking groceries from a supermarket or "cash and carry" and delivering these to households. This is the most common business model in e-grocery

retailing today. It has worked well as a value-added service for supermarkets (Kämäräinen et al 2001b). However, the increased amount of users of the service has forced them to look for more efficient picking solutions.

The second alternative is to create a totally new channel between producers and the consumer. This is an opportunity when sales volumes are sufficiently large. In this model, the e-grocer purchases items straight from the producers and manufacturers, stocks products in the distribution centre, and makes home deliveries directly to the consumers. In this model, picking and packing are more efficient than when operating from a store. Increased picking speed can be achieved due to operations being designed especially to serve home delivery (Holmström et al 1999). However, a distribution centre requires high start-up investments. Hitherto, we have seen mainly pure e-grocers using this kind of model. However, there are also some e-grocers based on traditional grocery retailers who have found this kind of model valuable.



The e-grocer as an intermediary in the supply chain.

The e-grocer using a distribution center in the supply chain.

Figure 7. The e-grocer as an intermediary or using their own distribution centre in the supply chain (Kämäräinen 2000).

In addition to different alternatives for picking, there are different alternatives and solutions for the reception of goods. The delivery concepts offered usually differ in three respects: delivery lead time, reception time (the reception box or attended reception), and the available delivery time windows (Saranen and Småros 2000) The most common home delivery model is that the customer can select a time window when the groceries are delivered. In practice, this means that the e-grocer gives two or three alternative time windows per day for the customer and the customer selects the most suitable, depending on his own timetable. However, the customer has to be at home to receive the goods in the selected time window, which is usually two or three hours.

The second alternative is that the reception of the goods is unattended, i.e. reception boxes are used. There are three types of reception facilities (Punakivi and Tanskanen 2002; Kämäräinen and Punakivi 2002a). A reception box is a customer-specific locked reception box installed in the customer's yard or garage (Kämäräinen et al 2001b; Punakivi and Saranen 2001). It is usually refrigerated. Another type of reception facility is a reception locker, which consists of several reception boxes and can be installed, for example, in car parks or railway stations. The third option is a delivery box, which is an insulated secured box equipped with a docking mechanism (Punakivi et al 2001a). The e-grocer drops the delivery box off to the household and picks it up again during the next delivery or after a given time.

2.2.2 Review of the e-grocery retailing market

The history of the e-grocery business is short and chequered. The first "e-grocer", Grocery Express, was founded in San Francisco in 1981. It offered home delivery for groceries ordered via Prodigy (an on-line service with a simple user interface), phone, and fax (Mendelson 2001). In Finland, the first e-grocery pilot started in 1996 (Nurmi 1998). After fast market growth at the end of the 1990s, many players have collapsed. However, the e-grocery business is still one of the fastest-growing areas of e-commerce (Rowland 2001). In the future, the e-grocery business is forecast to continue to grow fast (Mullaney and Leonhardt 1999; Cuglielmo 2000). However, estimates about future market share vary greatly (IDC 2000; Jupiter 2001). The estimates given by van der Laan can be seen as a realistic demand forecast. According to van der Laan (2001), market share is forecast to be

between 2.5% and 4% of the total grocery market in most European countries by 2006. In the USA, market share can rise to up to 3-5% by 2006 (van der Laan 2001).

However, the market share of e-grocery is still tiny. For example, the share of the e-grocery market is estimated to be only about 0.2% of total grocery retailing in the USA, 0.3-0.7% in the UK, and 0.1% in Finland (IDC 2000; Finch 2001; @ Your Home 2001, Päivittäistavarakauppa 2001). The development of the e-grocery business in Scandinavia has been fastest in Sweden, where market share is about 2%, with about 50 e-grocers (Wikström and Persson 2001). In Finland, there were more than 20 e-grocers in 2000 (Jaakola 2000). However, the amount has decreased radically in the last two years. Finnish e-grocers are based on a model where picking is done from existing supermarkets, but in some cases cash and carries are used for picking. Reception boxes were used in one pilot project, but generally reception is based on attended reception (SOK 2001). All the e-grocers, except Ruoka.net, are more or less value-added services for existing grocery retailers.

In Europe, the amount of e-grocers was approximately 550 in the year 2000 (CIES 2000). The fastest growth rate was in the UK, where the e-grocery business is the strongest in the world, with an annual growth of more than 250% (CIES 2000). The biggest players are Tesco.com, Sainsbury's, and Iceland in the UK, and Carrefour in France (van Gelder 2002a). Generally, picking is done from existing supermarkets, as in Finland. However, there are some players, such as Telemarket in France and the former Matomera in Sweden, who use distribution centres for picking (Gallo 2001; Johnsson 1999). Asda and Sainsbury's in the UK have also used distribution centres, but recently replaced them with store-based picking. Some e-grocers, such as SOK in Finland and Foodferry and Sainsbury's in the UK, have also set up pilots to test the feasibility of unattended reception in practice (SOK 2001; Homeport 2002).

In the USA, hopefuls such as Webvan, Streamline, Shoplink, and Homeruns controlled the e-grocery market at the end of the 1990s. These pure players designed their operations from scratch and usually started by investing in distribution centres. Some players, such as Streamline and Shoplink, offered reception boxes for their customers as well (Streamline

1999; Shoplink 1999). Nowadays, these players have collapsed, whereas Peapod and Groceryworks dominate the market.

In Europe, it was mainly large food retailers who initiated the e-grocery business. In the USA, the market was very different, with pure e-grocers taking the lead in this business (Lewis and Allen 2000). However, this arrangement has changed during the last two years. Pure e-grocers in the USA have mainly failed, whereas the European grocery giants – Tesco and Ahold – have built their own e-grocery strategies and made acquisitions in the USA (see Appendix IV). Nowadays, Peapod is owned by Ahold and Groceryworks by Safeway and Tesco (Prior 2001; Weiss 2001).

2.2.3 Earlier research

In spite of public interest in the e-grocery business, only a small amount of research effort in the area of e-grocery logistics can be seen outside the Intertrade project. This research has mainly concentrated on the mistakes early players made (Rosen and Howard 2000). In this section, a review of e-grocery logistics research is presented and, in addition, some success factors are identified.

The main logistical challenges in the e-grocery business seem to lie in achieving efficient picking and home delivery operations (Lewis 2000; Lee and Whang 2001; Kämäräinen 2002, Punakivi 2003; Ring and Tigert 2001; Yrjölä 2003). The dissertation of Yrjölä (2003) concentrates on finding out if the e-grocery business cost structure can take over the traditional grocery business cost structure (Yrjölä 2000; Yrjölä 2001; Yrjölä et al 2000; Yrjölä and Tanskanen 1999; Yrjölä 2003). In this dissertation four working hypotheses and one main hypothesis are created to gain new knowledge about overall e-grocery supply chain cost structure. The main hypothesis is that "e-grocery with home delivery can be more efficient than supermarket retailing handling a similar volume of sales". The dissertation of Yrjölä builds on the results of the pre-understanding phase and joint research work of the authors Punakivi and Kämäräinen (Yrjölä 2003).

Yrjölä suggests that 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. He criticises the fact that the e-grocery business is usually seen as a supermarket copied into an electronic form. In other words, it is seen only as an opportunity to buy products, whereas the starting point of operational design should be the household's needs. From the customer's point of view, e-grocery shopping can be the same, regardless of the supply chain behind it. Therefore, Yrjölä suggests that supply chain design should take better account of the possibility of adding new services for the customers.

According to Yrjölä, incorrect cost allocation can distort the e-grocery cost structure. Even a small-volume store-based e-grocery business can be seen as profitable if the costs of the goods sold and of picking and home delivery are not allocated correctly. For example, if e-grocery retailing is only a marginal business for the traditional store, fixed store costs are not usually allocated to e-grocery retailing at all. Cannibalising one's own traditional grocery retailing does not mean additional sales and profits in the long run. On the other hand, it is suggested that trying to create a completely new supply chain from suppliers to households appears to be too much to achieve in one go. Purchasing, logistics, and customer acquisition costs, together with the slow changes in consumer behaviour, are too much to overcome at once. Yrjölä points out that e-grocers have a strategic problem which can lead to a complete deadlock situation if customer demand cannot be increased by creating services with an acceptable cost level to all parties involved.

One of Yrjölä's main conclusions is that the operational costs of a distribution centre can be lower than the operational costs of a supermarket. He has calculated that store-based picking is less expensive than using a specialised distribution centre if turnover is less than one million euros. A turnover of more than 3 million euros means that a specialised distribution centre appears to be more efficient than store-based picking, even in the worst case. However, the distribution centre has to be purpose-built for shopping basket assembly and have a reasonably stable workload. Yrjölä also introduces the combination of store-based picking and a specialised distribution centre as an opportunity for gradual low-risk growth for the e-grocery business. This is called the hybrid model, and in it supermarkets are redesigned so that order picking and home deliveries can be performed more effectively than in a conventional supermarket. One of the main characteristics is that

grocery products in a supermarket are initially divided into three categories based on sales volume.

Yrjölä claims that efficient home delivery can be reached with a moderate market share. He discusses the importance of unattended reception for overall supply chain cost structure and claims that only service models that give flexibility in route planning and optimisation can provide efficiency. However, investments in unattended reception should also be taken into account. Yrjölä suggests that the cost-effectiveness 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. According to the dissertation, the most useful factor is sales per square kilometre. It is calculated that any decrease in distance has very little effect on total costs when the average distance between drops goes below 500 metres. In other words, it means annual sales of at least 167,000 euros per square kilometre. Generally, Yrjölä suggests that new efficiency indicators are needed to measure the efficiency of the e-grocery business. He claims that sales per distribution centre and sales per square kilometre are good indicators when choosing a home delivery service model and potential market areas.

Investments in unattended reception are discussed briefly in Yrjölä's dissertation. It is suggested that in the long run households themselves could make investments. This requires the solutions of unattended reception to be seen as additional fridges and freezers, and not only for the purpose of receiving goods. Household-based built-in solutions are seen as potential solutions. However, it is pointed out that it will take many years before the amount of built-in reception is substantial. Therefore, it is suggested that investments are examined as a separate investment for the time being. Yrjölä has calculated that the annual cost of a customer-specific reception box is 175 euros a year, assuming a purchase price of 1000 euros with 8 years' depreciation and annual electricity costs of 50 euros. Yrjölä suggests that customer-specific reception boxes are feasible in suburban areas, whereas shared reception boxes are feasible in city centres and attended reception (with fixed routes) in rural and village areas.

Yrjölä has also examined the possible implications for the middle and upstream of the supply chain. He has divided groceries into Class A, B, and C products, depending on the

sales volume. The implications for suppliers of groceries when changing from supermarkets to specialised distribution centres were studied in a brewery, a dairy products manufacturer, and a meat packaging company. The number of cases in the interview is very limited and the results are seen only as guidelines. It is concluded that there are no remarkable implications for the cost structures of the case companies. It is suggested that sourcing and production planning and distribution benefit from the change. However, it is also pointed out that a specialised distribution centre cannot work efficiently without consolidating customer orders for the logistically largest product groups into direct overnight orders to suppliers. In most cases, this requires new investments in order handling.

The main finding of the dissertation is that e-grocery retailing with home delivery service can be made more efficient than today's supermarket. Yrjölä has calculated that it can be possible when using a specialised distribution centre for picking and when annual sales are more than 200,000 euros per square kilometre. In other words, this equates to at least 25 four-person households per square kilometre who purchase 90 per cent of their groceries from the service. Yrjölä states that e-grocery retailing is a very local business and that store-based picking is a good alternative if fast roll-out with low investments is required. Also, the hybrid model is seen as a platform for gradual low-risk growth for e-grocery retailing. The distribution centre is seen as potentially much more efficient, but it is a slower approach and needs big investments. Yrjölä concludes that whatever service model is chosen, it should be first be made to work in a fairly compact geographical area and then copied to new areas.

Laseter et al (2000) have studied existing home delivery models and their potential in big U.S. cities. They claim that with the existing volume it is impossible to achieve a sales density high enough to alter fundamental delivery economics for the "last mile" operations with attended reception. The work in progress dissertation by Punakivi (2003) also takes into account models of unattended reception (Punakivi 2000; Punakivi and Saranen 2001; Punakivi and Tanskanen 2001; Punakivi and Holmström 2001a; Punakivi and Holmström 2001b; Punakivi et al 2001a; Punakivi et al 2001b). The objective of the dissertation is to identify, model, and analyse the costs of different home delivery operation models in the e-grocery business. The focus of the work in progress dissertation is on comparison between

home delivery costs when using attended reception and different models of unattended reception (Punakivi 2003).

Punakivi emphasises the importance of the development of home delivery operations. In particular, the importance of delivery accuracy, delivery frequency, and delivery lead time will increase due to the development of e-business. In addition, he points out that some country-specific challenges, such as local infrastructure and consumers' shopping habits, become relevant when developing home delivery operations in a B2C environment.

Punakivi models different e-grocery operation models in a multi-vehicle environment using the RoutePro vehicle routing tool. Different delivery operation models are studied and the costs are modelled on the basis of a sample of point-of-sales data from one of the largest grocery retailing companies in Finland. The data collected (81,139 receipts) included quantities, volumes, dates, shopping times, and the prices of shopping baskets. The data used were limited to those concerning shopping baskets exceeding 25 euros. In addition, home delivery modelling was limited to the selected test area (135km^2) in the Helsinki metropolitan area. Due to these limitations, the research data included 1,639 shopping baskets and 1,450 individual households.

Punakivi points out that the more options the customer is allowed when choosing the delivery time window, the more vehicles and working hours are needed. This means a longer total distance driven. Punakivi has compared the costs of different delivery models to the current cost of customers visiting a supermarket. He presents significant cost savings in home delivery operations when using a two-hour delivery time window, but, on the other hand, points out that even more remarkable cost savings can be achieved by using unattended reception. The average cost per attended stop with a two-hour delivery window is claimed to be 2.57 times higher when compared to that of unattended deliveries. It is also pointed out that even if 10% of deliveries are attended this will double the number of vehicles needed when compared to the situation in which all home deliveries are totally unattended. In other words, with customer-specific reception or delivery boxes, savings of 44 to 53% can be reached compared to attended reception with a two-hour delivery time window. When using shared reception boxes, cost savings as high as 55 to 66% are claimed.

Punakivi has also calculated whether investments in unattended solutions could be justified by the cost savings in home delivery operations. It is stated that an investment level of 1,000 euros per reception box, together with the costs of installation, would mean a payback period of 6 to 13 years on a piece of equipment whose maximum life cycle is assumed to be 7 years. Punakivi points out that the payback period for customer-specific reception boxes is too long and this model will remain a niche service. He sees more potential in shared reception boxes. Similarly, it is calculated that an investment level of 24,000 euros in a shared reception box (including 24 units) would mean a payback period of 2 to 5 years when the number of daily deliveries varies between 20 and 720, assuming 50 and 75% utilisation rates.

In addition, Punakivi has taken environmental issues into account. It is concluded that all the home delivery service models are more environmentally friendly than the current situation in which customers use their own cars for shopping. A reduction in traffic from 54 to 93% is posited, depending on the home delivery model used. Kärnä (2001) has estimated that "the indirect effects of EGS adoption become even more significant than the way in which the EGS shopping process is organised". However, she points out that as long as the scale of e-grocery retailing remains small, there will not be a significant reduction in the amount of materials or energy consumed.

McKinnon and Tallam (2003) have studied security problems common to most forms of unattended delivery and suggest ways of overcoming them. They have classified unattended delivery methods into secured delivery, which includes home access systems and reception boxes, and unsecured delivery, which includes traditional drop-offs and collection points such as neighbour and commercial outlets. It is posited that giving the delivery driver internal access to the home or an outbuilding creates the most vulnerable security scenario. On the other hand, communal reception boxes are seen as the most secure alternative. McKinnon and Tallam conclude that a major shift to Internet shopping would be likely to cut shrinkage levels in the retail business.

