# HORIZONTAL COOPERATION IN TRANSPORT AND LOGISTICS

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PROEFSCHRIFT

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| COPROMOTOR | dr. Wout Dullaert |

# PREFACE

For four and a half years I have been doing research at Tilburg University. This research was partially funded by consultancy projects at Informore BV and TNO Mobility and Logistics, both of which are gratefully acknowledged for their sponsoring. After one and a half year, I made the switch from Informore to TNO, which entailed a drastic change of topic. Also at Tilburg University I made a shift: from the contract research institution CentER Applied Research, to the department of Econometrics & Operations Research. Although both shifts were temporarily disruptive, it is fair to say that eventually they turned out for the best.

In writing my thesis, I received invaluable support and contributions from numerous people. First, I would like to thank my promotor Hein Fleuren for his mental support and his indefatigable attitude towards the avalanche of manuscripts I spammed him with towards the final date. Hein offered me the opportunity to start my PhD project, and therefore I cannot thank him enough. Then, I am largely indebted to my copromotor Wout Dullaert. Without his contagious enthusiasm, friendship, and (at times slightly exaggerated) compliments, this thesis would have been of a much lower standard. Among many other things, Wout taught me how to write academic papers, how to be more self-assured about my work, how to learn from setbacks, how laugh about setbacks, and how to relax at conferences. Thirdly, I would like to express my gratitude to Marc Salomon, my initial copromotor. His extremely quick mind has been a great inspiration for me in the early period. Furthermore, I wish to express my appreciation to Kees Ruijgrok for his valuable comments on my manuscript. Finally, I thank the other members of my committee, Peter Borm, Herbert Hamers, Alan McKinnon and Bart Vos for taking the time to read this unintentionally bulky thesis.

A second group of people I would like thank are my colleagues in four different working environments. Since I was lucky enough to have had so many nice and knowledgeable people to work with, I have to limit myself to mentioning my closest colleagues. In chronological order, I start by thanking the people of Informore, Willem and Noel in particular, for the joyful period in Hilversum. Also at CentER Applied Research I found myself in a pleasant working environment, offering the friendship of Gijsbert and Mark as a bonus. Thirdly, I am largely indebted to the people at TNO. Especially Bas, Egbert, Kees, and Kees, were a true source of inspiration. Finally, I thank all members of the Econometrics & Operations Research department of CentER for the excellent research conditions.

Furthermore, it is fair to say that the writing of the papers that underlie this thesis has been a true example of horizontal cooperation. I thank my co-authors Peter Borm, Olli Bräysy, Martine Cools, Wout Dullaert, Hein Fleuren, Bas Groothedde, Herbert Hamers, Tarja Joro, René de Koster,

Ieke LeBlanc, Marc Salomon and Sven Verstrepen for the enjoyable moments we shared during our cooperation.

All the encouragements in my professional surroundings would however have been in vain without the support of my family and friends. My PhD research period, university studies, secondary school, and even primary school have brought me friends for life. I am happy that two of them, Ellen and Erik, agreed to be my ‘paranimfen’. Besides my friends, also my family is very important to me. Here I would like to thank my father, who deceased far too early, and my mother for always supporting me and giving me the opportunity to develop myself into the person I am today. I do realise that in a family business it is not obvious that a son is given such a free rein in his choice of education as I enjoyed. I hope that, in a sense, this doctoral degree is a compensation for all their efforts in my favour. Furthermore, I thank Mariëtte, Wladimir, Thomas, Yvonne, Joost, René, Coby, Remko, Sandra, and Ilse for the strong family ties. However, my deepest gratitude goes out to Wendy. Her love and support in both the difficult and joyful moments have been wonderful. I very much look forward to the steps in life that we are going to take together.

Frans Cruijssen Tilburg, September 2006

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# CHAPTER 1 INTRODUCTION

Christopher (1988) defines a supply chain, as “the network of organizations involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the eyes of the ultimate customer”. Furthermore, logistics can be defined as the total process of moving goods from a supplier of raw materials to an ultimate customer in the most timely and cost-efficient manner. Supply chains have become an important and complex component of the economy. For example in the year 2000, logistics costs in the Netherlands amounted to € 49.7 billion, or 12.4% of the gross domestic product (NDL, 2005).

An efficient organization of logistics operations is crucial for both companies and the economy as a whole. It is reckoned that companies that have been able to establish a competitive advantage in the last decade are typically those companies where logistics management has a high priority (Groothedde, 2005).

## 1.1 TRENDS IN THE LOGISTICS SECTOR

In recent years the European logistics playing field has been going through considerable changes. In this section the trends having the strongest impact on logistics are discussed. They are: 1) Globalisation and increased competition, 2) One-stop-shopping and heightened customer expectations, 3) Increasing costs of road network usage, 4) Information and communication technology, and 5) Environmental management. The discussions below are partly based on Cruijssen and Verweij (2006).

*Globalisation and increased competition*. The sector of logistics service providers (LSPs) is traditionally characterised by a large number of small, often family-owned companies. Together these companies constitute a considerable market share. As an illustration, Eurostat figures (E.R. 9) show that there are as much as 46,000 road transport companies in Germany, 39,000 in France, and 37,500 in the United Kingdom. Meanwhile however, the fast globalisation of the world economies is starting to impose new and stronger requirements on LSPs. The fading trade barriers and simplified customs procedures have led to strong geographical specialisation of production. In addition, considerably lower labour wages in Asia, as compared to Europe and North America, have caused a shift of production of commodities to the Far East. This has strongly intensified transport from and to Asia. As an illustration, the number of containers imported from China via the port of Rotterdam has grown explosively from 300,000 in 2000 to 1,100,000 in 2005. Other European and North-American ports show similar statistics. Western European countries in particular, also have to cope with the consequences of the expansion of the European Union (EU). On May 1st 2004, ten new countries with a combined population of almost 75 million joined the EU. These countries, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia, generally have lower labour prices than the 15 incumbent EU countries and as a result more production is relocated towards the new southeastern borders of the EU.

This globalisation of production has caused supply chains to stretch and become less predictable. This makes it more difficult for the many small LSPs to fulfil the requirements of their customers. Often only the large global LSPs have the skills and capabilities to generate the critical mass of transport flows that is needed to stay cost efficient in the stretched supply chains and meet the demands of their (multinational) customers. The small LSPs in contrast experience intensifying competition, because of the expansion of these large global players. This puts severe pressure on profit margins, resulting in bankruptcies and the market concentration in the transport industry that is witnessed in recent years. As an illustration of these difficult market conditions for smaller LSPs, Eurostat figures (E.R. 9) show that after an increase in the 1990s, the number of active road transport companies has been strongly declining over the last five years in the three largest European economies (see Figure 1-1).

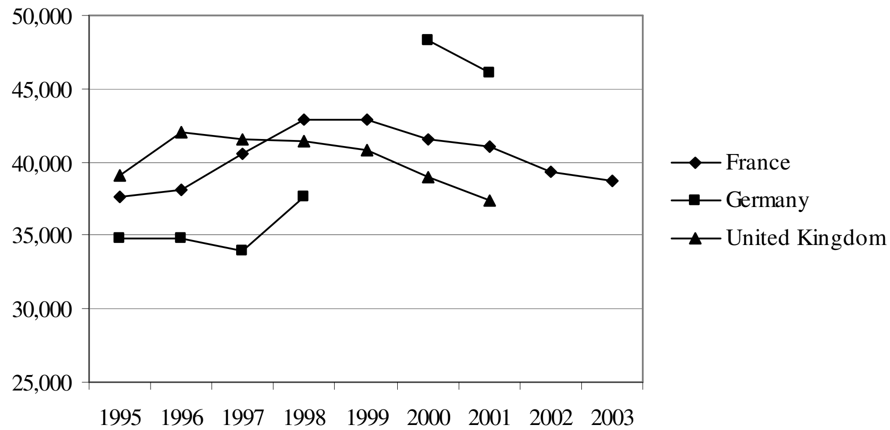


Figure 1-1. Number of road transport companies (source: Eurostat, E.R. 9)

*One-stop-shopping and heightened customer expectations*. In modern supply chains, customers expect goods to be delivered in the right amount, at the right time, to the right place, in perfect condition and at the lowest price. Moreover, customers are increasingly searching for LSPs that can offer them the full package of logistics services. Figure 1-2 provides an overview of the logistics functions that were still handled separately in the 1960s. Over the last decades, customers have been outsourcing whole packages of these activities to LSPs. This means that besides basic transport and/or warehousing, LSPs should now also be able to offer for example reverse logistics services, packaging, forecasting, after sales service, or Information and communication technology (ICT) services.

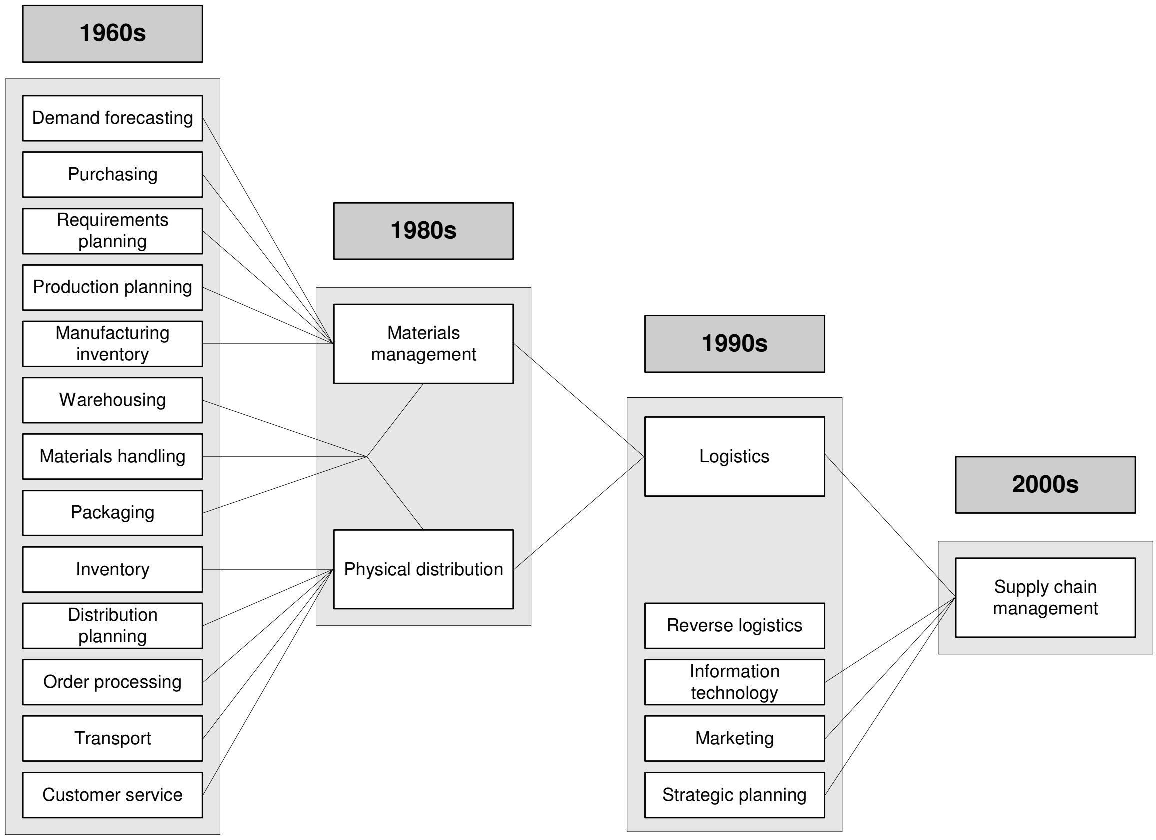


Figure 1-2. The evolution of logistics service integration 1960-2000 (based on: E.R. 24)

Besides these extra services, shippers also expect superior quality and timeliness of service. From a logistical point of view, the manufacturing trends of Just-in-Time, agility, postponement, and Efficient Consumer Response are aimed at a reduction of inventory costs. These concepts give rise to more frequent and smaller shipments with narrower time windows, which complicates LSPs' operations considerably. Mentzer et al. (1999) review the literature on logistics service quality and develop a logistics service quality scale. This scale consists of nine dimensions that are considered to be the main determinants of logistics service quality: 1) Information quality, 2) Ordering procedures, 3) Ordering release quantities, 4) Timeliness, 5) Order accuracy, 6) Order quality, 7) Order condition, 8) Order discrepancy handling, and 9) Personnel contact quality. In order to stay competitive in today's competitive industry, LSPs must score properly on all of these factors.