Peters (2000) has studied the differences between traditional fulfilment and e-fulfilment. He points out that e-fulfilment involves more than reengineering the picking process in an old warehouse. Hill (2000) claims that catalogue, wholesale, B2C, and B2B e-commerce

each require a slightly different strategy in the building of a distribution centre. Jaakola (1999) has studied the structure and layout of an e-grocery distribution centre. He presents different solutions for efficient manual picking. Jaakola and Kämäräinen (2000) point out that picking in the e-grocery business is very demanding because of many restrictions, rules, and regulations, such as temperature requirements and sell-by date limitations, which have to be followed.

De Koster (2002) has studied the relationship between the operational complexity of e-grocers, the existence of traditional sales channels, and the distribution structure for Internet customers. The study was carried out in 1999-2001 and included 39 companies offering groceries with Internet ordering. It found out that assortment type i.e. full-line or non-full-line (the assortment is full-line if it consists of ambient and a substantial number of frozen and fresh products) does not determine the company's distribution structure. However, it was found that more orders per week led to more use of specialised distribution centres. A strong relationship was found between e-grocery business model and distribution structure, meaning that pure e-grocers have specialised distribution centres more often than companies with an existing store infrastructure. The study points out that traditional grocers tend to keep using their existing infrastructure for fulfilment, but there is some weak evidence that a large number of orders favours the use of a specialised distribution centre. De Koster (2002) concludes that although more complex operations tend to have specialised distribution centres, incorrect cost allocation between store and Internet orders and the cannibalisation of existing stores may have an impact on the distribution structure chosen.

In addition to picking and home delivery, there are also other challenges. Ring and Tigert (2001), have studied the reasons for e-grocers' failures. They make the criticism that even if e-grocers could solve the twin cost killer problems – picking and home delivery – they still have insufficiently high demand, very high up-front marketing costs, and a lack of trust among consumers. Kämäräinen and Punakivi (2002b) point out that, especially in the case of pure players, weak negotiation and purchasing power with suppliers, inefficient customer acquisition, low order frequency, and a lack of services have been the main reasons for failure.

Tanskanen et al (2002) have studied different service models in the e-grocery business and identified six factors necessary for successful e-grocery operation. They suggest that a successful e-grocer can be built by focusing on customer density, customer loyalty, the buying power against suppliers, a good ordering interface, good availability of product information, and high margin products, in addition to the groceries. Småros et al (2000) add that high customer demand can be reached only if the right mix of services can be created. Ancar et al (2002) present similar results. They have studied different ways to create customer value in the e-grocery business. The importance of finding and targeting the right customer segments for the specific products or services is emphasised.

Morgansky and Cude (2000) point out that the reason why a home delivery service makes customers' lives easier is that it gives them more freedom and leisure time. Morgansky and Cude (2002) analyse consumer demand for the acceptance of store-based e-grocery shopping using data collected in three studies in the USA from 1998 to 2001. In their study, the typical e-grocery customer is a female who is better educated, has a relatively high income, and tends to be somewhat younger compared to the general population. Most households included children and two adults. The study found that experienced e-grocery shoppers have significantly reduced the time used for grocery shopping. More interestingly, in 1998, only 19.3% of the survey participants bought groceries mostly online, compared to 73.5% in 2001. The most important reasons for e-grocery shopping were convenience/time and physical constraints. Heikkilä et al (1998a) contend that the most likely customers can be found among suburban family commuters, elderly and disabled people, and computer-literate young people.

This section has summarised earlier research in the area of e-grocery logistics. From the logistical point of view there is a very limited amount of logistics research in the area of the e-grocery business outside the Intertrade project. This research has mainly studied existing solutions, taking account of the limited data available. The studies of Punakivi (2003) and Yrjölä (2003) also examine cost structure and operational efficiency for e-grocery solutions and models that are not yet being utilised. A summary of the other Intertrade research results and links to this study is presented in Figure 8.

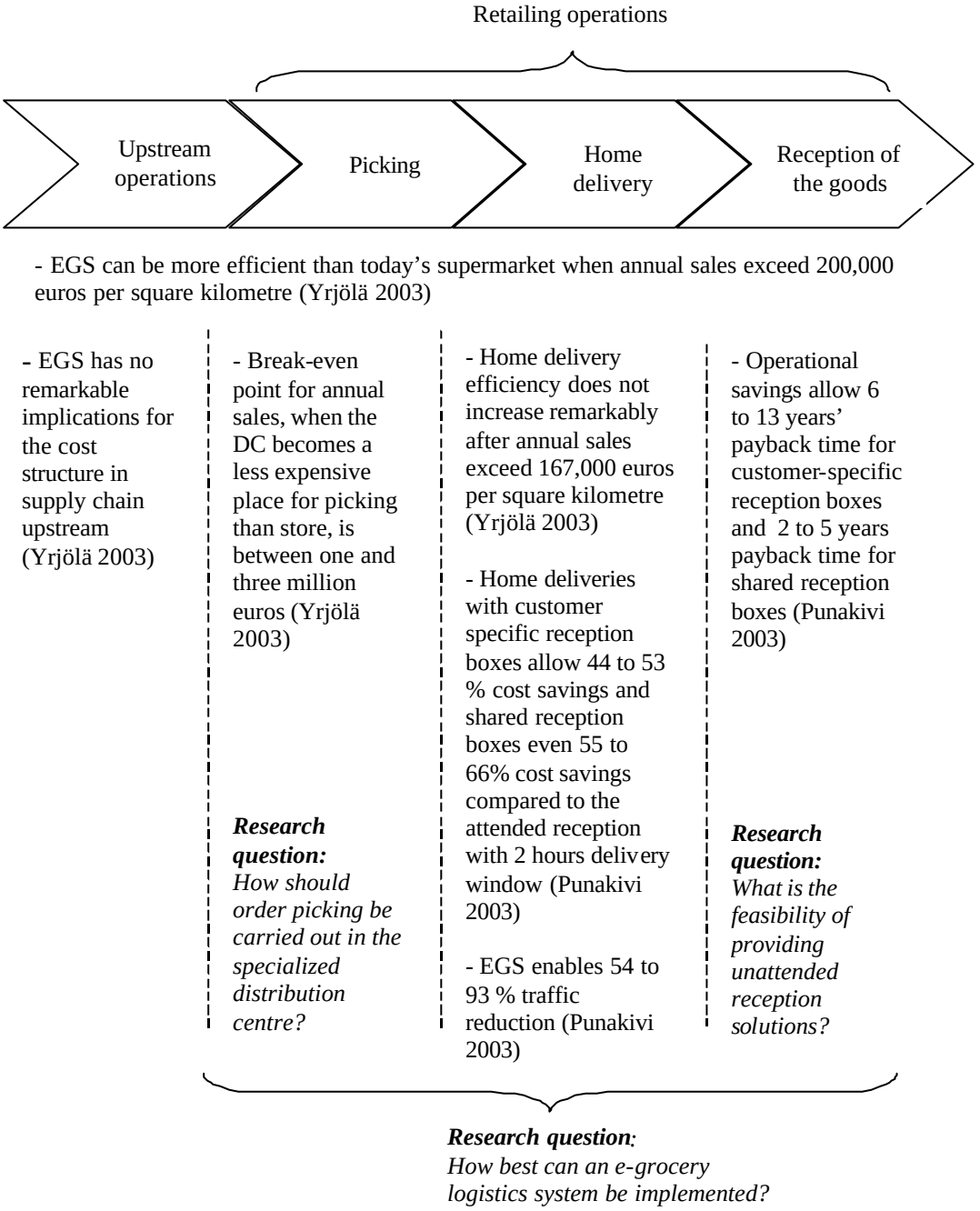


Figure 8. Summary of the main results from other Intertrade research and links with this study.

As shown in Figure 8, there still exists a lack of research in the areas of picking automation, the feasibility of unattended reception, and the implementation of a whole e-grocery logistics system. Therefore, this dissertation aims to attain new knowledge of implementation issues, taking into account different logistical solutions and the interdependencies between them.

3 HYPOTHESES AND RESEARCH PAPERS

The previous chapter presented an overview of the e-grocery business and a literature review of useful theories needed in the research field. This chapter covers the hypotheses of the dissertation. These are created to consolidate the existing knowledge and to create new ones in order to better understand the problems and provide directions for future research in the field. In addition, an overview of separate papers and their contributions to the dissertation is presented in this chapter.

3.1 Hypotheses

In this section, three hypotheses are created. A hypothesis has an important role in the development of a theory (Emory 1985). To understand better the requirements of successful e-grocery retailing and its implementation process, a deeper understanding of the logistical solutions and dynamics of e-grocery logistics systems is needed. The hypotheses of this dissertation are formulated through a deductive strategy which aims to draw conclusions through logical reasoning. In deduction, knowledge is increased by accepting or rejecting hypotheses, which helps in the creation of explanations or predictions (Ghauri et al 1995). The philosophies of Popper have also had an important role in the formulation of hypotheses. Approaches to hypotheses are discussed further in Chapter Four.

As described earlier in this dissertation, there are various operational models in the e-grocery business, without there being a shared opinion as to which is the right one. The early players introduced different logistical solutions and combinations without success. However, they agree that the two biggest cost drivers are order picking and home deliveries. Existing e-grocers have shown that there are two alternative places where to do the picking, the existing supermarket or a distribution centre especially designed for efficient picking operations. However, there has been considerable uncertainty concerning the level of automation in the distribution centre. This research concentrates on picking in the distribution centre and studies the potential of investment in automation compared to manual picking work. This is related to Research Question II. The difference in cost-

effectiveness between manual and automated picking solutions must be understood in order to realise how order picking should be carried out in the distribution centre. In order better to test the effects of picking automation, the following hypothesis is created on the basis of Research Question II and existing understanding in the field:

Hypothesis I: **Automated picking in an e-grocery distribution centre is more cost-effective than using manual solutions.**

Hypothesis I has to be tested in order to get an answer to Research Question II. Therefore, the impacts of automation investments on picking and overall cost-effectiveness are studied. In addition, alternative ways to achieve cost-effective picking operations will be presented.

Investment in unattended reception would be a means of reducing the current operational cost level (Punakivi 2003). However, only very limited pilot projects and market tests for different modes of unattended reception exist. As Punakivi has shown, the savings achieved in delivery operations are unlikely to cover the investments in the reception boxes. Furthermore, customers' willingness to accept a new service is still unknown. Therefore, it is important to study the economic feasibility of different modes of unattended reception. The third research question is related to the feasibility of unattended reception solutions. Based on Research Question III and existing understanding of usage of unattended reception solutions, the second hypothesis is formulated so as better to understand the feasibility of unattended reception solutions in the e-grocery logistics system.

Hypothesis II: **Unattended reception solutions are not economically feasible for e-grocery retailing.**

Hypothesis II has to be tested in order to get an answer to Research Question III. The answer will demonstrate if there are feasible revenue models for unattended reception solutions.

Picking and reception solutions require high levels of investment and have been stumbling blocks for many players. In addition, there have been numerous different opinions as to how to implement an e-grocery logistics system. Some e-grocers have contended that the best way is to start by investing in picking facilities, while some others think that investments should start with reception facilities or value-added services. This is related to Research Question I.

Finding the right logistical solutions and combinations would be a means to a profitable e-grocery business. Therefore, the big challenge is to find out guidelines for a successful implementation process. The early e-grocers implemented their logistical solutions very differently. The third hypothesis was created to increase knowledge about the implementation order of solutions in e-grocery logistics systems. It is formulated and tested on the basis of an understanding of existing e-grocery implementations, Research Questions I, II, and II and knowledge gained through the testing of Hypotheses I and II.

Hypothesis III: **The order of implementing solution components is not significant in e-grocery retailing.**

Hypothesis III has to be tested in order to get an answer to Research Question I. To find an answer, the interdependencies between different elements of the e-grocery logistics system are studied. In addition, implementation alternatives are studied. The answer will demonstrate if there are differences between separate implementing strategies.

3.2 Overview of separate papers included

This dissertation consists of five separate papers. These papers examine the logistical issues of the e-grocery business from different points of view. The contributions of the papers are presented in Table 1.

Paper I Kämäräinen, V., Småros, J., Holmström, J., Jaakola, T. (2001), "Cost effectiveness in the e-grocery business", *International Journal of Retail and Distribution Management*, Vol. 29, Number 1, 2001, pp. 41-48

Paper II Kämäräinen, V., Saranen, J., Holmström, J. (2001), "The reception box impact on home delivery efficiency in the e-grocery business", *International Journal of Physical Distribution and Logistics* Management, Vol. 31, Number 6, 2001, pp. 414-426

Paper III Kämäräinen, V., Punakivi, M. (2002), "'Unattended reception - a business opportunity?", forthcoming in the *International Journal of Services Technology and Management*

Paper IV Kämäräinen, V., Punakivi, M. (2002), "Developing cost-effective operations for the e-grocery supply chain" forthcoming in the *International Journal of Logistics: Research & Applications*, Vol. 5, Number 3, 2002, pp. 285-298

Paper V Småros, J., Holmström, J., Kämäräinen, V. (2000), "New service opportunities in the e-grocery business" *International Journal of Logistics Management*, Vol. 11, No. 1, 2000, pp. 61-73

Paper I presents some basic principles of how to cut costs in the e-grocery business. The authors' focus is on operational costs and, especially, investments in picking automation. Solutions aimed at achieving better picking efficiency are presented and investment in automation is modelled. Other authors participated in the modelling and provide an

especially detailed example of how an e-grocery distribution centre for efficient picking could be designed.

Paper II identifies different operational models for the e-grocery business and studies how different goods reception solutions affect delivery time and the efficiency of home delivery. The author's focus is on different ways to receive the goods and defining service levels for these concepts from the customer's point of view. The second author demonstrates the delivery efficiency of using a reception box by simulating two alternative reception concepts. Furthermore, the impacts on total operational costs for the e-grocer are discussed.

Paper III assesses the business opportunities offered by different concepts of unattended reception. The author identifies and examines different concepts and revenue models for unattended reception. He evaluates the potential of different revenue models on the basis of modelling and concrete examples. In addition, the second author examines different models, taking into account their operational efficiency. The results are supported by the e-grocery pilot experience and interviews with the managers of catering kitchens made together with the second author.

Paper IV identifies existing operational models of e-grocery retailing and discusses how better customer service and lower costs could be maintained. Based mainly on the results of the author's licentiate thesis, this paper gives suggestions as to how e-grocers can improve their operations and implement their supply chain successfully. The effects of different alternative modes of reception, home delivery solutions, services, supplier-customer relationships, demand variation, and operations in the distribution centre are studied. In addition, examples are presented of how e-grocery operations can be developed.

Paper V discusses new service opportunities in the e-grocery business. The contribution of the author has been in providing an example of demand-based product segmentation. This example is used to present the ways in which different individuals or households consume products in different product categories. How every household or consumer needs to be taken into account as an individual case and how this results in requirements for the customisation of combinations of logistical services are also discussed.

Table 2. Papers included and their contributions to the study.

	Hypothesis I	Hypothesis II	Hypothesis III
Paper I	**Models and evaluates the impact of automation investment on efficiency in the distribution centre.**		Discusses the impacts of different picking solutions on e-grocery cost-effectiveness and evaluates the value of investment in picking automation.
Paper II	Discusses the impact of different home delivery models on order picking.	Presents different alternatives for receiving goods and discusses customer service levels.	Discusses different reception solutions and models operational savings for two of them.
Paper III		**Models and assesses the business opportunities offered by different unattended reception models.**	Identifies potential revenue models for unattended reception and gives a concrete example of implementation.
Paper IV	Estimates how different kinds of picking and order assembly models have succeeded.	Presents early e-grocery models and discusses the importance of reception facilities.	**Identifies different solutions and combinations used in the e-grocery business and discusses these solutions' inter-dependencies and weaknesses.**
Paper V		Discusses how the service needs of individuals should be better taken into account.	Presents new services and gives an idea of how these could improve logistical efficiency.

4 METHODOLOGY OF THE RESEARCH

In this chapter, the research methodology for the dissertation is presented. The first section discusses the research approaches and methodology. The second section introduces the framework of the research process and the third section presents supporting research activities.

Generally, science can be divided into basic science and applied science. Research in Industrial Engineering and Management (IEM) belongs among the applied sciences (Olkkonen 1994). Applied science lies between traditional sciences and technology and describes how things *should be* in order to achieve a certain aim (Hameri 1990). Applied science tackles practical problems aiming to create utility by finding generalisable laws for phenomena. According to Niiniluoto (1993), results in applied science are required to be relevant, simple, and easy to use in practice. Näsi (1980) states that results in applied science can be evaluated on the basis of their applicability, usability, practicability, and feasibility.

According to Ghauri et al (1995), practical problem-solving and decision-making have become more similar to research. Nowadays, economic and marketing research has an important role in companies' decision-making and actually "research in business studies is not much different from practical problem solving". Figure 9 presents how Neilimo and Näsi (1980) classify research approaches in business studies on the basis of four research dimensions: rational, empirical, descriptive, and normative. On the basis of these four dimensions of research they present four different approaches to business studies: the nomothetical (natural scientific), the decision-oriented (management science-oriented), the action-oriented (hermeneutic), and the conceptual. Kasanen et al (1993) added constructive research to the classification.

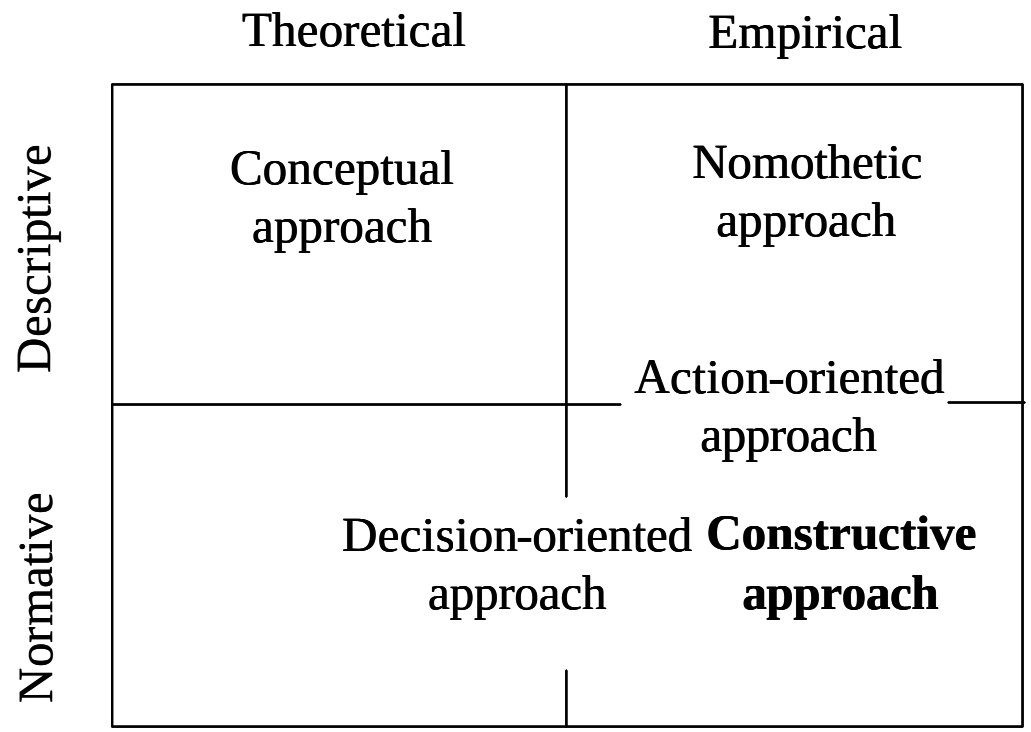


Figure 9. Research approaches in economics (Kasanen et al 1993).

4.1 Research approaches and methods

This research was carried out under the aegis of the Department of Industrial Engineering and Management at Helsinki University of Technology. Traditionally, the department has emphasised the importance of the practical utility of research. Therefore, the following criteria have to be met when choosing a research approach: relevance, contribution, and evidence (Eloranta 1999). Relevance means a high priority in the domain of business problems and clear value for practitioners. Contribution means novel research results and increasing the existing body of knowledge. Evidence means that the solution has to be verified rationally and empirically. Constructive research fulfils the main criteria set for IEM and has therefore become a popular research approach among IEM researchers in Finland (Kaski 2002).

The existing understanding of the phenomena and the research questions presented in Chapter One offers a basis for selecting an applicable research approach. Reflecting the goal and detailed objectives of this study, constructive research was seen as the most

potentially valuable approach for this dissertation. However, this dissertation consists of five different research papers and a binding story. Therefore, there is no single research approach. A constructive approach is used, especially in the separate research papers. In addition, a system approach and the philosophies of Popper are used when approaching multiple and diverse research objectives in this binding story.

The methods used within the research approaches are both quantitative and qualitative. Modelling is utilised, especially when estimating the potential of different picking and reception options. It is used in Research Papers I, II, and III. The models are created to evaluate the efficiency of different logistical solutions and are also used to support investment decisions and are therefore not created at the detail level. The models are tested and supported by gathering data by participating in the pilot project steering group, interviewing experts in the field, and benchmarking and analysing existing e-grocery companies. The models are presented in the separate research papers and the results are summarised in Chapter Five. In this binding story, these models are then examined as a part of a complex logistics system creating different scenarios for the implementation process. Supporting activities and methods are presented in Section 4.3.

Development of hypotheses

In this dissertation, the three hypotheses are created and tested by means of modelling and scenario planning in order to achieve a deeper understanding of the requirements of implementation and operation development processes.

Induction and deduction are ways of establishing what is true or false. Induction is based on empirical evidence and means the drawing of general conclusions from the researcher's empirical observations (Ghauri et al 1995). Deduction is based on logic and means the drawing of conclusions through logical reasoning (Ghauri et al 1995). The strategy used in this study to increase knowledge is deductive. It means that this research follows the logic of a deductive strategy, which aims to increase knowledge by disproving hypothesised relationships among variables that have been deduced from propositions and earlier theories.

Instead of trying to approach the research problems by formulating hypotheses that can be proved to be exactly right, knowledge is increased by creating hypotheses, which are then subjected to critical tests and run a high risk of being proved false. The approach is chosen because the aim of this dissertation is to achieve an understanding of a very complex system, not only some specific part of it.

The research approach has many similarities to the philosophies of Popper. According to Popper (1963), science starts with problems rather than with observations. An essential idea in Popper's approach is that the growth of knowledge proceeds from these problems and from attempts to solve them. These attempts involve the formulation of theories, which must go beyond existing knowledge. Therefore, the role of independent creative imagination in the formulation of a theory is an important element.

According to Popper, the process of science is full of conjectures and refutations. Scientific knowledge, aims, and standards grow only through an unending process of trial and error. Popper emphasises the importance of taking risks and the ability to learn from mistakes in problem-solving. In other words, the best way to increase the body of knowledge is to create hypotheses that can be proved to be false. Popper also emphasises the importance of severe criticism and testability of the hypothesis; the greater the risk and the greater the testability, the better the solution is. This helps more informative theories to be created. Popper claims that in spite of the fact that a new solution can be tested and proved to be false, it can never be logically verified and established as true. However, it is the best available theory until it is again proved to be false and/or superseded by a better theory.

Constructive approach

The constructive approach means problem-solving through the construction of organisational procedures or models (Kasanen et al 1993). Constructions tend to create a new reality by producing solutions to explicit managerial problems. The idea is that every research project is a unique single case, but connected to the more comprehensive theory (Puolamäki 2000). The constructions can vary from simple models, to complex management systems, to manifestos of new ways of approaching and doing things in

organisations (Lukka 2000). Constructive research can be either quantitative or qualitative or both. In this dissertation both approaches are used.

Papers I, II, and III are based mainly on quantitative modelling, where models are created to evaluate the efficiency of picking automation, home deliveries, and the use of reception boxes. On the other hand, the approach in Papers IV and V is more qualitative. These papers' focus is on evaluating different models and services, taking account of small customer surveys. Linking the problem and its solution to accumulated theoretical knowledge is an essential part of the constructive approach. The individual solutions and models tested in the research papers are handled as a more complex system in the binding story. Therefore, a system approach is also used. Table 3 lists some characteristics of constructive research and presents how these are applied to this study.

Table 3. Some main characteristics of constructive research congruent to this study.

Characteristic of the constructive research method	How applied in this dissertation?
Suitable for explicit managerial problems (Kasanen and Lukka 1995; Kasanen et al 1993; Lukka 2000)	Logistical problems studied in this dissertation are practical real-world problems.
The research problem can be tied to the existing body of knowledge (Kasanen et al 1993)	Research is linked to the earlier research and existing theories. (Chapter 2)
The research problem should include both scientific and practical relevance (Kasanen et al 1993)	The research problem is new in science and topical for the management of many grocery retailers.
Solutions are produced through the construction of models, plans, or organisational procedures (Kasanen et al 1993)	Solutions are based on modelling supported by real-life pilot, interviews, questionnaires, literature, and market information. (Chapters 3 and 4)
A successful constructive research produces new solutions to the problem (Kasanen and Lukka 1995; Kasanen et al 1993)	Results introduce new body of knowledge concerning the implementation and operational development processes in e-grocery retailing. (Chapter 4)
Usability of results can be evaluated on the basis of practical market tests (Kasanen et al 1993; Lukka 2000)	Some companies have already applied the results of the dissertation. (Chapter 5)

An essential idea in constructive research is to solve existing managerial problems so that both practical relevance and a connection with theory occur. The constructive approach assumes that theory is built into the relationship between the author and the management of the case company (Vafidis 2002).

An important characteristic of the research problem in the constructive research is that there should be both scientific and practical relevance. In constructive research, the usability can be demonstrated by implementing solutions. According to Kasanen et al (1993), the "actual usefulness of a managerial construction is never proved before a practical test is passed". However, it is difficult to estimate practical adequacy before the implementation process.

Kasanen et al (1993) divided the research process in constructive research into six different phases:

1. find a practically relevant problem;
2. obtain a general and comprehensive understanding of the topic;
3. innovate, i.e. construct a solution idea;
4. demonstrate that the solution works;
5. show the theoretical connections and the research contribution of the solution concept, and
6. examine the scope of applicability of the solution

The order of these phases can vary from case to case. Lukka (2000) added a new phase to the process. In Lukka's research process the second phase involves creating long-term cooperation between the researcher and the case company. In addition, Lukka points out the importance of the possibility of publishing research findings. This was also a very important element during the present research process.

The implementation of a research solution is an important market test in constructive research. Kasanen et al (1993) introduce three different levels for the market test.

- weak market test – has any responsible manager been willing to apply the construction in his or her actual decision-making?

- semi-strong market test – has the construction become widely adopted by companies?
- strong market test – have those business units applying the construction systematically achieved better financial results than the others?

According to Kasanen et al (1993), it is very uncommon that constructions succeed in passing the first step at the first attempt. Usually, passing requires several attempts. However, an unsuccessful market test does not necessarily mean that the research is worthless (Puolamäki 2000). Usually, a market test is complicated and there are many external elements, such as complicated organisational processes, that have an impact on implementation.

Constructive research typically applies the case study method (Kasanen et al 1993). Case studies are a good approach to the explanation and understanding of new topic areas (Eisenhardt 1989). This study also includes characteristics of case research. Actually, the difference between a case study and the constructive approach is small. The most remarkable difference is that a case study aims at bringing about changes in organisational procedures. In addition, only a few variables are tested in a case study, whereas constructive research tries to understand the whole system by developing and testifying new constructs.

In constructive research, validity can be evaluated on the basis of a market test (Kasanen et al 1993). A market test in constructive research is not enough to evaluate the quality of the research results (Eloranta 1999). However, if a market test is not passed, it does not mean that the results are worthless. The focus of this research is restricted to the individual logistics solutions and their inter-relationships. Therefore, this is one reason why market-based evaluation was not seen as a potential approach. Therefore, in this dissertation, results will be evaluated more extensively on the basis of case research. In case studies, the validity of the research can be divided into construct validity, external validity, and internal validity (Yin 1989). The research results are discussed in Chapter Six.

System approach

When conducting business research that aims at solving managerial constructions, there is always the possibility of finding clues to surprising relationships (Lukka 2000). In addition to approaching separate logistics solutions by modelling, this study aims at deepening the understanding of e-grocery logistics and implementation issues from the whole logistics system point of view. Therefore, system view is seen as an approach to deepen the understanding of the inter-dependencies of different logistics solutions and the potential of different implementation scenarios.

System thinking first appeared in the biological sciences in the 1950s and 1960s (Bertalanffy 1968; Jackson 1993). It was adapted by the social sciences and can be seen as an approach for understanding real-life phenomena. The system approach to physical distribution management and the total cost concept was discussed as early as the 1960s (Smykay et al 1961). System thinking aims at enhancing learning in complex systems. Instead of examining just some specific part of a system, system thinking aims at the understanding of complex systems by examining the "big picture" and relationships inside it. An essential idea of system thinking is that everything is connected to everything else, i.e. it is impossible to do one thing without this having an influence on other things. The term "synergy" is very important in system theory. General system theory is based on system thinking, "with the aim of fostering generalists qualified to manage today's problem better than the specialists" (Skyttner 2001). General system theory consists of individual methods such as system approach, system analysis, and system dynamics.

Successful approaches to learning about complex dynamic systems require: 1) tools to elicit and represent the mental models we hold about the nature of difficult problems; 2) formal models and simulation methods to test and improve our mental models, design new policies, and practise new skills, and 3) methods to sharpen scientific reasoning skills, improve group processes, and overcome defensive routines for individuals and teams (Sterman 2000).

There are many tools to improve our ability to learn about and manage complex systems. These tools assist in the evaluation of the consequences of new policies and new structures designed (Sterman 2001). Some of the most popular methods are causal loops, system

modelling, scenario planning, and simulation. Causal loops are used to illustrate the interdependencies inside the organisation or system. Elements are related by causal links, which include either positive or negative feedback. The feedback system is seen as an essential part of system thinking (Sterman 2000). In this dissertation, the approach to individual solutions of logistics has been constructive, but the whole logistics system is approached as a complex system where changes in individual logistics solutions can have an effect on the behaviour of the whole logistics system. An interrelations approach is used, especially when evaluating conditions for successful e-grocery logistics system implementation in Section 5.3.

System modelling combines process mapping and simulation and can be seen as another effective tool to illustrate system thinking in practice. Stock-and-flow maps, interrelationship digraphs, and macro flow charts are some frequently-used mapping techniques that are used to show both the external and internal boundaries and interdependencies, along with important linkages (Wolstenholme and Stevenson. 1994). In scenario planning, chance interdependencies and uncertainties are examined as a part of the future environment. Scenario planning is used as a tool to help managers imagine different possible strategies in the future. This method is used especially in Chapter Five when creating and evaluating investment strategies on the basis of the results of the research.