*Increasing costs of road network usage*. Sending shipments from A to B via the European road network has become more expensive over the last years. This has three major causes. Firstly, for example in the Netherlands, the price of one litre of diesel has risen from € 0.33 in 1986 to € 0.90 in 2006 (E.R. 26). Since fuel cost may constitute up to 30% of total running costs of a transport company, this cost increase is seriously jeopardizing these companies' profitability. A second factor that increases the cost of road transport is the introduction of road pricing mechanisms, such as the German Maut system. As of September 2003, trucks heavier than 12 tonnes are charged a lump sum fee if they use the German highways. Besides these extra direct costs, the introduction entails supplementary costs for a transport company in the form of the purchase and installation of an On-Board-Unit and extra administration costs. This results in a significant cost increase for transport tasks to be carried out in, from, or to Germany. Finally, the cost level of using the road system is also increased because trucks need more time to travel from A to B as a result of heavy congestion. As an illustration, a single-way trip from London to Leeds took 186 minutes in 2002, but in 2006 already 213 minutes, representing an increase of 14.5% (McKinnon, 2004a). These longer transport times are exemplary for the whole of Western Europe. They have direct cost consequences, such as increased fuel and labour costs, but also indirect costs because the unpredictability of traffic jams hampers the LSP's planning and makes compliance with delivery time windows more difficult. Although hard to measure, Goodwin (2004) estimates that for the United Kingdom, annual costs of congestion amount to € 45 billion. It is expected that ceteris paribus road traffic will grow faster than road capacity, and therefore innovative ideas are necessary to avoid a total blockage of the road system in the coming years.

Whether the customer or the LSP will carry the burden of the increased costs of using the road system, depends on their respective market and bargaining power. In most supply chains however, the strongest power lies with the customer (i.e., the shipper), so that the LSP is the most likely party to incur the increased costs. For example in the food retail industry, which will be considered in more detail in Chapter 8 and Chapter 9, retailers are in the position to dictate conditions to their product suppliers and service providers. Fearne (1994) argues that one of the reasons for this is that retailers provide a service that benefits the other firms further up the supply chain. Thus, most firms recognise the need to do their business in such a way that the needs of the retailer are met.

*Information and Communication Technology*. The increased possibilities offered by ICT have been a trend for decades and are still one of the key factors influencing the structure and performance of supply chains (Fisher, 1997). Radio Frequency Identification (RFID) for example enables a better control of logistics processes and allows customers to track and trace their shipments in real-time. Other technological innovations that assist LSPs are onboard computers, route planning software, navigation systems, and cellular phones.

ICT also facilitates intensified data sharing between supply chain partners (Cruijssen, 2003). Many types of data can be shared to boost supply chain performance, such as inventory levels at production facilities (Gavirneni, 2001), sales data (Lee et al., 2000), production schedules (Lee and Whang, 2000), manufacturing capacities (D'Amours et al., 1998), and performance metrics (e.g. Lee and Whang, 2000). The growing presence of for example Electronic Data Interchange (EDI) systems makes that a lot of this information is readily available. Moreover, the advent of the Internet has opened up new possibilities also for the small and medium sized companies (SMEs) who mostly cannot afford to implement an EDI system (Stefansson, 2002). This is of special importance to the transport sector, because there most of the companies are in fact SMEs. One important innovation that is facilitated by data sharing via the Internet is the concept of *freight exchanges* (McLaren et al., 2002; Cruijssen, 2003). An example of a freight exchange is *Teleroute* (E.R. 31). The basic idea is as follows. Forwarders submit their delivery orders in a computer system via the Internet and specify the quantity involved, the pickup date, the destination(s), etc. Carriers can browse this information by means of a number of search criteria. If a specific order interests a carrier, he contacts the shipper. By using a freight exchange, carriers can increase their load factors, mainly by acquiring suitable loads for backhauls if such a load is not yet available in their own order base. On the other hand, shippers can acquire transport capacity at a lower price than they are used to, because of the increased market transparency.

*Environmental management.* Increasing concerns about climate change, impacts on air quality, ground and water pollution, and perceptions of increased risks for health and safety of citizens from industrial activities have led to a significant increase in research at the intersection of environmental management and operations (Corbett and Kleindorfer, 2001). Poist (1989) already reckoned that logistics is especially well positioned to contribute to environmental and ecological control in terms of packaging issues, pollution control, and energy and resource conservation. In 2000, transport accounted for 57% of global oil consumption (Fulton, 2004). Because of the strong public concerns about environmental issues, there exists a strong pressure on logistics companies to explicitly incorporate environmental management into their business processes. In transport, this can be done by putting soot filters into use or by purchasing trucks that are more fuel-efficient. This however introduces extra costs for the carriers for which they are not directly compensated.

Another way in which logistics managers can influence environmental damage, lies in tactical planning and logistics systems design. Facility location, the sourcing of raw materials, transport mode selection, and high quality route planning all offer opportunities for making logistics 'greener'.

## 1.2 CHALLENGES FOR THE LOGISTICS SECTOR

The trends discussed in the previous section impose challenges for the logistics sector. In the current section, challenges for shippers and LSPs are discussed separately.

### 1.2.1 Challenges for Shippers

Section 1.1 indicates that transport and logistics is evolving from a necessary, though low priority function to an important part of business that can enable companies to attain a competitive edge over their competitors. Because profit margins are shrinking especially in the transport-intensive commodity producing sectors, efficient logistics management can be the decisive factor for a company's success, since competition will take place on the basis of costs, service and timeliness.

| Capability | Explanation |
|---|---|
| Time compression | Reduced transport times can decrease the required level of inventory, especially safety and pipeline inventory. This time compression can be achieved by acquainting suppliers and LSPs with relevant information as fast and accurate as possible. |
| Reliability | Supply chain partners depend on reliable deliveries for their own production and sales efforts (Morash and Clinton, 1997). Customer dissatisfaction, overstocking at retailers and uncommunicated promotional actions are sources of unreliability of the logistics process and are symptomatic for suboptimal supply chains (cf. LeBlanc, 2006). |
| Standardisation | For example the advent of EDI and standard Enterprise Resource Planning (ERP) software has caused a strong integration and automation of many of the business practices associated with the production and distribution operations of companies. This facilitates information exchange and improves visibility and planning at the operational and tactical level of operation. |
| Just-in-Time | A Just-in-Time (JIT) inventory strategy can be implemented to improve a company's profitability by reducing in-process inventory and its associated costs. Stock levels are kept low so that savings can be attained on both warehousing and inventory costs. For a successful JIT implementation, the presence of high quality information systems containing reliable data is vital. |
| Flexibility | In today's constantly changing market places, the flexibility of a company to fulfil its customers' requirements is often an important capability. Having the logistics skills to support last minute changes in order specifications is therefore a necessary condition for a company's success. Here, 'flexibility' is an umbrella term for responsiveness, agility, and adaptivity. For a detailed discussion of these three separate logistics virtues, see Verweij and Cruijssen (2006). |
| Customisation | Companies must be able to offer their customers tailored services, rather than a rigid standard package. This customisation might occur in both product and distribution characteristics. For example, a producer of soda drinks must be able to supply one customer by shipping large volumes to its distribution centre, while for another customer Vendor Managed Inventory (VMI) on store level is asked for. |

Table 1-1. Key logistics capabilities for shippers

In order to increase the efficiency of logistics processes, shippers have to make logistics an integral part of their business process. Only if the work of the internal departments of procurement, sales and manufacturing are in harmony with logistics, merchandise can be delivered to customers in the right amount, at the right time, to the right place, in perfect condition and against the lowest price. Companies that are successful in their supply chains are those that have developed the capabilities listed in Table 1-1. In the right-hand column, an explanation of the importance of each capability is provided.

### 1.2.2 Challenges for Logistics Service Providers

Whereas shippers must have the adaptive logistics organization that facilitates the increasing customer needs as described in the previous section, LSPs must be able to actually execute the tasks that arise from these new logistics requirements. Unfortunately, LSPs are having severe difficulties with these newly posed demands (see also Chapter 6). The shorter lead-times, narrower time windows and smaller quantities demanded by shippers have caused lower load factors, increased empty running, worsened profitability, and, as a final result, an increase in the number of bankruptcies. The situation is worst for those LSPs that are active in the more traditional forms of logistics services, such as storage and basic distribution. As an illustration, Figure 1-3 shows the declining profitability of Dutch road transport companies over the last 10 years. It turns out that since 2002 road transport companies on average are losing money.

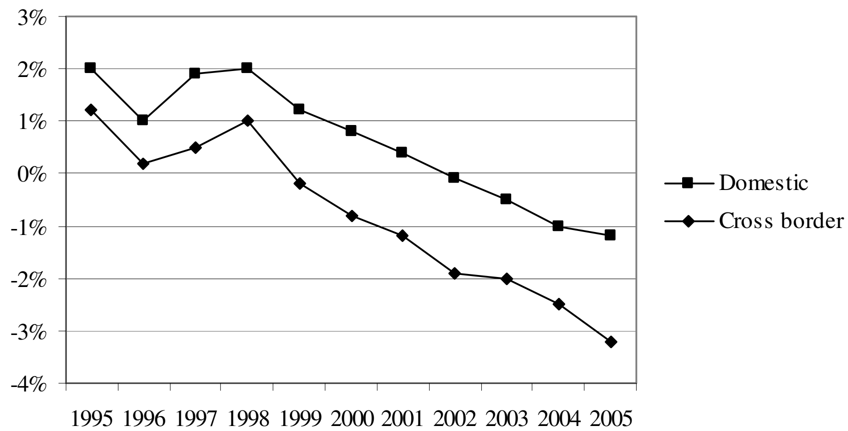


Figure 1-3. Profitability of Dutch road transport companies, source: TLN (2006)

The most prominent reason for this bad financial performance of LSPs is that they cannot transfer the increased operating costs to their customers. The Dutch transport and logistics industry association TLN reports that in the period 2000-2005, average operating costs increased by 16%, while the average price level of the logistics services only rose by 8% (TLN, 2006). The reason for this lies in the fact that the fragmented LSP sector is unable to take a stand against their large (often multinational) and thus powerful customers. This unbalanced market power creates the vicious circle for LSPs displayed in Figure 1-4. LSPs are characterised by low profit margins, a strong fragmentation and price competition. As a result, they do not have the time and monetary resources to develop new skills or undertake new projects to discern themselves from competitors and to better serve customers. Consequently, the sector remains traditional in the sense that no innovation or pro-active initiatives are undertaken to structurally improve the level of service. Therefore, the logistics services will remain commodity-like and competition will be focused on the lowest price, instead of superior quality. This induces even thinner profit margins and stronger competition, starting another iteration of the vicious circle.