In supply chain management, modelling techniques usually focus on some specific part of the supply chain. However, there is a potential risk of optimising only part of a supply chain, while greater benefits could come from changes to other parts of the chain (Rushton and Saw 1993). Jay Forrester conducted one of the best-known supply chain simulation experiments in the 1960s (Forrester 1961). He examined the effect of information delays and amplification on operations. By building a dynamic computer model, Forrester demonstrated how small changes in retail sales affected the behaviour of the whole supply chain. Forrester defined "a complex system to be a high-order, multiple-loop, non-linear feedback structure", where feedback loops were seen as a major source of behaviour and policy difficulties (Richardson 1991). According to Forrester, the main reasons for high demand amplification were a high number of inventory levels, data processing delays, and different policies on orders and inventories. In addition, he pointed out the fact that there

are also other possible causes for long cyclic disturbances, such as advertising, price discounts, and consumer credit. Later, Towill et al (1992) pointed out that the biggest improvements can be reached by sharing information about true market demand among the different players in the supply chain.

4.2 Research process

In this research, the process progressed from hermeneutic descriptive understanding, to functional constructive action, to descriptive explanation. It can be described by using the structured constructive research process of Kasanen et al (1993). The phases of the process were described earlier, in Section 4.1

The first phase is to find a practically relevant problem. At the beginning of this research, problems were found through the observation that new market players, e-grocery retailers, faced serious problems in controlling logistical costs. In addition, this field was underanalysed in the literature.

In the second phase more focused problems and research questions were developed by obtaining a general and comprehensive understanding of the topic. Therefore, customer needs and the requirements for competitive logistics in the e-grocery business were evaluated. This process started at the beginning of the research work. The author took part in the pre-study phase in the summer of 1998. As a result of the pre-study phase, a deeper understanding of customer needs and logistical challenges in the e-grocery business was reached. During the research process, a more detailed literature review of logistics and e-grocery retailing was carried out. This is summarised in Chapter Two. Understanding of the topic was also accumulated through logistics and retail conferences, company visits, and interviews of experts. The research model applied during this phase was hermeneutically descriptive and aimed at understanding the research situation.

The third phase was to construct and develop a solution idea. The development process can be seen as a profound example of co-operative teamwork in which both practitioners and the researchers contribute, based on input information of both practical and theoretical origin. The construction of new solutions includes the discovery of the principles of

different logistical solutions and their applicability to e-grocery retailing. The author started to study different e-grocery logistical solution options, build models for investments in picking automation, and, later on, build revenue models for unattended reception for the e-grocery retailing environment. The models and constructions used are summarised in Chapter Five and described in greater detail in the research papers.

The fourth phase demonstrates that the solution works. This phase should be viewed as one of the key characteristics of the constructive approach (Lukka 2000) In this research process, the models created are tested and the results are evaluated by comparing them to the market information and analyses. This phase also answers the research question. The potential risks of optimising only one part of a system was minimised by close co-operation between the researchers and the companies. At the beginning of the ECOMLOG research programme the areas that offered the greatest potential for improvement were identified through the joint efforts of the research team and the participating companies. Steering groups, management meetings, and group meetings were used as an innovative environment to develop and test solution ideas during the research process (see Appendix V). Some of the results are also evaluated on the basis of small customer surveys. This phase is described in the research papers and Chapter Five of this binding story.

In the fifth phase of the constructive research process, theoretical connections and the research contribution of the solution concept are shown. In this research, individual solutions are presented in the research papers and these are linked together in the binding story. This binding story discusses relevant theories and their relationships to the research problems in Chapters Two and Five. The research contribution is presented in both individual papers and this binding story's Chapter Six.

The last phase of the constructive research process examines the scope of applicability of the solution. In particular, the usability of results in practice is important in IEM research. This research aims at managerial implications by giving guidelines for the implementation and operation development processes in the e-grocery business. The scope of applicability is also discussed in both individual research papers and this binding story's Chapter Six.

4.3 Supporting activities

In addition to the modelling involved in constructive approach and system thinking, some supporting activities and methods were used in the research. This was important because of the new research area and thus the limited available data. At the beginning of the e-grocery boom in particular, most of the players developed their businesses secretly and were not willing to share information. Therefore, important sources of supporting knowledge during this study have been magazines, newspapers, the Internet, logistics and retail conferences, a visit to the Swedish firm Matomera, and IPO (Initial Public Offering) information from listed companies in the USA. Furthermore, interviews with e-grocers' management and grocery retailers, participation in the Intertrade steering group meetings, management group meetings, and e-grocery pilot steering group meetings proved important fora in which to refine and consolidate research ideas (see Appendix V).

The data collected from customer questionnaires, shopping baskets, delivery routes, and store picking in the e-grocery pilot project was used as an input when testing the models and evaluating results. The target of the e-grocery pilot was to research and develop a home delivery concept for the grocery business. Concept development for the e-grocery pilot was carried out together with one of the biggest grocery companies in Finland. In addition, a manufacturer of reception boxes was involved in the concept development. The pilot is described in Paper III. At the beginning of the e-grocery pilot, the author also administered two questionnaires with Johanna Småros and the Gallup Marketing Research Company. However, the samples were very small and the results should be examined more from a qualitative than a quantitative perspective.

5 REVIEW OF THE RESULTS

This chapter presents the results of this dissertation. The results are mostly summarised from the five different papers included in the dissertation. Most of the results are presented and discussed in more than one paper. Therefore, this chapter is structured according to the previously-presented hypotheses, not according to the papers. Section 5.1 focuses on cost analysis for automation investment in order picking. The focus of Section 5.2 is on answering Hypothesis Two by analysing different reception solutions and possible revenue models. Section 5.3 presents alternative e-grocery logistics system implementation scenarios. This section covers Hypothesis Three. Some of the results have already been briefly discussed earlier, in the Introduction and literature review chapter.

5.1 Evaluating the potential of picking automation investment in the e-grocery environment

Hypotheses One and Two concern the operational efficiency of different logistical solutions and are approached through modelling in the research papers. The first hypothesis claims that "**Automated picking in e-grocery distribution centre is more cost-efficient than using manual solutions".** This is examined in this section, mostly on the basis of Paper I. Papers II and IV make minor contributions.

According to Paper II, it is possible to reach considerably lower operational costs by cutting picking costs. Paper I asserts that the picking speed of e-grocers varies considerably, depending on who does the picking and what the level of automation is. According to Paper IV, store-based picking was the first operational model introduced in the e-grocery business. The slowest picking speeds are found in conventional stores without any automation, while the highest rates occur in highly-automated distribution centres. Nowadays, store-based picking is a strategy mainly for those retailers who have a strong network of traditional supermarkets. However, efficient operations on a large scale require the use of a distribution centre. By investing in a distribution centre it is possible to cut picking costs because of increased picking speed, lower labour costs, and more efficient space utilisation (Jaakola 1999; Kämäräinen et al 2001a)

Major investments in automation are made in order to achieve higher operating margins. According to Paper I, the main benefit of automation is reduced labour costs through reduced labour requirements. However, according to Paper I, a highly-automated distribution centre does not guarantee improved cost-effectiveness. For the investment to be profitable, the savings have to be at least equal to the investment. In other words, to be profitable, investment has to be made on just the right level, without under- or overinvestment. In Paper I, the maximum total investment, i.e. the break-even point, is calculated in order to find out the right level of automation investment. It is taken into account that capacity utilisation rates in the grocery business vary greatly and that on average they are always less than 100% in reality. However, according to Paper I, e-grocers have to invest according to the peaks in demand, while 100% capacity utilisation is not realistic. This leads to situations in which e-grocers exaggerate the capacity in use.

According to the results presented in Paper I, capacity utilisation can vary greatly when investing according to peaks in demand. This means a significant level of unused capacity. In Paper I, this is illustrated with an example of how differences in utilisation rates affect the value of the investment. Figure 10 shows how capacity utilisation has a significant effect on cost savings. It is suggested that in a case where the original picking speed is 200 lines per hour per worker, savings can be achieved only if picking speed is at least doubled when the utilisation rate is 50%. However, if capacity utilisation is high, savings are also achieved easily.

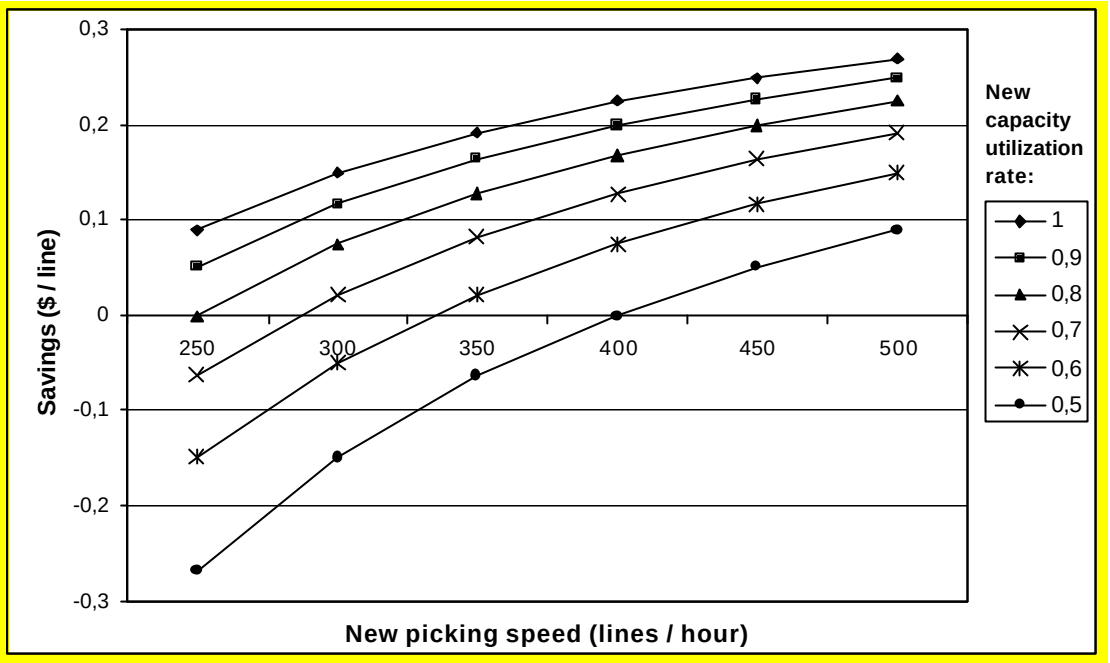


Figure 10. Example of total cost savings per line, i.e. the value of the investment, at different rates of capacity utilisation (Kämäräinen et al 2001a).

Paper II supports the results of Paper I. It indicates that there is a strong link between delivery and order picking. Inefficient home delivery is very closely linked to the picking problem, i.e. an efficient supply chain cannot be created if these two operations do not dovetail efficiently. It means that the timing of the picking also has an important role in home delivery efficiency. Assembly of customer orders should be organised according to the delivery routes. Otherwise, there will be difficulties in achieving a steady workload in both operations. On the other hand, it means that the balancing of the workload in delivery affects order picking similarly. This would make automation a more attractive alternative.

Another alternative way to improve the cost-effectiveness of the distribution centre is to use labour more efficiently. In Paper I, the distribution centre is presented as a factory that assembles grocery orders, rather than a highly automated warehouse for storing goods. This means that automation is not necessarily a means to achieve efficient operations in the distribution centre. It is claimed that by using labour and designing the distribution centre on production principles such as JIT and lean production instead of automation, a more flexible distribution centre can be built. In e-grocery order assembly, efficiency, quality,

and costs should be important elements, as they are in product assembly (Jaakola and Kämäräinen 2000).

According to Paper I, the design of the distribution centre should be based on product characteristics. Preservation temperatures are also crucial from the layout point of view. If picking cannot be performed just before home deliveries take place, it is important that items are moved to the assembly area just before delivery, thus keeping them at the appropriate preservation temperatures for as long as possible. It is important that there is enough space to handle items. The tighter the warehouse layout, the greater the danger of loss to productivity and flexibility (Ackermann 1999). In addition to the temperature limitations, products can be divided into different groups on the basis of the frequency of their occurrence in customers' orders. In this way it would be possible to minimise the use of labour, i.e. minimise handling, thus making order picking more efficient. The aim is to achieve fast product flow through the distribution centre. Ideally, the products are just cross-docked in the distribution centre. The Swedish firm Matomera applied JIT principles in their distribution centre. Matomera received and collected customers' orders in the morning and sent their grocery requirements to their wholesalers and suppliers. The groceries were received in the distribution centre after midday and were cross-docked according to customers' orders. Deliveries took place the evening of the same day. By using the principles of JIT and cross-docking, Matomera created fast product flow, without waste, through the distribution centre. In this way it is possible to build more flexible picking operations and demand variation is not such a big problem.

Paper IV claims – using some real-world examples - that automation in the e-grocery business growth phase is not a good alternative because of low and varying demand. Manual solutions are more advantageous for the distribution centre because of the high level of flexibility they offer. For example, Webvan in the USA used highly automated distribution centres. The investments were from $25 million to $35 million per distribution centre, while less automated distribution centres require investments from $4 million to $6 million each (Cuglielmo 2000). Webvan calculated that at a capacity of 8000 orders per day, seven days a week, with an average order size of $103, it could achieve an operating margin of 12%, compared to 4% in a traditional supermarket. However, Webvan faced problems in warehouse automation and also the "order density" problem (Taylor and

Cleary 2000). It operated at a loss with a less than 20% capacity load at the end of 1999 and never achieved more than a 30% capacity load (Cuglielmo 2000). E-grocers with less automated DCs have lower break-even points. For example, Home Runs in the USA calculated that their break-even point is 8,000 orders a week and Telemarket in France have estimated that theirs is 10,000 orders a week (Mullaney and Leonhardt 1999; Gallo 2001). According to Tesco, the break-even point for a DC is 5,000 orders a week (@ Your Home 2001).

To summarise the results from Paper I and partly from Papers II and IV, it can be said that the first hypothesis, "**automated picking in an e-grocery distribution centre is more cost-effective than using manual solutions",** is not confirmed if customer demand is low or varies considerably. However, automation can be a valuable solution when trying to increase picking efficiency in the distribution centre. The problem is how to ensure the investment level is right when demand is still low and can vary greatly. To realise cost savings, high capacity utilisation must be achieved, which means a high break-even level. If demand and capacity utilisation vary significantly, cost savings cannot be realised with automation. In this case, it is better to build a flexible distribution centre using more manual solutions with labour instead of automation.

5.2 Analysing the feasibility of unattended reception modes

The second hypothesis claims that "**unattended reception solutions are not economically feasible for e-grocery retailing".** This hypothesis is examined mostly in Papers III and II, whereas Papers IV and V make minor contributions. In Paper II, four different ways to get orders to customers are identified. These are:

1) pick-up by the customer
   - customers pick up groceries from the local supermarket or a warehouse;
2) shared reception boxes
   - there is a shared pick-up point near the consumer;
3) the household's own reception box
   - orders are delivered to the household's reception box, and

4) attended reception

- the shopkeeper or a third party delivers groceries to a given place, where the customer accepts the delivery.

According to Paper II, all four solutions are potential models for e-grocery retailing. However, pick-up by the customer does not eliminate the customer's working trouble completely, because he still has to travel to and from the store. Only two of the solutions, households' own reception boxes and shared reception boxes, allow significant cost savings in home delivery operations (Punakivi and Saranen 2001; Kämäräinen et al 2001b; Punakivi 2003).

According to Paper II, the potential of unattended reception is significant in the grocery business because groceries require many different temperatures and are frequently purchased. Unattended reception decreases the costs of deliveries, meets the temperature requirements of groceries, and makes customers' lives easier. Paper V shows that reception boxes provide the possibility of offering new services and in this way increase the amount of loyal customers. It is also pointed out that reception boxes enable continuous product flow to the household and make it easier to offer high margin consumer goods to customers. Papers IV and V introduce the vendor-managed inventory (VMI) service as an example that makes it possible to take care of the customer's inventory by guaranteeing that the customer always has enough of some continuously-consumed products. However, individual demand patterns vary considerably and should be examined separately for each household and product.

Home delivery cost savings made possible by unattended reception are one of the key drivers for investing in these facilities. Modelling home deliveries in one vehicle environment indicates a potential for savings of over 40% in home delivery costs when using customer-specific reception boxes, compared to the current model of attended reception with two-hour delivery time windows (Kämäräinen et al 2001b). Punakivi et al (2001a) modelled home deliveries in a multi-vehicle environment with a wider customer base and claim that cost savings even greater than 50% can be reached if customer-specific reception boxes are used. Paper III indicates that in spite of the cost savings, the investments in unattended reception are high from the e-grocer's point of view and are

seen as a major obstacle to the generation of profit with individual reception boxes. According to Paper IV, investments in the customer-specific reception box are between 1,000 and 2,300 euros. For an e-grocer with five thousand customers, customer-specific reception boxes would mean investments of 5.0 to 11.5 million euros. In this case, the payback period would be from 6 to 13 years (Punakivi and Tanskanen 2002). According to Paper III, this is far too long a period; suppliers would like a lifespan of 3 to 5 years for this kind of investment in accounting.

According to Punakivi and Tanskanen (2002), the cost savings using shared reception boxes are as much as 55–66% compared to the concept with attended reception and two-hour delivery time windows. This means a payback period of 2 to 5 years for shared reception boxes. However, due to low customer demand, it is unlikely that e-grocers will be willing to invest in unattended reception. It means that, in most cases, operational cost savings will not be high enough to justify the investment decision. Therefore, additional revenues are needed.

According to Paper III, investment in unattended reception can be profitable. Three potential alternative investors are studied. These are:

1) the customer;
2) the e-grocer, and
3) a third party, i.e. the operator.

According to Paper III, investment in the reception box is high from the customer's point of view if he does not view the customer-specific reception box in a similar way to other home appliances. If the e-grocer would like to cover the investment in a customer-specific reception box, the opening fee ought to be more than 5 euros per delivery, supposing an average of two deliveries weekly. In other words, the customer should pay more than 40 euros a month. This ordering frequency is also supported by the information collected during the e-grocery pilot in which the customers used customer-specific reception boxes. As around 5 euros per delivery is the break-even figure, it is hard to believe that the customer-specific reception box itself could be a business opportunity for the e-grocer or third party in a B2C environment. However, there are other possibilities for the e-grocer

who can offer high-margin products together with the groceries and who would like to tie the customer to his own service. If the e-grocer or supplier finances the reception boxes, the value of the total investment is very high. However, the e-grocer can also reduce his own costs by collecting fees from the customers.

Paper III presents new revenue models for unattended reception. It indicates that if the third party – the operator - invests in the reception boxes, a fee based on transactions or monthly usage can be collected. However, as has been shown, customer-specific reception boxes have limited potential. The study demonstrates that shared reception boxes used by many customers offer better conditions. Actively offering reception facilities to B2B customers can also support demand. According to Paper III, business customers such as restaurants, schools, and day nurseries would also be interested in using the reception facilities. In addition, access to the boxes can be granted to many players. The fees can be collected from various sources, i.e. from different suppliers and customers. In the beginning, a figure of 0.5-1 deliveries per day per locker seems reasonable, meaning that the service fee should be set between 2.5 and 5.0 euros. The potential to make a profit with the shared reception box is considerable if the utilisation rate is high enough. For example, if the operator can rent out one locker two or three times a day for 2 euros, the model is already very profitable. However, to get enough customers, numerous suppliers are also needed.

Whatever solution is chosen, more customer demand is needed to make the concept profitable. According to the Gallup Web (2001), 45-50% of Finnish Internet users are already interested in using unattended reception for groceries purchased online. In particular, active Internet users and Internet users living in the countryside are very interested in unattended reception. In Europe, up to 40% of active or potential online grocery shoppers would be interested in unattended deliveries (Lewis 2001). In the UK, goods worth around £18.9 billion were delivered to homes in 2000 and as much as 60% of small package deliveries may fail because the customer is not at home (@ Your Home 2001). However, these studies do not indicate how much consumers are willing to pay for such services.

To summarise the results from Papers III and II and partly from Papers IV and V, it can be said that the second hypothesis, "**unattended reception solutions are not economically feasible for e-grocery retailing",** is not confirmed. Although the reception facilities used in the existing e-grocery pilots and start-ups have more or less been only value-added services, unattended reception can be economically feasible. The potential depends greatly on the type of reception facility, i.e. a customer-specific reception box or a shared reception box, in addition to the revenue model chosen. Investments in the reception facilities are high and if the e-grocer or customer makes the investments, it is likely that access to the reception boxes would be limited. Therefore, the investor in the reception facility possessing the greatest potential is the third party, i.e. the operator who could offer reception facilities to both B2C and B2B customers, thus keeping the reception system open so that various service providers can offer services. In this way it is possible to offer facilities with a reasonable user fee. However, in this case, too, capacity utilisation is a crucial factor.

5.3 Terms for successful e-grocery logistics system implementation

The third hypothesis claims that "**the order of implementing solution components is not significant in e-grocery retailing**." Paper IV is the main contributor on this topic. Papers I, II, III, and V also make contributions. As shown earlier, in Chapter Two, e-grocers have implemented their businesses very differently. However, there are no players who have enough resources and money to invest in all the solutions simultaneously. Therefore, it is important to understand how different solutions impact on the overall efficiency of e-grocery retailing. This section presents and evaluates alternative e-grocery logistics system implementation scenarios.

How does the order of implementation affect efficiency and service? From the logistical point of view customers are only interested in getting the goods at the right time in the right place. How, then, can one choose the right order in which to implement the elements, in addition to the right solutions inside the elements? In spite of there being a common aim, there is no shared opinion about a successful supply chain model for the e-grocery business (Taylor and Cleary 2000; Järvelä and Tinnilä 2000).

There are three ways to improve the profitability of the e-grocery business. It can be improved by increasing overall logistical efficiency, increasing sales volume, or by investing in value-added services and in this way improving customer value and profitability. Different solutions that have been proposed were studied earlier in this dissertation and partly in other related studies (Yrjölä 2003; Punakivi 2003; Småros et al 2000). Paper I presents picking solutions, Papers II and III focus on reception alternatives and models, and Paper V discusses services. Figure 11 presents different investment alternatives designed to improve e-grocery logistics system performance. Investments in reception facilities can also be seen as service investments. However, investments in reception boxes are large compared to other service investments and are also made in order to improve operational efficiency. Therefore, reception box investments are handled separately from service investments. Service investments are divided into online services (such as food recipes or checklists) and physical services (such as replenishment services).

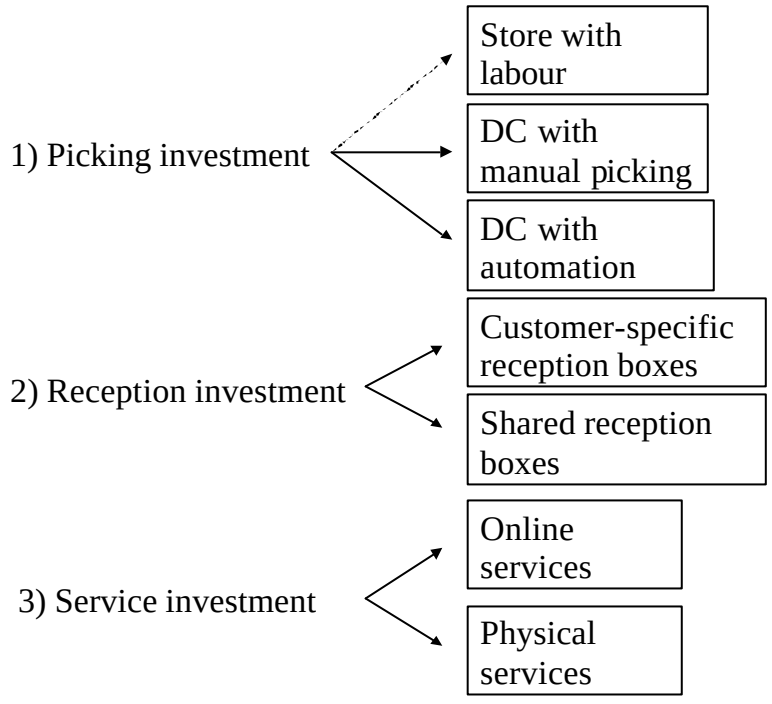


Figure 11. Different investment alternatives to improve e-grocery logistics system performance.

To establish a successful roadmap for investments, different scenarios for the implementation process are studied in the following section. These scenarios are shown in Figure 12.

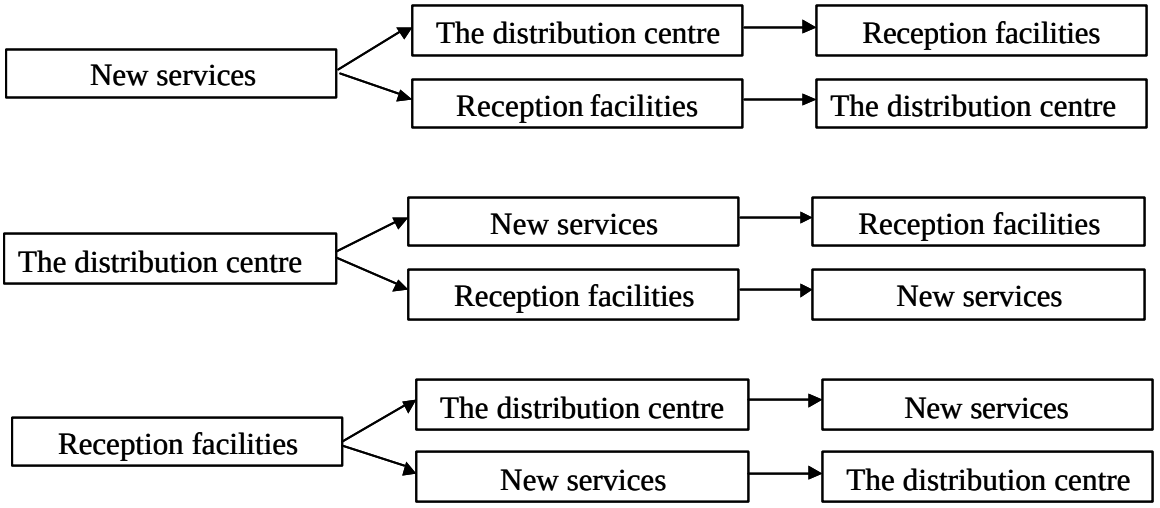


Figure 12. A roadmap for logistical investment scenarios in e-grocery retailing.

Scenario I: Starting with investments in value-added services

Paper V demonstrates that by implementing the right mix of services, it is possible to impact strongly on customer value. Different solutions such as long-term deals with consumers, manufacturer loyalty programmes, replenishment services, and a more interactive buying process make it possible to establish a deeper relationship with the consumer and increase customer value simultaneously (Kämäräinen and Småros 2000). The ability to add products and services such as laundry, videos, film processing, financial services etc. to grocery purchases can make the service even more attractive for the consumer and increase the e-grocer's margins. These kinds of services, connected to an effective loyalty programme, are a good investment for the e-grocer. However, to avoid customers' being disappointed, services and products have to be designed and tested carefully before implementation. If customers gain rich shopping experiences from the beginning of the service's implementation, it is easier to create lasting relationships. Otherwise, customers become disappointed and change to another service.

New services have a moderate impact on demand variation. For example, a VMI service for the household has an impact on demand, i.e. demand will be more stable if basic demand is known beforehand (Småros and Holmström 2000). This can have a remarkable influence on overall profitability (Haapanen and Vepsäläinen 1999). According to Paper IV, in this way, by understanding customers' individual needs, it is easier to create services that match demand.

Service implementation does not require investments in infrastructure, as indicated in Papers I, II, III, and IV. In addition, it is a fast way to start a business. According to Paper IV, only those players who use existing networks of supermarkets for their picking have implemented this kind of strategy. This kind of implementation strategy has been used, for example, by Tesco, whose supermarkets' service areas cover more than 90 percent of the UK population through 300 stores.

Value-added services have only a limited opportunity to have a direct impact on operational efficiency. However, due to the investments in new services, such as replenishment, there are better opportunities to arrange picking and transportation operations in a more efficient manner in the distribution centre (Waller et al 1999). However, by investing in services it is possible to generate a critical mass of customers and thus later make a profitable investment in operations. If volume has risen enough, the next investment can be made in a distribution centre, with or without automation. Otherwise, it is better to concentrate on improving services by means of reception boxes.

Scenario II: Starting with investments in the distribution centre

Distribution centres should not be the primary target of e-grocery investments, if they are not actually needed. However, when volume increases, a distribution centre with manual solutions becomes a more efficient place for picking than a supermarket. Paper I shows that investments in starting distribution centres from scratch are remarkable, typically from $4 million to $6 million per distribution centre, but can grow up to $25-$35 million if a high level of automation is used (Cuglielmo 2000). If demand is uncertain or varies significantly, possible cost savings with automation cannot be realised. In that case, a better strategy is to build distribution centres designed for manual picking. In this way, better capacity utilisation and margins can be reached. Generally, solutions that guarantee

flexible and expandable product flow and layout design should be the main goal of picking investment. In this way, picking speed can be improved radically.

Improved picking speed also has an impact on the efficiency of home delivery. Orders can be picked in time and so give more freedom in planning home deliveries. This means, for example, more customers per route and thus improved routing optimisation. Due to the improved picking speed, customer value can also be increased. This happens, for example, due to the shorter delivery lead-time (time from order to delivery).

Improved picking speed itself only has a minor impact on demand variation, but, combined with unattended reception, it opens up new opportunities to level out demand. Paper II demonstrates that overall efficiency in the e-grocery business can be improved by combining reception facilities with a distribution centre. For example, with improved picking speed it is possible to level out the load on the distribution centre by picking and delivering orders to the reception boxes before the peak hours in the afternoon.

Paper IV indicates that building a network of distribution centres from scratch is a risky business compared to the other alternatives. This kind of implementation strategy has been used, for example by Webvan, who built a network of highly automated distribution centres, but never reached a break-even point. On the other hand, the distribution centre is the only way to go into business for pure e-grocers, who do not want to, or cannot, use traditional grocery retailers' supermarket network. In this case, the best strategy is to build distribution centres based mainly on manual solutions. However, even a manual distribution centre requires major investments and usually rules out the possibility of investing in reception facilities.

Scenario III: Starting with investments in the reception facilities

In spite of the long payback periods, investment in reception boxes is an inviting alternative for the e-grocer. A large amount of support for such investment is presented in Papers II, III, IV, and V. How, then, do investments in reception facilities impact on other elements of the supply chain? According to Paper II, reception boxes can have a strong positive impact on the efficiency of home delivery and so create the possibility of

decreasing delivery costs if the delivery window is not too tight for the supplier. This means that different reception alternatives, and especially reception boxes, create a basis for more efficient home deliveries. According to Papers IV and V, reception boxes enable value-added services for the customers and so also improve customer value. It is possible to implement, for example, replenishment services and long-term deals with consumers. These services are difficult to implement without reception boxes. For example, Streamline's investment strategy was to implement its distribution centre and reception boxes simultaneously. By using reception boxes and offering value-added services to its customers it got 85% of the money that its customers spent on its product groups (Ransdell 1998). However, Streamline tried to implement the three alternative strategies simultaneously and ran out of money before reaching a sufficient volume and customer frequency.