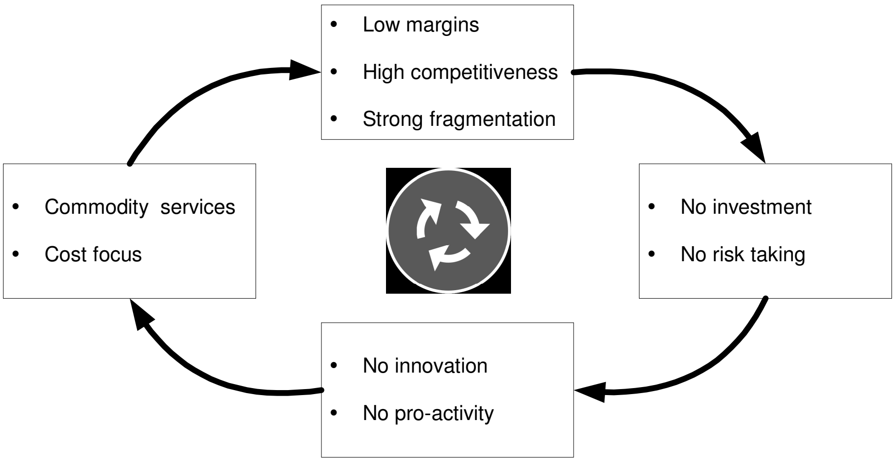


Figure 1-4. The vicious circle of LSPs (based on E.R. 7)

The challenge for LSPs is of course to break out of this vicious circle for example by implementing innovative software, logistics concepts or business models that strengthen their bargaining position with respect to their customers. In other words, they have to become the customer's partner instead of merely its supplier. Such cooperation between shippers and LSPs is in line with the development of LSPs from traditional carrier companies to fully-fledged partners that help shippers to structurally improve their logistics performance in an innovative way. This spectrum of LSPs is explained in Table 1-2, based on Vannieuwenhuyse (2003).

| LSP type | Description |
| --- | --- |
| (1PL) | In a 1PL concept, logistics activities are not outsourced, but performed in-house by the shipper. |
| 2PL | In the 2PL concept, a shipper outsources transport to a carrier company that is expected to perform a number of clear-cut tasks. The planning and organization remain in the hands of the shipper. |
| 3PL | A third party logistics service provider (3PL) allows shippers to outsource a whole package of logistics services. This LSP takes the responsibility for the planning and organization and in that role communicates with both the shipper and the receiver(s) of the goods. |
| 4PL | A 4PL concept represents a situation where even the management of logistics activities is outsourced. The 4PL focuses entirely on this management task and therefore generally does not own logistics assets. This concept becomes beneficial if the 4PL manages multiple supply chains amongst which synergies can be exploited. |

Table 1-2. Service based categorisation of LSPs

## 1.3 INNOVATION IN LOGISTICS

The logistics challenges for both shippers and LSPs outlined in the previous section call for innovative actions. Particularly the LSPs have to break the vicious circle depicted in Figure 1-4. Rogers (1995) defines innovation as “an idea, practice or object that is perceived new by an individual or other unit of adoption”. Although there has been quite an explosion in the body of literature on innovation since 1980 (see Castellacci et al. (2005) for a recent review), this literature has mainly focussed on technical innovation in production environments. Unfortunately, logistics research has largely ignored the concept of innovation (Flint et al., 2005). This section introduces logistics innovation by discussing the possible types, the influence of organizational learning, the possible goals, and finally the speed of adoption.

### 1.3.1 Types of Logistics Innovation

‘Logistics innovation’ is defined as: creating logistics value out of new products or services, new processes, new transaction types, new relationships or new business models (cf. Verweij and Cruijssen, 2006). Logistics value can be either decreased logistics costs, or increased service to customers. The definition distinguishes five underlying innovation types that are further developed in Table 1-3.

| Type of logistics innovation | Explanation | Example |
|---|---|---|
| Product-innovation (service-innovation) | The accomplishment of new products or services. An indicator is the share of a company's total budget that is spent on Research and Development (R&D). | The introduction of real time tracking and tracing for parcel services. Customers can constantly track the whereabouts of their shipment and are notified in case of disruptions. |
| Process-innovation | Changes in the way products or services are performed or produced. | The introduction of a standard load carrier that is used by almost every carrier and shipper in an industry (e.g. the roll pallet in grocery retailing) can significantly improve efficiency of logistics processes. |
| Transaction-innovation | New ways of selling products or services. | If home delivery orders can be placed electronically via the Internet, more timely and reliable information becomes available, so that better delivery routes can be constructed. |
| Relationship-innovation | The development of new relationships (vertical, horizontal or lateral, see Chapter 2). | Horizontal cooperation between road transport companies by means of joint route planning (see Chapter 4) can considerably cut down transport costs. |
| Business model-innovation | Changes in a company's overall mode of operation. | An LSP that disposes of his fleet and turns into a 4PL. |

Table 1-3. Five types of logistics innovation

### 1.3.2 Organizational Learning

Innovation is closely related to organizational learning. The latter facilitates the former and some organizations even consider learning to be a strategic resource that creates a differential competitive advantage (Sinkula, 1994). The organizational learning literature is diverse and spans multiple disciplines. However, Flint et al. (2005) found four general themes that are useful in the context of logistics innovation.

Firstly, learning can occur at various levels that range from direct responses to stimuli, pondering behaviour, and thinking about the process of learning itself. Low level learning would merely be a response to a customer's request, whereas higher level learning would involve contemplating ways of gaining insight into changes in customers' desired logistics value, and ways of sharing these insights across the organization. Secondly, organizations often find it difficult to share *tacit knowledge*, such as knowledge that is embedded in experience but difficult to articulate, and to develop this into explicit knowledge. If organizations have difficulties sharing tacit knowledge, such as about changes they sense in their environments and customer behaviour, more far-reaching logistics innovations will often not materialize. Thirdly, Huber (1991) states that an organization learns if behaviour changes as a result of processing information. This suggests that LSPs should actively gather information on changing or unmet customers' desired logistics value from whoever may have that information within or outside the organization. This is a necessary condition for logistics innovation to take place. Finally, there is evidence that organizational learning is highly idiosyncratic, meaning unique to each organization. Logistics companies may learn differently depending on their unique nature, the specific situations in which learning takes place, and the cultures in which the companies are embedded. This means that innovations developed by two logistics companies may be entirely different even if inspired by similar market and customer trends.

### 1.3.3 Goals of Innovation

The general underlying goal of each innovating firm is either to resist or to beat its competition. In practice, these goals take the shape of more specific derived goals formulated by the company's (logistics) management. Table 1-4 discusses the goals most often observed in the logistics industry

| Goal | Explanation/Example |
|---|---|
| Improved service | Customer satisfaction is vital in competitive environments, such as the logistics industry. An example is that orders by the same customer are consolidated into one shipment so that the customer's dock is visited less often. |
| Improved quality | Innovative systems can improve the quality level of logistics services. For example, trucks can be equipped with apparatus that signal any problems so that the number of breakdowns reduces and service becomes more reliable. |
| Creation of new markets | Cooperation between road transport companies or warehousing firms (see e.g. Chapter 2) can significantly expand these companies' geographical coverage. Besides new geographical markets, logistics innovation can also create or open up new functional markets. |
| Market share increase | Innovative ideas tailored to a specific shipper's needs can persuade this shipper to hire the LSP. |
| Extension of service package | Installing an EDI connection with a number of key customers enables an LSP to offer additional services, such as inventory replenishment. |
| Reduced resources and costs | Implementing a superior route planning tool makes it possible for planners to construct more efficient routes, so that the same number of shipments can be dealt with by less trucks. |
| Reduced environmental damage | With the increased environmental concerns, there is growing recognition that issues of environmental pollution accompanying industrial development should be addressed simultaneously with the operational process of supply chain management, thus contributing to the development of so-called 'green' supply chains (Sheu et al., 2005). |
| Conformance to regulations | It has become customary that city centres are open for trucks only during narrow time windows in the morning. Shippers and LSPs have to change their ordering and service routines in response to this. |

Table 1-4. Goals of innovation

### 1.3.4 Speed of Adoption

With regard to the speed of adoption, three types of logistics innovations can be distinguished (Flint et al., 2005). One extreme case is an innovation that is entirely new to the logistics industry, such as the introduction of inter-modal containers. This innovation resulted in an industry-wide change, and is therefore referred to as a *radical innovation*. On the other extreme, there are *incremental innovations*, or innovations that have been around for a while and are adopted over time by logistics firms that redesign their processes. An example of an incremental innovation would be the implementation of a warehouse management system. In between these two extremes are so-called *middle space innovations* (Kahn, 2001), such as the development of an improved customer relationship management system.

In the generally low-tech logistics sector, incremental innovation is most common, because of the lower risk involved and the easier implementation trajectory. As indicated in Section 1.2.2, this is a result of the industry's strong cost-focus, which makes it hard for companies to get round their day-to-day operational woes and worries and take a bird's eye view and critically assess their core inefficiencies. Loosely speaking, incremental innovation can help to *resist* competition and protect market shares, but to *beat* competition and strongly increase market shares, more radical innovation is called for. Germain (1996) found a positive correlation between the costs of an innovation and its radicalness. Especially when the innovation must come from an LSP, this is a serious impediment for radical innovations, because, as illustrated in Section 1.2.2, their margins are often very thin. In order to still be able to develop or implement innovative projects, a possible solution might be for LSPs to turn to horizontal cooperation.

## 1.4 HORIZONTAL COOPERATION IN TRANSPORT AND LOGISTICS

Horizontal cooperation is a relationship-innovation that, when managed appropriately (see e.g. Verstrepen et al., 2006), is quite cheap and can help LSPs and logistics departments of other companies to take a stand against the severe pressure on logistics efficiency resulting from the developments described in Section 1.1. We limit the scope to horizontal cooperation on logistics activities on the landside. Therefore, for the purpose of this thesis horizontal cooperation in transport and logistics is defined as follows:

*Horizontal cooperation in transport and logistics is active cooperation between two or more firms that operate on the same level of the supply chain and perform a comparable logistics function on the landside.*

Furthermore, in the context of horizontal cooperation it is of little importance whether the cooperators are LSPs or shippers. Key is that the cooperating companies have direct control over the planning and execution of the logistics activities under consideration.

Horizontal cooperation in transport and logistics is the subject of this thesis. A detailed discussion of amongst others the available academic literature, practical examples, opportunities, impediments, and enabling concepts for horizontal cooperation can therefore be found in the coming chapters.

## 1.5 RESEARCH DESIGN

Having sketched the most relevant trends in logistics, the challenges for shippers and LSPs, the need for innovation and the concept of horizontal cooperation, the current section describes the research design employed. The thesis is practice oriented in the sense that most of the results are based on real-life datasets. In case studies conducted, the most important goal was always to learn lessons that are applicable in other cases or industries as well. On the other hand, in chapters that have a more theoretical point of departure (e.g. Chapter 4), efforts are made to draw conclusions that are directly applicable in practice.

### 1.5.1 Main Objective

The fast growing presence and importance of horizontal cooperation in the contemporary logistics industry (see Chapter 3) calls for a stronger basis in formal literature, which has largely ignored the topic until now. Therefore, the main objective of this thesis is to identify the relevant research components and to instigate academic exploration of the topic. Hopefully, the developed insights and results encourage academics to further develop this interesting topic, and logistics managers to consider horizontal cooperation as a new solution to the challenges that their operation is confronted with.

### 1.5.2 Research Questions

The main objective is further developed by means of the following five specific research questions that will be addressed:

(Q1) What are the expected cost savings of horizontal cooperation through joint route planning?

(Q2) To what extent do logistics practitioners consider horizontal cooperation a viable business approach?

(Q3) Is there a relation between a company's (financial) characteristics and its attitude towards horizontal cooperation?

(Q4) Do regional differences exist between LSPs' attitudes towards horizontal cooperation?

(Q5) Which logistics concepts can be used to enable horizontal cooperation?

In the remainder of this thesis, these research questions will be answered more or less in the order in which they are presented above (see Figure 1-5 in Section 1.6 below).

### 1.5.3 Methodology

Research on horizontal cooperation in transport and logistics is still in its infancy and has links to fields ranging from psychology and sociology to operations research and mathematics, although it is admitted that the sociological and psychological aspects of horizontal cooperation will only be discussed obliquely in this thesis.

The consequence of this wide range is that many different research techniques are used in this thesis. These include case study analysis, surveys, exploratory factor analysis, regression, game theory, vehicle routing heuristics, and facility location heuristics. Depending on the research question under consideration, the most suitable technique is chosen.

## 1.6 OUTLINE

Figure 1-5 gives the outline of the thesis. The abbreviations Q1-Q5 refer to the research questions that are the focus of the specific chapters.

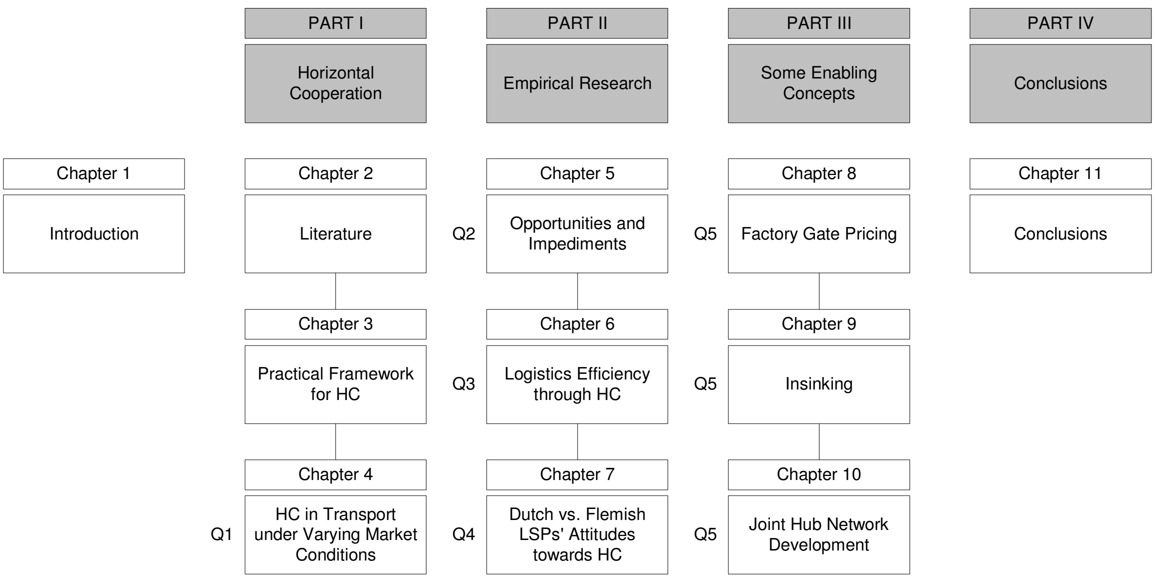


Figure 1-5. Outline of the thesis (HC=Horizontal cooperation in transport and logistics)

The remainder of this thesis consists of four major parts. To start PART I, Chapter 2 surveys the relevant literature. Although the field itself is underdeveloped, valuable lessons can be learned from related existing literature. Once this academic basis is laid, Chapter 3 takes on a practical perspective by developing a typology of horizontal cooperation initiatives encountered in practice. Finally, in Chapter 4 the savings from horizontal cooperation in the form of joint route planning in a road transport setting will be estimated. In a sense, this is the 'purest' form of horizontal cooperation in transport and logistics as considered in this thesis.

PART II is the empirical part and also consists of three chapters. Chapter 5 provides the basis in the form of a large-scale survey in Flanders that measures LSPs' attitudes towards opportunities and impediments for horizontal cooperation. Chapter 6 then uses the outcomes of this survey in search for significant relations between company characteristics and attitudes towards horizontal cooperation. To finish PART II, Chapter 7 introduces a similar survey organized in the Netherlands and makes a comparative analysis between the two regions.

PART III shows how innovative logistics concepts can facilitate horizontal cooperation. The three chapters of this part are devoted to Factory Gate Pricing (Chapter 8), Insinking (Chapter 9) and Joint Hub Network Development (Chapter 10).

In the last part of this thesis, PART IV, conclusions and recommendations for further research are formulated. Here, also research questions Q1-Q5 will be revisited collectively.

The thesis is structured in such a way that individual chapters can be read in isolation as well. Every chapter starts which a brief introduction of items developed in previous chapters that are needed to understand the current chapter. Similarly, chapters end with a discussion of intermediate conclusions.

## 1.7 PUBLICATION BACKGROUND

Most of the contents of this thesis have already been published in the form of (working) papers:

| | |
|---|---|
| Chapter 1 | Cruijssen, F. (2003). A survey on European inter-organizational data sharing implementations in transportation, *Klict position paper*. |
| | Cruijssen, F. and C. Verweij (2006). Europese logistieke netwerken: Optimalisatie Europese netwerken voor verladers. *Transumo report*. (In Dutch) |
| Chapter 2 | Cruijssen, F., W. Dullaert and H. Fleuren (2006). Horizontal cooperation in transportation and logistics: A literature review. *Tilburg University Working Paper*. |
| Chapter 3 | Verstrepen, S., M. Cools, F. Cruijssen and W. Dullaert (2006). A framework for horizontal cooperation in logistics. Paper presented at *International Conference on information systems, logistics and supply chain*. May 15-17 2006, Lyon, France. |

| | |
|---|---|
| Chapter 4 | Cruijssen, F., O. Bräysy, W. Dullaert, H. Fleuren and M. Salomon (2006). Joint route planning under varying market conditions. *CentER Discussion Paper* 2006-49, Tilburg University, Tilburg, the Netherlands. |
| Chapter 5 | Becker, J., M. Cools, F. Cruijssen, W. Dullaert, B. Vannieuwenhuyse and T. Verduijn (2005). Samenwerking in logistieke dienstverlening: Visie van Vlaamse verladers en dienstverleners. *Kwartaalschrift Economie*, **2**(1), 29-51. (In Dutch) |
| | Cruijssen, F., M. Cools and W. Dullaert (2006). Horizontal cooperation in logistics: Opportunities and impediments. *Transportation Research Part E*, In press. |
| Chapter 6 | Cruijssen, F., W. Dullaert and T. Joro (2006). Logistics efficiency through horizontal cooperation: The case of Flemish road transportation companies. *CentER Discussion paper* 2006-14, Tilburg University, Tilburg, the Netherlands. |
| Chapter 7 | Cruijssen, F. and W. Dullaert (2006). Bang of voorzichtig? Een vergelijkende analyse van de houding van vlaamse en nederlandse logistiek dienstverleners ten aanzien van horizontale samenwerking. *Tijdschrift Vervoerswetenschap*, **42**(1), 2-7. (In Dutch) |
| Chapter 8 | LeBlanc, H., F. Cruijssen, H. Fleuren and M. de Koster (2006). Factory gate pricing, An analysis of the Dutch Retail Distribution. *European Journal of Operational Research*, **174**(3), 1950-1976. |
| Chapter 9 | Cruijssen, F., P. Borm, H. Fleuren and H. Hamers (2005). Insinking: a methodology to exploit synergy in transportation. *CentER Discussion Paper 2005-121*, Tilburg University, Tilburg, the Netherlands. (*Winner of Junior Best Paper Award at the BIVEC_GIBET Transport Research Day 2005, Hasselt University, Hasselt, Belgium*) |
| Chapter 10 | Cruijssen, F. and B. Groothedde (2006). Joint hub network development. *Tilburg University Working Paper*. |

# PART I PRELIMINARIES

*Having introduced the common trends and challenges that logistics companies face, in the following chapters the subject of this thesis is introduced: horizontal cooperation in transport and logistics. This discussion consists of three parts. First, a broad literature review of horizontal cooperation in transport and logistics and related fields is provided. To the best of our knowledge, this is the first time such an overview is made. Second, horizontal cooperation is regarded from a practical perspective. Based on cases encountered in practice and the lessons learned from literature, a typology for horizontal cooperation initiatives is constructed. Finally, Chapter 4 zooms in on a basic form of horizontal cooperation, joint route planning, to estimate the potential savings and their sensitivity to various market characteristics. At the end of PART I the subject of this thesis will be clearly defined and positioned. Moreover, the underlying motive of attaining synergy will be illustrated and quantified.*

# CHAPTER 2 LITERATURE

## 2.1 INTRODUCTION

In 1993, eight competing medium-sized Dutch producers of sweets and candy came to an agreement of intensive cooperation designed to increase the efficiency of their delivery processes. Together, they supplied 250 drop-off points (e.g. retail distribution centres), the majority of which received goods from more than one of the eight producers on a daily basis. A Logistics Service Provider (LSP) was hired to consolidate and deliver the shipments from these eight companies to their customers. The prime goal of the cooperation was to cut transport costs, but at the same time customer service was increased because the consolidated shipments reduced the number of deliveries, which in turn reduced unloading and handling costs. Moreover, customers were able to access a broader product assortment more easily. This cooperation, called *Zoetwaren Distributie Nederland* (ZDN: Dutch Sweets Distribution) has proved quite successful and still exists today.