In addition to more efficient home deliveries, unattended reception also means more stable demand within a day, i.e. picking, packing, and delivery can also be done outside rush hours. For example, the e-grocery pilot presented in Papers III and IV charged 33 euros a month, including a customer-specific reception box and two deliveries a week. Deliveries were on Tuesdays and Thursdays before 6 p.m. In this case, the reception box concept itself solved the problem of demand fluctuation inside a day. However, it did not solve demand variation inside a week Therefore, different pricing models are needed. Paper II indicates that reception boxes also have an impact on activities in the distribution centre. Reception boxes, which make possible wider delivery windows and flexible routing, allow the optimising of picking in the distribution centre. This makes possible a more flexible picking timetable in the distribution centre.

Shared reception boxes are a good alternative for investment. The payback period is reasonable and a wider customer base and greater revenues can be reached more easily than by investing in customer-specific reception boxes. The cost-effectiveness of the model can also be improved by simultaneously offering reception facilities to companies. According to the analysis presented in Paper IV, the operator has the greatest opportunities to run reception boxes in a cost-effective way. The operator would be able to link up many different kinds of service providers, all utilising the new customer direct delivery channel based on unattended reception. In addition, the operator has a better opportunity to achieve

critical customer mass, which is crucial, especially in the launch phase. Therefore, shared reception boxes financed by many service providers or a third party are seen as a good starting point for investments. In this way, it is possible to create a basis for versatile services and enough demand for the investment in the distribution centre to be profitable.

In Table 4, possible inter-dependencies are evaluated on the basis of earlier scenarios with the following scale (service investments are restricted mainly to physical services that have an impact on the system's logistical activities):

+ = weak positive impact
++ = moderate positive impact
+++ = strong positive impact

Table 4. Possible inter-dependencies between different elements of the e-grocery logistics system.

	Customer value	**Home delivery efficiency**	**Picking efficiency**	**Stable demand**
Investments in new services	+ + +	+	+	+ +
Investments in the reception facilities	+ + +	+ + +	+ +	+ +
Investments in the distribution centre	+	+	+ + +	+
Different pricing models	+	+ +	+ +[2]	+ +

Pricing policy can be seen as a supporting solution when trying to improve overall efficiency. For example, demand variation in grocery retailing can be remarkable and can be levelled without investment by using different pricing models. Different delivery times and days can be priced differently and so influence demand inside the day and between the different days of the week. This gives more cost-effective options to customers as well. It would also be possible to create different combinations of delivery days without the

reception boxes and charge customers differently, depending on which combination the customer has chosen. In this way the e-grocer could also level demand and improve picking and delivery efficiency. However, the benefits of different pricing models depend heavily on customers' willingness to adapt to different delivery days and times. Therefore, pricing should only be seen as a support for the investment.

To summarise the results of Papers IV and, partly, from Papers I, II, III, and V, it can be said that the third hypothesis, "**the order of implementing solution components is not significant in e-grocery retailing**", is not confirmed either. The order in which solutions are implemented has an impact on successful investment. All the solutions have some impact on the other solutions and this should be taken into account when implementing an e-grocery business. While the goal should be creating a wide and loyal customer base in a dense area, investments should start with the reception facilities or value-added services. In spite of the high level of investment, reception boxes are a good way to tie customers to the service. There is an even better opportunity if a third party offers the reception boxes and the e-grocer can concentrate on implementing new services and acquiring new customers. Unfortunately, in the case of pure e-grocers, the distribution centre is often the only alternative for the investments. However, as we have seen during the last three years, this implementation strategy has been too expensive for most of the pure e-grocers.

[2] possible through more stable customer demand

5.4 Summary of results

This section summarises the research findings of this study. Table 5 presents the hypothesis created in Chapter Three and the conclusions.

Table 5. Summary of results.

Hypothesis	Description	Conclusions
I	Automated picking in e-grocery distribution centre is more cost-efficient than using manual solutions	If demand and capacity utilisation varies significantly, cost savings cannot be realised with automation.
II	Unattended reception solutions are not economically feasible for e-grocery retailing.	Shared reception boxes with an open system for many service providers have the potential to be profitable if capacity utilisation is high enough.
III	The order of implementing solution components is not significant in e-grocery retailing.	The order of implementing solution components has a strong impact on the success of e-grocery logistics system investment.

The first hypothesis claimed that the cost-effectiveness of the e-grocery business can be improved by investing in an automated distribution centre for picking. This hypothesis was not fully supported. According to the results, the potential cost savings resulting from automation may not be realised if the capacity of the distribution centre is not efficiently utilised. This diminishes the attractiveness of investing in automation and, on the other hand, makes investments in a manual distribution centre more inviting. Peters (2000) provides support for the results. According to Peters, the primary challenge of physical fulfilment is to determine if the equipment, layout, and system support a single-pick distribution environment. He claims that the first trap in e-commerce logistics is to over-invest in automation.

According to the second hypothesis, unattended reception solutions are not economically feasible for e-grocery retailing. This hypothesis was not proven in spite of the fact that the earlier research (Kämäräinen et al 2001a; Punakivi 2003) had shown that operational savings are not enough to cover investments in customer-specific reception boxes. The payback period for shared reception boxes is shorter and could be covered by operational

savings achieved in deliveries (Punakivi and Tanskanen 2002). However, it is unlikely that existing demand in the e-grocery business is enough to cover such investment; shared reception boxes are a new concept and there is no e-grocer who uses them regularly.

According to this dissertation, future potential exists when a third party, i.e. the operator, finances shared reception boxes and collects a transaction-based user fee. The operator has the greatest opportunity to achieve a high utilisation rate by offering a range of services combined from different suppliers. In addition, they can combine B2C deliveries with B2B deliveries, for example with catering kitchen deliveries. However, future demand is still unknown and a high customer density is crucial in this case as well. The study of Lewis (2001) supports future demand. It claims that as much as 40% of active or potential European online grocery shoppers would be interested in unattended deliveries. In spite of low market demand, there are already various reception box manufacturers in the market and it is easy to see the reason for that (Kämäräinen and Punakivi 2002a). For example, the value of the UK home delivery market was approximately 18.9 billion pounds in 2000 (@ Your Home 2001). This represented more than 420 million home deliveries in the UK alone.

The third hypothesis claimed that the order of implementing solution components is not significant in e-grocery retailing. This hypothesis was not confirmed. The evidence of this dissertation suggests that different solutions have some impact on the other solutions and this relationship should be taken into account when implementing an e-grocery business. It has been demonstrated that identifying success factors and understanding their dependencies and dynamics is an essential part of choosing the strategy and a successful implementation process. It has also been shown, by using examples, how e-grocers have made investments intended to lead to one efficient operation in a different order, whereas overall efficiency has remained poor. According to the results, it is more important to take into account the flexibility and usability of individual solutions in different market situations than the optimal performance of an individual solution.

Based on the research findings of this study, directions for investment strategies are given in Figure 13. It can be seen how the target of the e-grocery service and starting point, i.e. the model, significantly affect the roadmap chosen.

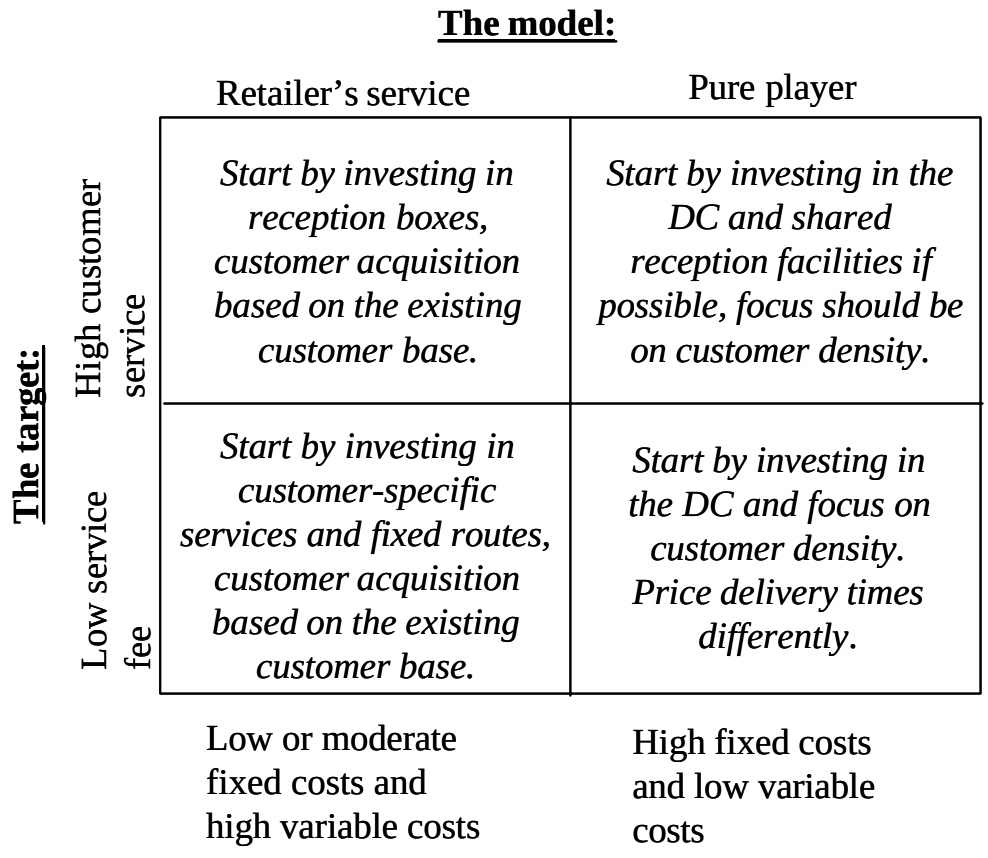


Figure 13. Alternative investment strategies.

In spite of the investment strategy chosen, it is not clear who controls the distribution centre, home deliveries, or the reception at the customer's end. In the e-grocery business, there can be many players, with their own preferences. Table 6 shows how the implementation of an e-grocery system can involve various players, in addition to many operations.

Table 6. Different operations and possible operation producers in the e-grocery supply chain (Kämäräinen 2002).

Operation	Producer of the operation
Marketing and reception of the orders	E-grocer
Purchasing and warehousing	Local supermarket / wholesaler / e-grocer (with the DC)
Inventory operations (shelving, picking, and packing)	E-grocer / 3rd party
Home delivery	E-grocer / 3rd party / (customer)
Reception of the items (i.e. reception box)	E-grocer / customer / 3rd party

From the e-grocer's point of view, the operations may very well be outsourced. The e-grocer may only be a marketing organisation, taking care of consumer marketing and receiving orders from consumers, outsourcing everything else to third parties. This creates markets for 3PL and 4PL providers. On the other hand, it is possible that the e-grocer will take care of everything from purchasing to home deliveries and the reception of the goods at the customer's location. This is the most common model today. However, it is not necessarily the most efficient from the logistical point of view. For example, if the e-grocer makes investments in reception boxes, it is likely that access to the reception boxes would be limited, although a more efficient solution would be to create an open system. Therefore, the focus of development of the e-grocery logistics system should be more on the common goals and the relationship between different components inside the system than the separate parts of the system. Only in this way can economic viability be reached.

6 EVALUATION OF THE RESEARCH

In this chapter, the results of this dissertation are discussed from the managerial point of view. In addition, the implications for research and practice, the contribution and relevance, validity and reliability, and limitations of the study are discussed. Finally, directions for further research are given.

6.1 Discussion

The solutions and strategies presented in this dissertation give guidelines for the implementation and operation development processes in the e-grocery business. Alternative solutions and investment strategies are discussed in the following section.

Investment in services is the fastest way to implement a business and expand a customer base. According to Christopher (1993), "understanding customers' service preferences is the starting point for re-engineering logistics processes to ensure greater cost-effectiveness, thus customers' service preferences should be the starting point for the development of logistics and supply chain strategies". However, in the case of e-grocery retailing, there are numerous services that cannot be implemented without reception facilities. Shared reception boxes are a good starting-point for a wider customer base. This study has shown that there are also opportunities to make a profit with reception box services. However, it is difficult for an individual e-grocer. Therefore, the reception box model is a good starting-point for investment only if an open system for many players can be created. This situation can be compared to the state of ATMs (automatic teller machines) in the early 1980s in Finland. All the banks had their own ATMs, but soon they noticed that if ATMs were open to the customers of other banks, the market would grow and the costs of transactions would decrease. If progress with reception boxes develops similarly, it is a good starting-point for investment. Otherwise, it is unlikely that fixed reception facilities will become general solutions.

According to Bovet and Martha (2000), the reception box is a major benefit from the supply chain perspective, because it enables unattended delivery and it allows the aggregation of orders and route optimisation. In some cases, unattended delivery can also

be implemented without fixed reception facilities. This can be done, for example, by using ice in the delivery boxes that the supplier leaves in front of the customer's door. However, the use of this kind of arrangement is limited because of temperature laws and the fear of theft in many countries.

Existing grocery retailers have a different starting-point from which to develop their business than pure players. They are not forced to start their investments with the distribution centre and the focus can be on other important issues, such as value-added services, until demand has grown enough. An e-grocery business based on "bricks and mortar" also means that the business would be based on retailers' traditional relationships with suppliers, as well as their customer base. This provides the e-grocer with better conditions for customer acquisition and improves purchasing power with suppliers (Kämäräinen and Punakivi 2002b). In e-grocery retailing, compact delivery areas and large shopping baskets are preconditions for profitability. Superior customer service is required because a strong customer relationship and customer retention rate are crucial to operationally efficient delivery areas. This is especially important when investing locally, for example in reception boxes. Therefore, long-term profitability in e-grocery retailing is even more dependent on customer relationships and customer retention rates than in traditional grocery retailing. Some pure e-grocers, such as Peapod in the USA, have started picking from their stores or "cash & carries". However, this model means one extra level for the supply chain and also high purchase prices. One possible alternative would be building a common distribution centre for the e-grocery business and small business customers, such as catering kitchens. However, this model requires consumers and small business customers to use similarly-sized packages. Therefore, in the case of pure e-grocers, existing picking facilities are not usually competitive and so investments in the distribution centre are needed first and foremost.

The distribution centre requires substantial investments, but also offers opportunities radically to improve picking efficiency and space utilisation, as well as to reduce losses due to pilferage or spoilage (Kämäräinen 2000). In addition, availability information is often better in the distribution centre. This is important, because e-grocers typically have a substitution rate of up to 15% (Thom 2002). The distribution centre does not necessary require any extraordinary technology in order to be effective. More important is flexibility

of layout and storage equipment. According to Ackerman (1999), "the storage layout should be designed to place the 20% of items that constitute 80% of activity in the places where they can be easily received and shipped". When designing the distribution centre, it should be taken into account that pallet racks, shelving, and storage cabinets are adjustable, portable, and capable of being moved to another location or sold, i.e. the distribution centre should rather be designed for flexibility than efficiency at maximum capacity (Ackerman 1999). This is important, especially in the e-grocery business, where growth rate is high and modifications to the distribution centre are part of everyday life. According to the results of Yrjölä (2003), the break-even volume for sales, i.e. the point at which the manual distribution centre becomes a cheaper place for picking than a store, is between 2 and 8 million euros. However, it does not mean that the business would be profitable.

If an e-grocery business is seen more as a complementary service for the traditional grocery retailer, there are other ways to develop the business. For example, home delivery efficiency can be improved by using fixed routes. This means that customers are given a fixed delivery timetable and they have to receive the order at exactly the given time. In this way, the delivery time is known beforehand and it means better opportunities to arrange delivery and picking operations more efficiently (Waller et al 1999). However, this reduces the flexibility of the delivery process and makes the service less attractive from the consumer's point of view, as they are now dependent on the supplier's timetable.