As will be shown in the next chapter, initiatives such as ZDN are encountered more frequently in practice. The shortening of product life cycles, fierce competition in global markets and the heightened expectations of customers have caused companies' profit margins to shrink. As a result, there exists a strong incentive to decrease the costs of non-value adding activities, such as basic distribution and warehousing. Burgers et al. (1993) argue that organizational inertia makes it difficult for firms to internally develop or purchase the capabilities required to deal with rapidly changing demand conditions. Moreover, the accumulating number of mergers and acquisitions within the logistics industry provides an impetus for companies to re-optimise their logistics processes. Consequently, the logistics market is undergoing a fundamental reorganization and since the potential of internal logistics optimisation is almost completely exploited, attention has shifted to better managing external relations in the supply chain (Skjoett-Larsen, 2000).

When redesigning logistics processes, one of the most fundamental choices that companies face is whether to i) outsource, ii) keep logistics execution in-house, or iii) seek cooperation with comparable companies to exploit synergies (Razzaque and Sheng, 1998). In production terms, this is called the *make/buy/ally* decision. Since today's demanding customers expect their goods to be delivered to the right place, at he right time, in the right amount, in perfect condition and all at the lowest price, companies often experience difficulties in satisfying these demands individually or by means of dyadic outsourcing relationships with LSPs. This has resulted in the third option of closely cooperating with other companies becoming more and more viable. Cooperation can occur in many ways. Commonly, a cooperative supply chain is characterised by its structure: vertical, horizontal, and lateral (Simatupang and Sridharan, 2002).

Firstly, *Supply chain management* is the term describing vertical cooperation, a topic that boasts an abundant amount of formal literature. Simchi-Levi et al. (2000) define supply chain management as “the set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed in the right quantities, to the right locations, and at the right time, in order to minimise system wide costs while satisfying service level requirements”. This definition indicates that supply chain management is aimed at installing beneficial cooperations and seamless linkages between parties operating at different levels of the supply chain to avoid unnecessary logistics costs, or ‘waste’. The key drivers of such costs savings are inventory and transport reductions, logistics facilities or equipment rationalisation, and better information usage. Examples of vertical cooperation are Vendor Managed Inventory (VMI), Efficient Consumer Response (ECR), and Collaborative, Planning, Forecasting, and Replenishment (CPFR).

Secondly, the European Union (2001) defines horizontal cooperation as “concerted practices between companies operating at the same level(s) in the market”. These can be either competing or unrelated companies that share private information, facilities or resources to reduce costs and/or improve service. Some examples of horizontal cooperation in logistics are Manufacturers Consolidation Centres (MCCs), joint route planning, and purchasing groups. Chapter 3 examines more types of horizontal cooperation in detail. Because of the dominant bargaining positions of some parties active on adjacent levels of the supply chain, it can be argued that horizontal cooperation can only occur if it is tolerated by some degree of (implicit) vertical cooperation. However, this vertical cooperation may better be described as ‘vertical approval’ by the dominant party, because the tolerating or facilitating company does not play an active role in the core activities of the cooperation. In this thesis, such an active role is required to be considered a full member of the cooperation (cf. the definition of horizontal cooperation in transport and logistics in Section 1.4). Vertical approval can however be very important for the chances of success of a horizontal cooperation. This is because differences in bargaining positions mostly manifest themselves along vertical links in supply chains, rather than on horizontal links. For example in the food retail industry, retailers have a dominant bargaining power over their suppliers (cf. Chapter 8). Therefore, vertical approval by the retailer is essential when suppliers consider starting up a horizontal cooperation, such as the joint route planning cooperation that will be described in Chapter 4. An example of vertical approval facilitating horizontal cooperation is a retailer settling for a somewhat lower service level to enable suppliers or LSPs to optimise the costs of their delivery processes by means of joint route planning. If on the other hand the dominant retailers themselves engage in horizontal cooperation, which is for example the case in the Insinking concept of Chapter 9, vertical approval is unnecessary.

Finally, Simatupang and Sridharan (2002) define a lateral cooperation as a cooperation aimed at gaining more flexibility by actively combining and sharing capabilities in both vertical and horizontal manners. The goal of lateral cooperations is to synchronise shippers and LSPs of multiple companies in an effective logistics network.

Whereas much has been written about both vertical cooperation in supply chains and lateral cooperation in supply networks, the literature on horizontal cooperation in transport and logistics is still in its infancy, especially where operational consequences are concerned. However, this type of cooperation is becoming more and more relevant in practice. The empirical research that will be discussed in Chapter 5 has indicated that generally LSPs consider horizontal cooperation to be an interesting approach to decrease cost, improve service or protect market positions. As a result, many horizontal cooperation initiatives are developing. In Belgium and the Netherlands, the European logistics centre of gravity, there are over 50 formally articulated horizontal logistics cooperations, having varying success. This practical relevance has provided the impetus for the review of available literature on horizontal cooperation and closely related fields in this chapter. As mentioned in Chapter 1, horizontal cooperation is also very interesting from a theoretical perspective, because it can be approached by various disciplines, offering a forum for, amongst others, economists, operations researchers and psychologists. The purpose of this chapter is to provide the starting point for intensified future research on the topic of horizontal cooperation. Literature has lacked such a broad review until now. Many of the elements that come up here will be elaborated on in later chapters.

This chapter is hereafter organized as follows. In Section 2.2, the concept of horizontal cooperation is discussed in detail by reviewing the literature and identifying various categorisations. Then, three sections are devoted to factors that influence the establishment of horizontal cooperations. These are, respectively, opportunities (Section 2.3), impediments (Section 2.4), and facilitators (Section 2.5). Finally, Section 2.6 concludes.

## 2.2 HORIZONTAL COOPERATION

Horizontal cooperation is about identifying and exploiting win-win situations between companies active at the same level of the supply chain in order to increase performance. These companies can be suppliers, manufacturers, retailers, receivers (customers), or LSPs. Horizontal cooperation requires inter-firm coordination, a concept that is well studied in organizational literature. Inter-firm networks denote complex arrangements of cooperative, rather than competitive, relationships between legally independent, but economically dependent companies (Pfohl and Buse, 2000; Sydow et al., 1995). For a detailed discussion of inter-firm networks from an organizational theory perspective, see Grandori and Soda (1995) and Nooteboom (2004).

### 2.2.1 Horizontal Relationships

Horizontal cooperation can take place between competing companies and between unrelated companies. Bengtsson and Kock (1999) identify four types of horizontal relationships, each with a different degree of cooperation and competition. Firstly, *Co-existence* refers to a relationship that does not include any economic exchanges and where the companies' goals are stipulated independently. Secondly, there is *Cooperation*, where tight bonds exist between companies that define and pursue common goals. The third type of horizontal relationships is basic *Competition*. This relationship is characterised by an action-reaction pattern as companies rely on the same or comparable suppliers and target the same group of customers. Finally, there is the relationship of *Co-opetition*, which is a common relationship for logistics companies, which cooperate horizontally. In this type of relationship, goals are jointly stipulated if the competitors cooperate, but not in cases when they compete. Co-opetition is especially beneficial if cooperation takes place for non-core activities, while competition remains unchanged for core activities. The non-core activities involving cooperation are preferably not visible to the customer (cf. 0). Bengtsson and Kock (2000) consider visibility for the customer as the most important characteristic in determining whether competition or cooperation should take place for a certain activity. For example, if there is cooperation between retailers for logistics activities, competition and differentiation can remain unchanged for other domains such as product prices and assortments. Co-opetition must not be seen as dangerous. Instead, top management should understand and communicate to organizational members that cooperation and competition can be applied simultaneously, and that both can contribute to achieving organizational goals (Bengtsson and Kock, 1999). More information on co-opetition can be found in Brandenburger and Nalebuff (1996) and Zineldin (2004). Later on in this thesis, three enabling concepts for horizontal cooperation will be discussed, where the horizontal relationship can be characterized as co-opetition (see PART III).

### 2.2.2 Types of Cooperation

Various types and designations of cooperative horizontal supply chain relationships have been discussed in both professional and academic literature. Cooperation, collaboration, alliances, and partnershipping are all used to refer to concerted practices on horizontal supply chain links. However, a high level of ambiguity exists between the definitions and characteristics of these relationships. Some authors explicitly discriminate between these appellations. For example, Mentzer et al. (2000) report that a focus group of twenty interviewed supply chain executives felt strongly that collaboration entails much more than cooperation, especially in terms of sharing information, risks, knowledge and profits. Golicic et al. (2003) also interviewed a focus group to construct a descriptor of relationships in terms of 'magnitude' or 'closeness'. Again one focus group member indicated that collaboration requires a higher level of closeness than cooperation, the difference being that with collaboration there must be a willingness to take an active role in making decisions and sharing more information. Most often however, the terms are used interchangeably, or the boundary between them is vague. For theory to be validated and advanced, a construct must however have a single, clear definition. For managers, ambiguity in these terms will lead to misconceived expectations (cf. Golicic et al., 2003). There is a large degree of consensus about which two types of relationships can be considered as the minimum and maximum levels of cooperation. These are, respectively, arm's length relationships and integrated (merged) firms (see also the subsection below). In between these two extremes however, there exists a whole range of cooperation types and/or names that can be perceived as 'fuzzy' and lacking structure. To illustrate this, an anthology in provided below of sometimes overlapping relationships all of which are referred to as being 'cooperative': *service agreements*, *joint ventures*, *cooperatives*, *consortia*, *cooperative agreements*, *licensing*, *industry standard groups*, *action sets*, *(non)equity agreements*, *collaboratives*, *mutually adaptives*, *bilateral governance*, *alliances*, *collaborative supply chains*, *supply networks*, and *partnerships*. Although some authors provide separate descriptions of some of these types, generally accepted definitions and distinctions are still lacking.

The next sections aim at structuring the cooperative relationships in between arm's length cooperation and integration. From here on, to avoid Babel-like confusion, all these relationships will be summarised as *cooperations*. Moreover, a restriction is made to *horizontal* manifestations of cooperation. Three important dimensions categorize horizontal cooperations. These are: 1) level of integration, 2) centralisation, and 3) scope and intensity.

***Level of Integration***

Lambert et al. (1999) identify three types of cooperation depending on the level of integration (see Figure 2-1). Although this categorisation was initially designed for vertical supply chain relationships, it can straightforwardly be translated to accommodate horizontal cooperation. This spectrum is completed on the left-hand side by *Arm's length cooperation*, and on the right-hand side by *Horizontal integration*, which are not considered to be genuine horizontal cooperation in the context of this thesis.

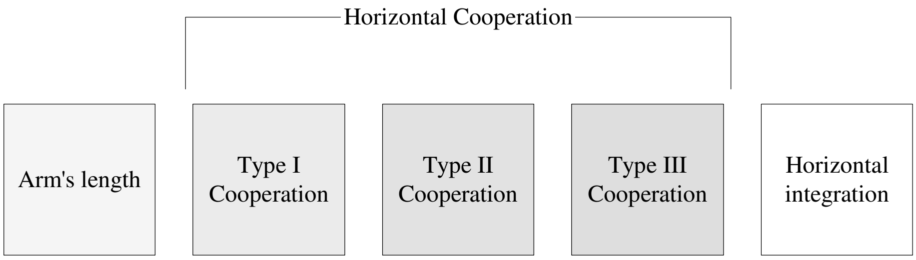


Figure 2-1. Horizontal cooperation and the level of integration (inspired by Lambert et al., 1999)

In an arm’s length cooperation, communication is of an incidental nature and companies may cooperate over a long period of time, involving only a limited number of exchanges. There is no strong sense of joint commitment or joint operations. An example in the logistics industry is if one LSP subcontracts a comparable LSP in the event of a capacity shortage. This horizontal subcontracting is discussed in detail by Spiegel (1993).

One can only speak of real cooperation if “there is a tailored relationship based on mutual trust, openness, shared risk and shared rewards that yields a competitive advantage, resulting in business performance greater than would be achieved by firms individually” (Lambert et al., 1999). As illustrated in Figure 2-1, horizontal cooperation can be subdivided into three types. A *Type I* cooperation consists of mutually recognised partners that coordinate their activities and planning, though to a limited degree. The time horizon is short-term and the cooperation involves only a single activity or division of each partner company. *Type II* is a cooperation in which the participants not merely coordinate, but also integrate part of their business planning. The horizon is of a long though finite length and multiple divisions or functions of the companies are involved. In *Type III* cooperations, the participants have integrated their operations to a significant level and each company regards the other(s) as an extension of itself. Typically, there is no fixed end date for such a cooperation. Type III cooperations are often referred to in literature as ‘strategic alliances’. Whereas the Type I and II cooperations are characterised by the absence of a formal contract, a *horizontal strategic alliance* is defined as a long-term (generally three years or more) explicit contractual agreement pertaining to an exchange and/or combination of some, but not all, of a firm’s resources with one or more competitors (Burgers et al., 1993). Strategic alliances have attracted considerable academic interest, see Todeva and Knoke (2005) for a review. They identify thirteen types of strategic alliances based on the level of integration and governance formalisation, ranging from market relations (lowest level) to hierarchical relations (highest level, such as mergers and acquisitions). This again indicates that there exists ambiguity in the definition and interpretation of the strategic alliance concept. The definition of Burgers et al. (1993) is used to emphasize the contractual binding and stronger sense of common goals and challenges as compared to Type I and II horizontal cooperations.

The extreme case of horizontal cooperation is a merger between companies. Bower (2001) distinguishes five distinct types of horizontal mergers (see Table 2-1).

| Merger type | Motives |
|---|---|
| Overcapacity merger | Aimed at restructuring an industry that is inefficient due to structural overcapacity. |
| Product or Market extension merger | Used to gain access to new products or (geographical) markets. |
| Geographic roll-up merger | Used to attain growth and efficiency gains in geographically fragmented markets. |
| Research and Development (R&D) merger | Aimed at obtaining or transferring R&D knowledge. |
| Industry convergence merger | Aimed at creating a whole new industry by joining powers of eroding industries. |

Table 2-1. Horizontal merger types according to Bower (2001)

Although some authors regard a strategic alliance to be a suitable base for a merger between the partners (e.g. Nanda and Williamson, 1995), Hagedoorn and Sadowski (1999) argue that these transitions only rarely occur (2.6% of all strategic alliances). An elaborate study of horizontal acquisitions can be found in Häkkinen (2005).

***Scope and Intensity***

Zinn and Parasuraman (1997) introduce a typology of so-called logistics-based strategic alliances. Although in principle this typology is set up for vertical cooperation, it has a direct interpretation for horizontal cooperation as well. It is based on two dimensions, being the scope and the intensity of the relationship between the partners. Scope is defined as the range of services for which cooperation takes place, and intensity is defined as the extent of direct involvement that exists between partners. Possible indicators of intensity are the sum of assets invested and the number of working hours dedicated to maintaining the cooperation. The level of intensity is proportional to the difficulty that a participant encounters if he should wish to replace one or more of his partners by other companies.

Based on these two dimensions, Zinn and Parasuraman (1997) classify logistics-based strategic alliances into four general types as displayed in Figure 2-2. In their paper, the authors provide illustrative examples of each of these generic types, as well as a list of their respective advantages and disadvantages.

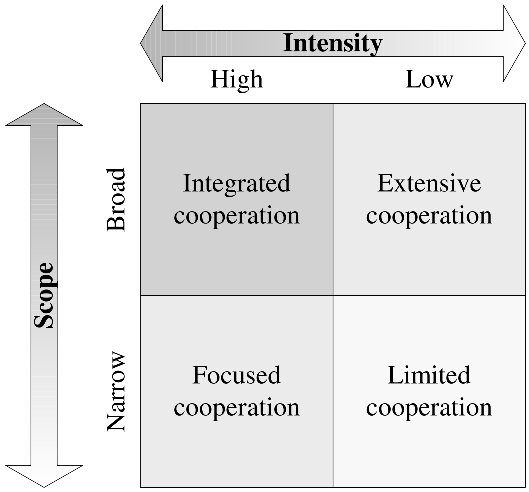


Figure 2-2. Classification based on scope and intensity, based on Zinn and Parasuraman (1997)

### 2.2.3 Horizontal Cooperation in Transport and Logistics

In the previous sections horizontal cooperation has been discussed in terms of *general firms*. This section will focus on horizontal cooperation in transport and logistics in particular. As mentioned in Chapter 1, for the purpose of this thesis logistics horizontal cooperation is defined as: *active cooperation between two or more firms that operate on the same level of the supply chain and perform a comparable logistics function on the landside*. Whereas horizontal cooperation is well documented for the maritime shipping and aviation industry, the literature on horizontal cooperation in logistics and transport on the landside is fairly limited.

In maritime shipping, *conferences* are a common concept. A conference is a cooperation of ocean carriers that offer their services on a specific transport line against collective tariffs and identical service levels (van Eekhout, 2001). These conferences offer advantages such as economies of scale as a result of larger volumes shipped and improved customer service (Shepperd and Seidman, 2001). Moreover, conferences prevent price wars by offering rate stability. Generally, shippers oppose conferences because they feel that the ability of carriers to effectively compete is greatly reduced by membership of a conference (Clarke, 1997). The frequent investigations into this claim have for example resulted in a series of US government acts dating from as early as 1916 through 1998 (cf. Lewis and Vellenga, 2000).

Horizontal cooperation also plays a dominant role in aviation. Some examples of airliner cooperation are: Skyteam (9 airlines), Star Alliance (16 airlines), Qualifier (11 airlines), and OneWorld (8 airlines). Economically, there are of course strong incentives for airlines to operate dense international networks. Growth through mergers and acquisitions may provide a strong expansion of a network. However, the granting of international traffic rights is largely confined to specific carriers substantially owned by individual countries. This has left cooperation between independent carriers as an effective compromise to international carriers, thus increasing the joint market power (Fan et al., 2001). In addition to the increased customer service that is offered, aviation cooperations (in literature these cooperations are commonly referred to as 'alliances') enable higher load factors for aircrafts and more efficient back office organization. For further information on airline alliances, see e.g. Park (1997) and Oum et al. (2000).

Although horizontal cooperation in aviation and maritime shipping share some of the opportunities, impediments and facilitators (see below) with horizontal cooperation on the landside, the different playing fields make it hard to draw conclusions for landside logistics. For example, market power considerations (and the probability of collusive actions) are much more prevalent than in the generally competitive landside transport sector with its many players. Secondly, ocean and air transport are different from landside transport since assets are more capital intensive and average hauls are much longer. Finally, the preferential treatment of domestic airliners in the granting of traffic rights, which is the dominant driver for horizontal cooperation in aviation, does not play a role in landside transport. Taking these important differences into account, we choose not to include a detailed analysis of horizontal cooperation in air and ocean transport in this thesis. More information on this topic can be found in the respective survey papers (see the discussions above).

In contrast to ocean and air transport, literature on horizontal cooperation in landside logistics is quite scarce. Here the most relevant publications on horizontal cooperation in logistics on the landside are discussed in chronological order. Firstly, Caputo and Mininno (1999) discuss horizontal integration of logistics functions in the Italian grocery industry. Various policies that competing companies can adopt to reduce total logistics costs are examined, such as standardized pallets and cartons, multi-supplier warehouses, multi-distributor centres, co-ordinated routing and joint outsourcing. Erdmann (1999) also discusses this subject and constructs a model to estimate the synergy potential in the German consumer goods industry. In another contribution, Vos et al. (2002) elaborate on horizontal cooperation by defining three types of synergy: *operational synergy*, *coordination synergy* and *network synergy*. This typology is based on the scope of the cooperation (see Section 2.2.2). Operational synergy concerns only a single process or activity. Secondly, if the cooperation takes place across several activities and there exists harmonisation of these processes, coordination synergy is exploited. Finally, network synergy resembles a cooperative restructuring of a complete logistics network by multiple partners. This typology shows a strong analogy with the *type I/II/III* classification for general cooperation by Lambert et al. (1999), discussed in Section 2.2.2. Bahrami (2002) refers to economies of scale in joint transport as *cost sub-additivity*, offering a real-life case study of two German consumer goods manufacturers (Henkel and Scharzkopf) that have merged their respective distribution activities. Three scenarios are compared: 1) the present situation without cooperation, 2) joint distribution within the current logistics structures, and 3) optimisation of the logistics structure based on the aggregate demand of both companies. The results indicate that scenario 2 saves 2.4% as compared to the base case in scenario 1, and scenario

3 saves 9.8%. The author calls Scenario 2 'process innovation' and scenario 3 is referred to as 'structure optimisation'. The fifth paper is by Hageback and Segerstedt (2004) who study joint transport in the small and remote municipality of Pajala in Northern Sweden. In order to stay competitive, the approximately twenty companies located in the region must cooperate to better fill arriving and departing trucks that connect Pajala with Sweden's economic centre in the south of the country. The authors call this 'co-distribution' and state that this is vital both for the companies and the municipality of Pajala. Possible cost savings are estimated around 33%. The most important problem with launching co-distribution seems to be the unfamiliarity of the companies' managers with innovative logistics concepts and sometimes even with the logistics market in general. Finally, Frisk et al. (2006) discuss the topic of horizontal cooperation in the Swedish forestry sector. Transport efficiency is crucial is this sector, because on average it corresponds to as much as one third of total production costs. The authors focus on the usage of cooperative game theory to allocate the costs of joint transport. These game-theoretic allocation rules are compared to practical rules of thumb.