Whatever investment path is chosen, a successful e-grocery business requires more customer demand. Customer density can be seen as one of the most important elements in e-grocery retailing (Van Gelder 2002b). According to Yrjölä (2003), sales per square metre are an important indicator and the crucial limit is an annual sales volume of approximately 167,000 euros per square kilometre. If sales increase above this figure, it does not have a significant impact on home delivery costs. Yrjölä (2003) goes even further; he claims that "if grocery sales are more than 200,000 euros per square kilometre per annum, it is highly likely that delivering the groceries from an LDC (local distribution centre) to the household will be cheaper than running a supermarket."

According to research conducted by Cranfield University (UK), technology and access to technology, consumer lifestyles, consumer dissatisfaction with the grocery shopping

experience, and the search for convenience are the drivers of the development of the e-grocery business (King 1999). Changes in consumer lifestyle can be recognised as one of the most important and complicated factors; purchasing behaviour between different consumers varies greatly and changes slowly. The roles of government and communities also have a strong impact on progress; issues in private motoring, the environment, suburban area services, and services for disabled and older people are crucial. These issues are especially important at the beginning of the business, when demand is still at a low level. To summarise, the solutions and implementation strategies chosen depend heavily on the targets of the service. If the e-grocery business is established only to support traditional grocery retailing, the starting-point is totally different when compared to that of the pure players.

The theories and methodologies used in this dissertation have provided support for the disproving of the hypotheses. The body of knowledge has been increased by drawing conclusions through logical reasoning in the area of e-grocery logistics system implementation and operations. Retail logistics, warehouse management, and consideration of the vehicle routing problem are approaches that have been taken to explaining the efficiency of individual elements and logistical solutions. The constructive approach and, especially, modelling were used when approaching the research problems in individual research papers. The methods of an inside system approach, modelling, scenario planning, and the interrelationship approach were used to evaluate logistical solutions as a part of a complex system. Sterman (2000) suggests that instead of examining just some specific part of the system, system thinking aims to understand complex systems by examining the "big picture" and relationships inside it. Therefore, this dissertation demonstrates how different parts of the e-grocery logistics system interact and therefore cannot be separated from each other in investment decision-making. Rushton and Saw (1993) emphasise that there is potential risk in optimising only part of a system, while greater benefits could come from making changes to other parts of the system (Rushton and Saw 1993). This risk also exists in the e-grocery logistics system, where the most efficient operational solution is not necessarily the most efficient from the point of view of the whole e-grocery.

In addition, the philosophies of Popper (1963) have been used to approach the inter-dependencies between different elements and solutions, in addition to increasing

knowledge about different investment strategies. Popper emphasises the importance of severe criticism and of the testability of the hypothesis; the greater the risk, the greater the testability, and the more testable the solution is, the better. In this dissertation, knowledge of different solutions and their inter-relations in the e-grocery business has grown as a result of the creation of critical and testable hypotheses. The hypotheses have been proved to be partly or totally wrong but provisionally retained as the best available truths until finally proved false or superseded by better ones.

6.2 Contribution and relevance of the research

In recent years, e-grocers have introduced many new solutions in order to create a more effective business. However, the inter-dependencies between different solutions are rarely discussed. From the academic point of view, these issues have not yet been studied in the e-grocery environment. The results of this dissertation have been published in five prestigious academic journals in the area of supply chain management and logistics. In addition, various articles from the ECOMLOG research programme have been published in prestigious academic journals and at international conferences.

Relevance in Industrial Engineering and Management (IEM) means that research has high priority in the domain of business problems and it has potential value for practitioners (Heikkilä 2000). From the commercial point of view, this study helps in the evaluation of logistical solutions and choosing investment strategies for e-grocery retailing. It presents various different viewpoints to be taken into account in practice.

This research has examined picking automation investment in the distribution centre, the feasibility of providing unattended reception solutions, and conditions for successful e-grocery logistics system implementation. Figure 14 summarises the main conclusions of this study and their position in the Intertrade project.

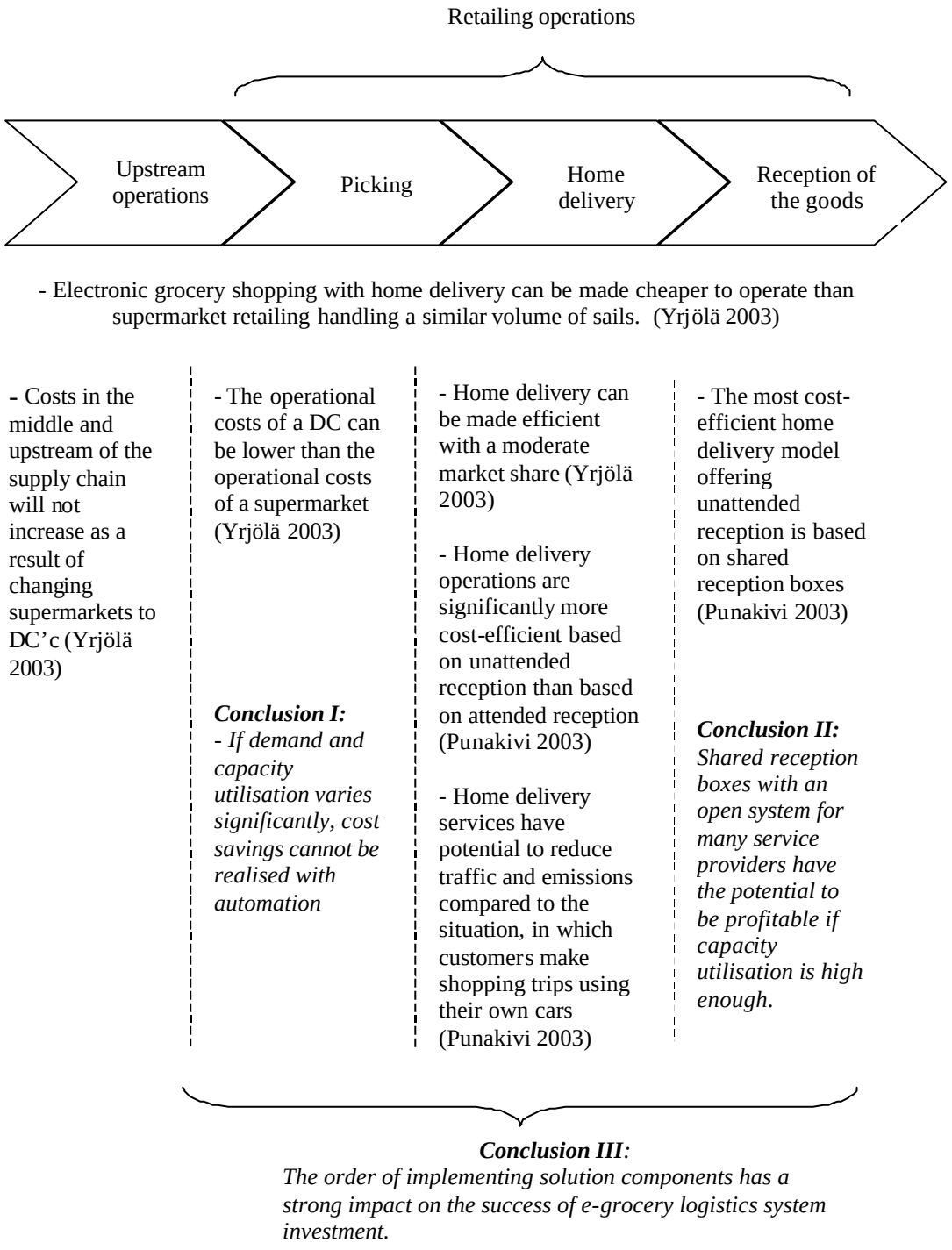


Figure 14. Conclusions of this research and links with other Intertrade research.

Earlier research in the field of the e-grocery business was presented earlier, in Section 2.2.3. The results of this study are very different from those of earlier research. However, they are not in conflict. Many management books, such as Bover and Martha (2000) and Hoover et al (2001), have taken e-grocery logistics into consideration, but only a few have

analysed it in order to achieve a deeper understanding of operational cost drivers and their inter-dependencies in the business. This emphasises the importance of this study.

Forrester (1961) suggested that interactions between the components of the system are often more important than the separate components themselves (Forrester 1961). This can be related to the results of this study. It is shown how an individual logistical solution in e-grocery logistics can be cost-effective, but, on the other hand, a profitable investment decision cannot be made without knowledge about the inter-relationship with the other solutions of logistics in the system.

The importance of finding and targeting the right customer segments for the specific products or services was also emphasised in this dissertation. The findings of this research support the results of Ancar et al (2002), who studied different ways to create customer value in the e-grocery business. This dissertation emphasises the importance of the goal of the service when choosing an investment strategy. The study of De Koster (2000) pointed out that traditional grocers tend to keep using their existing infrastructure for fulfilment, but there is some weak evidence that a large number of orders favours the use of a specialised distribution centre. This agrees with the results of this study.

Bovet and Martha (2000) pointed out that the reception box is a major benefit from the supply chain perspective, because it enables unattended delivery and it allows the aggregation of orders and route optimisation. However, this research emphasised that decreased costs do not necessarily mean profitability. Therefore, different revenue model alternatives were created and evaluated. Boversox and Closs (1996) pointed out that the overall target of logistics is to achieve the chosen customer service level at the lowest possible total cost. This supports the findings of the feasibility of unattended reception. It has been shown that different reception box models can offer different service levels and, on the other hand, costs for the customers. Not all the models can be profitable, but customers might be willing to pay for them.

The results of this dissertation suggest that if demand and capacity utilisation vary significantly, cost savings cannot be realised with automation in e-grocery picking. Therefore, it is posited that flexible manual picking has greater potential to achieve cost-efficient operation. This is supported by the results from the normal distribution centre environment. Ackerman (1999) suggested that when designing the distribution centre, it should be taken into account that pallet racks, shelving, and storage cabinets are adjustable, portable, and capable of being moved to another location or sold, i.e. the distribution centre should rather be designed for flexibility than efficiency at maximum capacity (Ackerman 1999). Additionally, Peters (2000) pointed out the fact that factors such as the demand pattern of the items, the configuration of the warehouse, the location of the items in the warehouse, and the picking method greatly affect the performance and efficiency of the picking operation. However, this dissertation emphasises the importance of flexibility in e-grocery picking operations because of special characteristics such as demand variation inside days and the week, preservation temperatures, hygiene requirements, and sell-by date limitations.

In practice, this study helps managers to understand better the influences of investment decisions on overall e-grocery business efficiency. The evaluation of picking automation potential has pointed out the fact that general rules of automation investment are also valid in the e-grocery business. However, there are special characteristics that should be taken into account when considering picking automation investment. These are too often forgotten nowadays.

Up till now, there has been no player in the various pilot projects who has pointed out how to make money by operating with reception boxes. This study has suggested different potential solutions for profitable reception box utilisation. Various companies have used the results of this research. Hollming Ltd. has invested in the development of different reception box concepts and the S-group has gained experience from the e-grocery pilot project. In addition, various other manufacturers of reception box concepts have used the results when evaluating business options (Whirlpool 2000; Homeport 2000; BearBox 2001; E-commerce delivery systems 2001).

In spite of various logistical solutions and alternative combinations in the market, knowledge of success factors has remained uncovered. This dissertation has evaluated different investment paths and strategies, taking account of earlier research in addition to the mistakes and success factors of the early players. Based on this, managerial guidelines for successful implementation have been created. These are especially important from the point of view of successful investment when choosing a market entry strategy.

6.3 Validity and reliability of the research

In constructive research, validity can be evaluated on the basis of a market test (Kasanen et al 1993). It can also be evaluated more extensively on the basis of case research. In case studies, the validity of the research can be divided into construct validity, external validity, and internal validity (Yin 1989). Construct validity means that the operational measures established and used are correct for the research, i.e. the constructs solve the research problems.

External validity means that the results of the research can be generalised. In constructive research, the results must be generalisable (Kasanen et al 1993). As usual, the generalisation of the results includes some limitations; this is also the case in this study. Firstly, some simplifications were made in order to make modelling possible and the results easier to present and understand. For example, when modelling different revenue models for reception boxes, installation and maintenance costs were not taken into account. Similarly, the efficiency of automation in the distribution centre was evaluated by creating a model for maximum justifiable investment. By using this model, the cost savings of automation at different rates of capacity utilisation were illustrated. However, this model did not take into account matters such as the size of the product range or the decrease in the costs of stolen and broken goods when changing from a manual to an automated picking environment.

Secondly, the examples and calculations presented are based on cost levels in Finland. For example, the price of picking per worker per hour is calculated on the basis of labour costs in Finland. Similarly, the costs taken into account in the modelling of reception box revenue and home delivery are based on cost levels in Finland. This limits the usability of

the results to Finland. However, if the parameters are changed the models presented can be generalised more widely. Thirdly, due to the limited availability of data, the results cannot be compared to benchmark figures in other geographical areas, where cost levels can be different. For example, specialised temperature-controlled delivery vehicles and reception boxes are required in Finland. (According to Finnish law hygiene and temperature restrictions have to be taken into account until the customer receives the groceries, i.e. picks them up from the reception box.) This means higher investments compared to more simple solutions, for example, with ice cooling. In addition, it should be taken into account that demand variation is presented only from the Finnish point of view.

Internal validity means establishing causal relationships. This study considers the success of the implementation process on the basis of system thinking. The focus is on how the solutions being studied interact with the other elements of the system. The essential question is whether it really measures what the researcher claims it does (Emory 1985). When considering internal validity, external disturbing factors should be excluded. However, in this kind of study it is impossible to eliminate all the factors that have an impact on the system. In this study, models and performance indicators were based on the researcher's practical understanding of the phenomenon and the existing body of theoretical knowledge and benchmarking information. In addition, these instruments were discussed and validated with experts in the participating companies. However, the amount of companies was small and thus can be seen only as a supporting element.

Stability and equivalence are two frequently-used perspectives of reliability (Emory 1985). Research is stable if the results are free of random elements, ie. they can be repeated by the same person with the same instruments. However, the problem is in measuring stability; situational factors, and thus also the results, may change over time. In this study too, the results change when customer demand and opinions change over time. Equivalence deals with the impact of different investigators or samples of items on error. In other words, equivalence is concerned with variations at one point in time among observers and samples of items (Emory 1985). In this study, the answers for Hypotheses I, II, and III would be the same regardless of the observer. However, depending on the observer, some different deductions about the inter-dependencies between different solutions and elements in the system can be made. To summarise, the results of this

research are limited because of the small market size and restricted amount of available data.

6.4 Directions for future research

A construction that works usually leads to new questions (Kasanen et al 1993). In this study, the most important business driver, and perhaps the most interesting area for future research, is customer demand. Currently, customer demand is low, but, on the other hand, only a few e-grocers exist in the market. In addition, the restricted number of services does not increase consumers' willingness to adopt the new concept. The primary focus of future research should therefore be on customer behaviour. Different pricing models, consumers' needs for different sets of services, and differences between consumer segments and geographical areas are important areas for future research. In particular, customer willingness to use shared reception box services should be studied, because the profitability of reception box concepts depends heavily on capacity utilisation rate.

Another interesting area for future research is the manual environment for order picking. According to this dissertation, creating flexible and expandable product flow and layout designs for the distribution centre should be more important than rapidly increasing the level of automation. Therefore, the design principles of a manually-based distribution centre should be studied more closely. The impact of combining groceries with general merchandise material flows should be studied. This could increase volume so that the break-even point for the deliveries and reception would decrease remarkably. In addition, the potential to link B2C order picking and deliveries to those of small business customers' (such as catering kitchens) operations is an interesting field of research. The timing of operations between the distribution centre and home delivery is also an important issue and needs more research.