## 2.3 OPPORTUNITIES OF HORIZONTAL COOPERATION IN TRANSPORT AND LOGISTICS

The overall driving force behind a cooperation is each participant's expectation of a positive net present value of the project (Parkhe, 1993). By cooperating, partners can generate so-called relational rents, which are defined by Dyer and Sing (1998) as "supernormal profits jointly generated in a relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific partners." This relational rent can also be referred to as *synergy*. It is argued that cooperating firms can generate relational rents through relation-specific assets, knowledge-sharing routines, complementary resource endowments and effective governance. In a logistics context, relational rents can be 'hard' (e.g. economies of scale) and 'soft' (e.g. learning). Bartlett and Ghoshal (2004) mention three ways in which cooperating firms can reap these benefits. These are: i) pooling their resources and concentrating on (core-) activities, ii) sharing and leveraging the specific strengths and capabilities of participating firms, and iii) trading different or complementary resources to achieve mutual gains.

As mentioned above, literature on horizontal cooperation in logistics as such is scarce. However, theoretical support for its opportunities (and its impediments) can be found in papers on more general types of cooperation in the organizational theory, marketing and logistics literature. Although these cooperations generally have a vertical (e.g. buyer-supplier) perspective, some of their goals have an interpretation for horizontal cooperation as well. This section presents an overview of opportunities that may trigger potential partners to engage in horizontal cooperation.

They are divided into three groups: costs and productivity, customer service, and market position. In Table 2-2, relevant references for specific opportunities are provided. Note that given the vast amount of literature on general business cooperation, these references will not be exhaustive.

### 2.3.1 Costs and Productivity

As mentioned above, cooperation provides companies with a platform to access the skills and capabilities of their partners (Kogut, 1988; Westney, 1988; Hamel, 1991). In this way, they can improve their own operational processes by increasing the ability to control costs and to reduce the costs of the supply chain (Gibson et al., 2002). Moreover, cooperation on non-core activities offers the potential of joint purchases (e.g. of trucks, onboard computers and fuel) in order to reduce purchasing costs (Dyer and Singh, 1998). The fact that cooperation on non-core activities is less visible to the customers renders this kind of cooperation less complicated (cf. 0).

### 2.3.2 Customer Service

The impact of cooperative specialisation for productivity is well known. Best practice value chains are characterised by interfirm specialisation allowing individual firms to focus on a narrow range of activities and engage in complex interactions with other firms (e.g. Alchian and Demsetz, 1972; Dyer, 1997). In doing so, cooperation not only offers benefits such as economies of scale, skilled labour force, high R&D level and access to superior technology, but also generates greater customer value added at lower cost (Zineldin and Bredenlöw, 2003). Moreover, cooperation enables companies to learn from each other’s skills and capabilities (Kogut, 1988; Westney, 1988; Hamel, 1991), which is another potential source of quality improvement at lower costs.

### 2.3.3 Market Position

The sheer size of the volumes involved in serving large industrial shippers sometimes prohibits LSPs from entering a tendering process on an individual basis. Horizontal cooperation is a useful tool to expand the available fleet, service range and geographic coverage, and, as a result, to increase the number of potential customers (Bleeke and Ernst, 1995). Moreover, it can provide a safeguard for companies in uncertain market conditions and enhance their competitive position or market power (Kogut, 1988). Finally, horizontal cooperation can be a very effective way of sharing the large investments needed for R&D projects. In this way, the uncertain payoff of these projects can be shared across the companies participating in the cooperation.

| Opportunities | Identified by |
|---|---|
| **Costs and productivity** | |
| Cost reduction | Hennart (1991); Frankel and Whipple (1996); Erdmann (1999); Lambert et al. (1999); Mentzer et al. (2000); Simchi-Levi et al. (2000); McLaren et al. (2002); Simatupang and Sridharan (2002); Esper and Williams (2003); Nooteboom (2004); Zineldin (2004); Todeva and Knoke (2005) |
| Learning and internalisation of tacit, collective and embedded knowledge and skills | Contractor and Lorange (1988); Kogut (1988); Ohmae (1989); Hennart (1991); Hagedoorn (1993); Mentzer et al. (2000); Simchi-Levi et al. (2000); Todeva and Knoke (2005) |
| More skilled (or more efficient use of) labour force | Mentzer et al. (2000); Simchi-Levi et al. (2000); Nooteboom (2004); Zineldin (2004) |
| **Customer service** | |
| Complementary goods and services | Contractor and Lorange (1988); Barratt (2004); Nooteboom (2004); Todeva and Knoke (2005) |
| Ability to comply to strict customer requirements/Improved service | Ohmae (1989); Bowersox (1990); Frankel and Whipple (1996); Lambert et al. (1999); Mentzer et al. (2000); McLaren et al. (2002); Simatupang and Sridharan (2002); Esper and Williams (2003); Zineldin (2004) |
| Specialisation | Mentzer et al. (2000) |
| **Market position** | |
| Penetrating new markets | Contractor and Lorange (1988); Ohmae (1989); Hennart (1991); Hagedoorn (1993); Fearne (1994); Erdmann (1999); Frankel and Whipple (1996); Lambert et al. (1999); Simchi-Levi et al. (2000); Nooteboom (2004); Zineldin (2004); Todeva and Knoke (2005) |
| New product development/R&D | Contractor and Lorange (1988); Ohmae (1989); Hagedoorn (1993); Fearne (1994); Lambert et al. (1999); Zineldin (2004) |
| Serving larger customers | Bowersox (1990); Simchi-Levi et al. (2000) |
| Protecting market share | Bowersox (1990); Frankel and Whipple (1996); Erdmann (1999); Lambert et al. (1999) |
| Faster speed to market | Lambert et al. (1999); Mentzer et al. (2000); Nooteboom (2004) |
| **Other** | |
| Developing technical standards | Nooteboom (2004); Todeva and Knoke (2005) |
| Accessing superior technology | Contractor and Lorange (1988); Frankel and Whipple (1996); Lambert et al. (1999); Simchi-Levi et al. (2000); Zineldin (2004) |
| Overcoming legal/regulatory barriers | Bowersox (1990); Hennart (1991); Nooteboom (2004); Todeva and Knoke (2005) |
| Enhancing public image | Mentzer et al. (2000) |

Table 2-2. Opportunities of horizontal cooperation

Sometimes, there are limits to the extent to which companies are allowed to benefit from these opportunities. For example, Todeva and Knoke (2005) also mention a cartel as a form of cooperation. Competition law does however not allow this kind of (horizontal) cooperation, because it restricts competition (see Vogelaar (2002) for a discussion of horizontal cooperation and European Commission (EC) competition law). EC competition rules in particular prohibit any agreements between undertakings that are restrictive of competition. This prohibition not only covers the most explicit and manifestly restrictive agreements, such as agreements between competitors to set prices, to share customers/markets or to limit production, but also any agreements or understandings between undertakings that might produce the same effect. Competition might be restricted if the horizontal cooperation involves players that together constitute a market share of over 10%. Fortunately, if cooperation takes place between large industrial shippers this most often concerns non-core activities. If on the other hand, cooperation takes place between LSPs, the current major fragmentation in this sector (cf. Chapter 6) ensures that partners will generally not reach the critical 10% market share.

It can be observed that different objectives give rise to different manifestations of horizontal cooperation. The nature and structure of these manifestations that are encountered in practice differ widely. They range from ad hoc freight exchanges between a limited number of partners to e.g. the joint operation of multimodal freight platforms. In Chapter 3 a typology is introduced in which thirteen practical manifestations of horizontal cooperation in transport and logistics are categorized.

## 2.4 IMPEDIMENTS FOR HORIZONTAL COOPERATION IN TRANSPORT AND LOGISTICS

The literature generally pays little attention to the woes and worries of close relationships. Instead, most publications focus on the (theoretic) advantages of cooperation and only report on successful case studies. Still, as many as 70% of all strategic alliances fail for one reason or another (Zineldin and Bredenlöw, 2003).

Horizontal cooperation is often an uncertain undertaking in which it is difficult to plan the required activities or measure the realised output. Although having a trustworthy relationship is important, the risk of opportunism remains real (Van der Meer-Kooistra and Vosselman, 2000; Tomkins, 2001). Opportunism, i.e., actions by the partner that do not comply with the spirit of the cooperation (Williamson, 1985; Das and Teng, 1998), is a typical example of relational risk.

Impediments and threats to horizontal cooperation relate to four areas: partners, determining and dividing the gains, negotiation, and coordination and Information & Communication Technology (ICT). A selection of the most prominent impediments in these areas are reported in Table 2-3, accompanied by multiple references.

### 2.4.1 Partners

Analysing a potential partner's strategic and organizational capabilities requires knowledge about its physical assets, as well as about its intangible assets and organizational capabilities (Bartlett and Ghoshal, 2000). This makes partner selection a difficult task. The search costs involved with finding potential trading partners and evaluating their aptness and reliability can be a big hurdle for small and medium sized companies (Williamson, 1985; North, 1990; Hennart, 1993; Bleeke and Ernst, 1995). Furthermore, recent empirical research (Chalos and O'Connor, 2004) confirms that partner unreliability constitutes a major contribution to the managerial complexity of cooperation.

### 2.4.2 Determining and Dividing the Gains

The narrow scope of most cooperations prevents full understanding of the nature, extent, and distribution of risks or rewards that might accrue in the course of the cooperation's evolution (Bartlett and Ghoshal, 2000). The importance of a fair distribution of expected and unexpected costs is also stressed in Gibson et al. (2002). Mistrust about the fairness of the applied allocation rule for savings has caused many horizontal logistics cooperation initiatives between shippers, and/or LSPs to marginalize or disintegrate. For example, in practical cases of cooperation by means of joint routing planning amongst LSPs, many allocation rules can be observed. Most often these are simple rules of thumb that distribute savings proportionally to a single indicator of either size or contribution to the synergy. Some examples are:

- Proportional to the total load shipped
- Proportional to the number of customers served
- Proportional to the logistics costs before the cooperation
- Proportional to the distance travelled for each shipper's orders
    - based on inter-drop distances of the constructed joint routes
    - based on direct distances from depot to outlet
- Proportional to the number of orders

Because these rules are easy and transparent and since each embodies a construct that arguably represents the importance of an individual partner to the group, they are likely to appeal to practitioners initially. However, when using a single construct, the others are obviously disregarded. In the long run, some participants will inevitably become frustrated since their true share in the group's success is undervalued. For example, if gain sharing takes place according to the number of drop points of each participant, a certain LSP who delivers a large number of drop points in a small geographical region will get a large share of the benefits, while his de facto contribution to the attained synergy is negligible if the other participants serve only few drop points in this area. Instead, to ensure a fair gain sharing mechanism, the marginal contributions of each LSP to the total gain have to be accurately quantified. These can then be allocated by means of concepts from cooperative game theory (see Chapter 9 and Chapter 10).

### 2.4.3 Negotiation

Bleeke and Ernst (1995) explain how the evolvement of the relative bargaining power of partners is the key to understanding whether or not a cooperation is likely to lead to a takeover. Relative bargaining power depends on three factors: the initial strengths and weaknesses of the partners, how these strengths and weaknesses change over time, and the potential for competitive conflict. Negotiation processes should always result in a win-win situation. Fierce negotiations with little value to be shared will not support the cooperation for a longer period. A positive attitude during the negotiations will have an important beneficial impact on the cooperation's longer-term success.