This dissertation shows how different logistical solutions and the order of implementing solutions affect investment in e-grocery systems. However, the timing of implementations also affects the profitability of the whole business and should therefore be studied more closely. In particular, the right timing for the biggest investments, i.e. the distribution centres and the reception boxes, is crucial from the point of view of profitability.

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APPENDIX I

The ECOMLOG company partners

During the period from 1999-2002, the following company partners were involved in the ECOMLOG research programme, in addition to the national technology agency, Tekes.

- **DNA Finland**, a mobile operator in Finland
- **Fazer** Confectionery, the biggest producer of chocolate and sugar confectionery in Finland
- **Trading House Hansel**, operator for public sector procurement and materials management in Finland
- **Nokia**, a Finnish-based mobile phone supplier and network manufacturer
- **Norpe**, a manufacturer of refrigerating equipment (part of the Hollming group)
- **Panimoliitto**, the Finnish brewery union
- **S-group**, the second biggest grocery retailer in Finland
- **Sonera**, the biggest mobile operator in Finland
- **Unilever**, an international grocery supplier
- **Valio**, the biggest supplier of dairy products in Finland

APPENDIX II

Research Questions in the Intertrade

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)

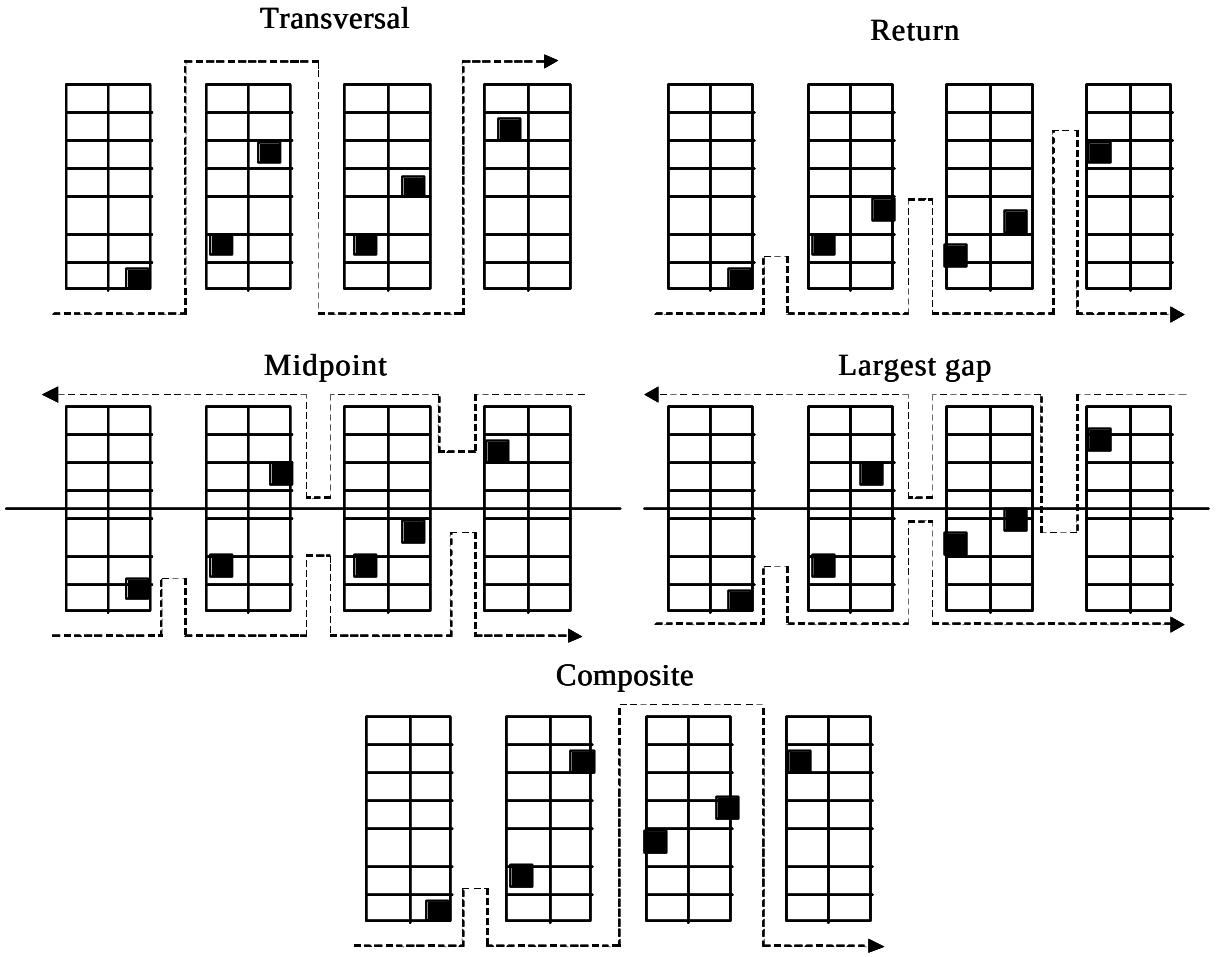
8.1 What are alternatives for the grocery manufacturer?

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 III

Different routing strategies for order picking (Peterssen 1997)



APPENDIX IV

Tesco.com (UK) began on-line sales in the mid-1990s (Hoyt 2001). Today it is the world's biggest e-grocer. By using its existing brand, suppliers, and database of 10 million affinity card holders, Tesco used $56 million to launch its online service (Anon. 2001). Tesco's strategy has been to build a successful store-based e-grocery model in a compact geographical area and then copy it to new areas (Reinhardt 2001). Tesco chose a store-based fulfilment model and with the first mover advantage it soon reached a coverage of 90% of the population in the UK (CIES 2000). Tesco completes a typical order of 64 items in 32 minutes at a cost of about $8.50, including labour (Reinhardt 2001). This is about 7% of the average $123 order.

In the fiscal year 2001, Tesco.com lost $13 million with sales of $336 million (Hoyt 2001). Currently, it claims to be profitable (Jones 2001). Tesco.com has approximately one million registered users and it receives 85,000 orders a week (Anonym 2002). Last year, Tesco.com launched its business model in the USA in cooperation with Safeway. Safeway's stores cover about 60% of the population in the USA. Tesco.com also operates in the Republic of Ireland and plans to start a service in South Korea.
(Anon.2002)

Webvan (USA) launched its service in the San Francisco Bay area in June 1999. Soon, in November 1999, it raised $375 million in its initial public offering (IPO) (Cuglielmo 2000). Webvan was a pure e-grocer whose strategy was to invest in huge, highly automated distribution centres from the beginning. It planned to develop a distribution network in 26 U.S. markets in two years (Cone 1999). The size of one distribution centre was approximately 350,000 square feet, equalling 18 traditional stores (Mendelson 2001). Webvan claimed that by using highly automated distribution centers with a capacity of 8,000 orders a day (7 days a week, with an average order size of about $103) it could achieve an operating margin of 12%, compared to a 4% operating margin for a supermarket (Cuglielmo 2000). Webvan averaged 18.1 inventory turns for the year 2000 (Mendelson 2001). At the beginning, Webvan offered a 30-minute delivery window selected by the customer. However, it soon tried to cut home delivery costs by expanding the delivery window to 60 minutes. Break-even was calculated to be $300 million. Webvan reached sales of approximately $260 million and went into bankruptcy – after spending $1 billion - in summer 2001.

Peapod (USA) started its operations in Chicago in 1990, taking orders by fax and phone (Dagher 1998). In 1997, it received its first Internet orders. Peapod entered the market by picking customer orders from retail partners' supermarkets. Currently, Peapod is owned by Ahold – the 3rd largest grocery retailer in the world. It serves five metropolitan areas, being the biggest e-grocer in the USA (van Gelder 2002a). Picking is done in distribution centres and supermarkets owned by Ahold. The average basket size is worth $135. Nowadays Peapod claims to be profitable in 4 of its 5 markets, with an annual growth rate of 35% (van Gelder 2002a).

APPENDIX V

Research ideas, constructs, and results were refined and consolidated at the Intertrade project's steering group meetings and the ECOMLOG research programme's management meetings. The steering group was created to supervise research projects and give directions for future research. It consisted of management staff from the company partners, researchers, and the project manager. The management group's role was to provide direction for the research programme and accept the budget. It consisted of managers and directors from the company partners, a representative from Tekes, and the Professor of logistics from Helsinki University of Technology. In addition, project managers and researchers took part in the meetings. Steering and management group meetings were held regularly and typically lasted two hours. The author took part in the following meetings. All the presentations and decisions made are documented.

The Intertrade steering group meetings and company participants:

Name	Title	Company	260599	190899	300999	111199	200100	230300	300500	170800	121000	141200	150201	100401	160801	161001	100102
Mr. Kalevi Hilden	Manager, logistics	Valio					X	X	X		X	X	X		X	X	
Mr. Juha Lyytinen	Development manager	Valio					X	X	X		X						
Mr. Lars Miikki	Business development manager	Hansel		X	X	X	X	X	X		X		X	X			
Mr. Jaakko Välttilä	Manager, logistics	Hansel		X	X	X	X										
Mr. Harri Matikainen	Manager, logistics	Hartwall				X	X	X		X	X	X	X				
Mr. Juha Korhonen	Research manager	DNA															X
Mr. Pasi Lehtinen	Distribution director	Sinebrychoff			X		X	X		X		X	X	X			
Mr. Hannu Kulju	Director	Sonera		X	X												
Mr. Timo Moilanen	Business development manager	Sonera					X		X					X			
Mr. Reino Aarinen	Manager, e-commerce systems	Hollming			X		X	X	X	X	X	X	X	X	X	X	X
Mr. Risto Salo	Managing director	Hollming					X										
Mr. Jari Lohi	E-business manager	SOK			X	X	X	X	X	X	X	X	X	X	X	X	X
Mr. Harri Mönkkönen	Director, Logistics and IT	SOK		X	X					X							

The ECOMLOG research programme management group meetings and company participants:

Name	Title	Company	170100	230500	050900	111200	050301	040601	170801	111201	190302
Mr. Risto Saarinen	Managing Director	Finnish Brewery Union		X	X	X	X	X			
Mr. Pekka Aaltonen / Ms Heidi Lindroth	Senior Technology Adviser	Tekes	X	X	X	X	X	X	X	X	
Mr. Timo Moilanen	Business development manager	Sonera					X				
Mr. Juha Lyytinen	Development manager	Valio	X	X	X		X		X	X	
Mr. Pentti Jukola	Business manager	Lever Faberge	X	X	X					X	X
Mr. Matti Saario	Managing director	Lever Faberge				X		X			
Mr. Vesa Antola	Director	Hollming					X		X	X	X
Mr. Risto Salo	Managing director	Hollming	X							X	X
Mr. Reino Aarinen	Manager, e-commerce systems	Hollming	X	X	X	X		X	X	X	X
Mr. Timo Raikaslehto	Manager, channel logistics	Nokia	X								
Mr. Jaakko Laine		Nokia						X			
Mr. Jussi Penttinen		Nokia					X		X	X	X
Mr. Visa Palonen	Vice President, e-business	SOK	X					X	X	X	
Mr. Jari Lohi	E-business manager	SOK	X								
Mr. Harri Mönkkönen	Director, Logistics and IT	SOK	X	X	X						
Mr. Tero Rautsola	Managing director	Fazer Confectionery			X	X	X	X	X		X
Mr. Petri Aro	Director	Hansel		X	X					X	
Mr. Lars Miikki	Business development manager	Hansel				X					
Mr. Juha Korhonen	Research manager	DNA Finland								X	X

The author participated in the e-grocery pilot steering group as a researcher and his main role was to analyse customer behaviour data and participate in concept development with Ms Johanna Småros from HUT / TAI Research Centre.

Name	Title	Company	15050	13060	15080	18090
Mr. Mika Teileri	Project manager	SOK / HOK	X	X		X
Mr. Tomi Jaakola	Logistics designer	SOK	X	X		X
Ms. Jari Lohi	E-business manager	SOK	X		X	X
Ms. Pirkko Laurila	Corporate development	Hollming	X	X	X	X

In addition, knowledge was collected and consolidated in interviews, group meetings, workshops (as a trainer), and conference discussions.

Date	Place	Person	Title	Company	Type
191099	Malmö, Sweden	Mr. Johan Johnsson	Project manager	Matomera	Interview
060900	London, UK	Mr. Mark Lunn Ms. Turid Borsheim	Marketing director	Homeport Ltd.	Interview
151200	Helsinki	Mr. Stefano Turconi Mr. Gunter Grittner Mr. Mika Laitinen		Whirlpool Ltd.	Interview
150101	Helsinki	Mr. Jari Lohi	E-business manager	SOK	Personal communication
170101	Helsinki	Mr. Tomi Jaakola	Logistics designer	SOK	Personal communication
310101	Milan	Mr. Stefano Turconi Mr. Gunter Grittner		Whirlpool Ltd.	Personal communication
280201	Helsinki	Mr. Risto Salo	Managing director	Hollming Ltd.	Personal communication
110501	Rauma	Mr. Reino Aarinen Mr. Vesa Antola	Manager, e-commerce systems Director	Hollming Ltd.	Personal communication
240501	Cardiff, UK	Mr. Robert Mason	Project manager	Cardiff University	Personal communication
270601	Helsinki	Main Intertrade company partners			"Last mile" workshop
030701	Helsinki	Mr. Visa Palonen	Director	SOK	Personal communication
050701	Helsinki	Mr. Reino Aarinen	E-business manager	Hollming	Personal communication
140801	Helsinki	Mr. Tomi Jaakola	Logistics designer	SOK	Personal communication
030901	Helsinki	Mr. Tomi Jaakola	Logistics designer	SOK	Personal communication
240901	Helsinki	Main Intertrade company partners			"E-fulfilment" workshop
151101	Helsinki	Mr. Sauli Harju	Development manager of logistics	Inex	Interview
111201	Helsinki	Mr. Reino Aarinen Mr. Vesa Antola	Manager, e-commerce systems Director	Hollming	Personal communication
210102	Seinäjoki	Mr. Erkki Muilu	Dirtector, logistics	Atria	Personal communication
060302	Helsinki	Mr. Vesa Antola	Director	Hollming	Personal communication
190802	Helsinki	Ms. Lowri Davies Mr. Mohammed Naim	Research coordinator Reader	DTLR, UK Cardiff University	Personal communication
011002	San Francisco, USA	Mr. Mark van Gelder	President and CEO	Peapod	Personal communication

Conference presentations and discussions:

Date	Conference	Place	Authors	Paper / presentation title
September 1999	Logistics Research Network conference, LRN	Newcastle, UK	Holmström J. Tanskanen K. Kämäräinen V.	Redesigning the Supply Chain for Internet Shopping - Bringing ECR to the households
February 2000	Eleventh international working seminar on production economics	Igls, Austria	Kämäräinen V. Saranen, J. Holmström J	How goods receipt affects e-grocery efficiency?
February 2000	Eleventh international working seminar on production economics	Igls, Austria	Yrjölä, H. Lehtonen, V.M. Kämäräinen, V.	An agenda for Electronic Grocery Shopping Supply Chain Research
September 2000	Logistics Research Network conference, LRN	Cardiff, UK	Småros, J. Kämäräinen, V.	ECR in the e-grocery business
November 2000	Cooperation for competition conference	Vaxjö, Sweden	Kämäräinen, V. Småros, J.	The manufacturers' new role in the e-grocery business
June 2001	Nordic research in logistics, Nofoma 2001 conference	Reykjavik, Iceland	Saranen, J. Punakivi, M Kämäräinen, V.	Reception box experiences from an e-grocery pilot
December 2001	International conference on Supply Chain Management and Information Systems in the Internet Age	Hong Kong, China	Kämäräinen, V. Punakivi, M.	Development of cost-effective supply chain in the e-grocery business

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