### 2.4.4 Coordination and Information & Communication Technology

The vast majority of the companies active in logistics execution are small and medium sized companies (SMEs). As SMEs tend to lag behind in implementation of ICT systems (Stefansson, 2002; Gunasekaran and Ngai, 2004), this can hamper those forms of cooperation that require intensive (order) data exchange. ICT is mainly an issue for horizontal cooperation agreements of a medium intensity. Low intensity initiatives often do not require specific ICT investments and high intensity initiatives are likely to generate sufficient revenue to pay back the required ICT investments.

| Impediments | Identified by |
|---|---|
| **Partners** | |
| Difference in interests, opportunistic behaviour | Stern and Heskett (1969); Mentzer et al. (2000); Simatupang and Sridharan (2002) |
| Difficulty in finding partners with whom to cooperate | Williamson (1985); North (1990); Hennart (1993); Bleeke and Ernst (1995); Sabath and Fontanella (2002) |
| Difficulty in finding a trusted party/person to lead the cooperation | Mentzer et al. (2000) |
| Differences in operating procedures | Bowersox (1990); Elmuti and Kathawala (2001); Simatupang and Sridharan (2002) |
| **Determining and dividing the gains** | |
| Difficulty in determining the (monetary) benefits | Razzaque and Sheng (1998); Zineldin and Bredenlöw (2003) |
| Difficulty in establishing a fair allocation of the benefits | Lambert et al. (1999); Bartlett and Ghoshal (2000); Mentzer et al. (2000); Gibson et al. (2002); Zineldin and Bredenlöw (2003) |
| **Negotiation** | |
| Disagreement over the domain of decisions | Stern and Heskett (1969); Barratt (2004) |
| Unequal bargaining positions (e.g. due to size differences) | Contractor and Lorange (1988); Bleeke and Ernst (1995); Zineldin and Bredenlöw (2003); Häkkinen et al. (2004) |
| **Coordination and ICT** | |
| High indispensable ICT costs | McLaren et al. (2002); Stefansson (2002); Gunasekaran and Ngai (2003) |
| High additional coordinating and controlling costs | Contractor and Lorange (1988); Mentzer et al. (2000); McLaren et al. (2002); Zineldin and Bredenlöw (2003) |
| Loss of control | Razzaque and Sheng (1998); Lambert et al. (1999); Elmuti and Kathawala (2001); Zineldin and Bredenlöw (2003) |

Table 2-3. Impediments and threats for horizontal cooperation

## 2.5 FACILITATORS OF HORIZONTAL COOPERATION IN TRANSPORT AND LOGISTICS

Even when companies have recognised that horizontal cooperation is a promising direction of thought and a project has been started, these same companies may not fully understand how to manage or maintain their cooperation. The transition to cooperation is often difficult because it involves changes in mind-set, culture and behaviour (Whipple and Frankel, 2000). The potential of horizontal cooperation is difficult to judge by merely performing a cost-benefit analysis or weighing the opportunities and impediments discussed in the previous two sections. Instead, there are many 'soft' factors that may play a crucial role in the success of a cooperation. These soft factors are here referred to as the facilitators for horizontal cooperation. This section discusses four groups of facilitators that are of crucial importance. These groups are labelled information sharing, incentive alignment, relationship management and contracts, and information and communication technology. Once again, the individual facilitators incorporated in one of these groups are gathered in a table (Table 2-4), together with useful references.

### 2.5.1 Information Sharing

In a horizontal cooperation, there is a clear need for the exchange of appropriate and reliable information about for example the extent to which each member benefits. The sharing of logistics information is important from a costs perspective because it can replace unnecessary costs for transport or storage of goods (Lee and Whang, 2001). Generally, information can be subdivided into two categories: proprietary and shared information. Proprietary information is necessary for a company to manage its internal processes and should only be accessible to a company's own employees. The shared information should however be available to all participants in a cooperation (Stefansson, 2002). If partners do not share these data, they will lack knowledge about each other's plan and intentions, and their activities will thus therefore not be adequately harmonized. This will result in suboptimal benefit to the cooperation (Simatupang and Sridharan, 2002).

Information types that can be shared include transport orders (e.g. Chapter 4 of this thesis), inventory levels at production facilities (e.g. Gavirneni, 2001), sales data (e.g. Lee et al., 2000), production schedules (e.g. Lee and Whang, 2000), manufacturing capacities (e.g. D'Amours et al., 1999), and performance metrics (e.g. Lee and Whang, 2000).

### 2.5.2 Incentive Alignment

As with virtually every business decision, entering a horizontal cooperation is also founded on the belief by a company's management that this individual company will benefit from it. The obvious result is that in a cooperation there are multiple companies striving to optimise their own profit. However, actions and decisions by one member will often result in costs or benefits to other participants as well. This phenomenon is referred to as *externalities*, *spillovers* or *neighbourhood effects* (Simatupang and Sridharan, 2002). It is important to remember throughout the cooperation that the core reason for each company to join will always be of a selfish nature. However, in order for the cooperation to succeed, partners must act harmoniously to achieve joint goals, i.e., there must be a strong sense of having shared costs, risks and benefits. Incentive alignment aims at providing a mechanism for (re)alignment of the benefits and burdens so that responsibility for the attainment of overall profitability is internalized to the individual participants. Simatupang and

Sridharan (2002) identify three types of incentive alignment strategies that can be used to motivate different members to align their behaviour with the overall goal of the cooperation:

1. *Rewarding productive behaviour*: rewarding observable actions that lead to a common goal, rather than rewarding the attainment of the goal itself.
2. *Pay-for-performance*: use performance metrics to evaluate the achievements of individual partners on important objectives of the cooperation.
3. *Equitable compensation*: joint goals are set and the created gains are allocated to the partners based on an ex ante agreed gain sharing mechanism.

The two most important concepts associated with aligning individual and joint goals are commitment and trust. Trust is a vital facilitator for cooperation. Relying on a partner that in principle has other objectives is a risky undertaking, and therefore trust is necessary to reach a useful level of cooperation. Commitment is closely related to trust and refers to the bond between companies in a cooperation. Rindfleish (2000) discusses the differences in trust between vertical and horizontal cooperations. The main observation is that resource-dependence is lower for horizontal cooperations, because these partners do not depend on each other to acquire necessary inputs. Moreover, the competitive element in horizontal cooperation increases the threat of opportunism and lowers the level of trust, because one participant may use information gathered in the cooperation to improve its market position at the expense of other participants. Therefore, it is argued that trust alone is not a suitable governance mechanism for horizontal cooperation. Instead it is advisable to construct a set of cooperation rules, i.e., partially replacing trust with control as a governance mechanism. An elaborate discussion of both trust and control in cooperations can be found in Das and Teng (1998). There are some situation-specific factors that may increase mutual trust in horizontal cooperation, such as the presence of shared customers (cf. Lambert et al., 1999). Finally, horizontal cooperations are likely to show more institutional and interpersonal connections (e.g. social contacts, sector associations etc.) than vertical cooperations. These connections can make up for the difficulties produced by initially low levels of trust, commitment and dependence.

### 2.5.3 Relationship Management and Contracts

The third group of facilitators for horizontal cooperation is summarised under the name ‘Relationship management and contracts’. On a high-level, two manners of formal relationship management can be distinguished. The first is a ‘strict’ contract, the second is a more ‘open’ contract structure.

Todeva and Knoke (2005) state that an open contract is more suitable in the pursuit of a collective goal, because this process typically depends on unanticipated future conditions that cannot explicitly and exhaustively be captured in formal contractual agreements. Therefore, an open contract is probably the best form to structure a horizontal cooperation. According to Lambert et al. (1996), the strongest cooperations generally have the shortest and least specific agreements or even no written agreement at all. A one or two-page document, outlining the basic philosophy and vision for the cooperation is generally all that is needed when the parties are truly committed to make the cooperation a success. Writing down all practical agreements for cooperation may even turn out to be a weak point in practical cases of horizontal cooperation (Verstrepen et al., 2006). Horizontal cooperation initiatives often grow 'from the inside' or as a small-scale experiment. Thus, the parties involved often consider the set-up of a binding juridical framework to be a burden instead of an aid or necessity. Afterwards however, the lack of a written agreement for cooperation can sometimes lead to problems in the event of unanticipated growth or conflict situations, or if the cooperation comes to an end. The set-up of a *charter of cooperation* to formally shape only the core aspects of the horizontal cooperation can therefore be a suitable compromise. The aim of such a charter is to determine the basic 'rules of the game' and vision for the future. It confirms the mutual trust and commitment, and as such forms the mortar of the cooperation. Its components need to be revised regularly along with the evolution of the cooperative agreement and the common vision (Ring and Van de Ven, 1992).

In addition to contractual issues, it is very helpful for efficient relationship management if the companies engaged in a horizontal cooperation show a certain level of mutuality, symmetry, and strategic fit. Mutuality means that the management of one participating company is able to put themselves in another participant's shoes. Secondly, partners can be considered symmetric if they have comparable market shares, financial strength, productivity, reputation and/or level of technological sophistication (Lambert et al., 1996). Finally, strategic fit between partners exists if the organizational structures and strategies are well suited to each other.

### 2.5.4 Information and Communication Technology

In order to reach the longer term opportunities of horizontal cooperation, in the short run the costs for efficient communication between partners must be low enough. Over the last years, new technologies have greatly enhanced inter-company communication. Some examples of new facilitating technologies are: TCP/IP, standard Enterprise Resource Planning (ERP) systems, Electronic Data Interchange (EDI), eXtensible Markup Language (XML), object-oriented programming environments, wireless communications and the Internet. Besides technically enabling cooperation, these technologies also reduce transaction costs and transactions risks, and therefore support an enduring success of a cooperation (Esper and Williams, 2003). A more detailed discussion of different technologies and concepts that foster cooperation is provided by McLaren et al. (2002).

| **Facilitators** | **Identified by** |
|---|---|
| **Information sharing** | |
| Integration of information | Moss-Kanter (1994); Mentzer et al. (2000); Whipple and Frankel (2000); McLaren et al. (2002); Simatupang and Sridharan (2002); Barratt (2004); Zineldin (2004) |
| Sharing of performance data | Gibson et al. (2002); McLaren et al. (2002); Barratt (2004); Zineldin (2004) |
| Transparency, 'open book' policy | Bowersox (1990); Mentzer et al. (2000); Gibson et al. (2002); Barratt (2004) |
| **Incentive alignment** | |
| Trust | Bowersox (1990); Mentzer et al. (2000); Whipple and Frankel (2000); Zineldin and Bredenlöw (2003); Barratt (2004); Hadjikhani and Thilenius (2005); Todeva and Knoke (2005) |
| Common interest and commitment | Moss-Kanter (1994); Mentzer et al. (2000); Simatupang and Sridharan (2002); Zineldin (2004); Hadjikhani and Thilenius (2005) |
| Mutual help and interdependence | Bowersox (1990); Moss-Kanter (1994); Kumar and van Dissel (1996); Mentzer et al. (2000); Gibson et al. (2002); Zineldin (2004) |
| Shared customer(s) | Lambert et al. (1999) |
| Integrity and a cooperative culture | Moss-Kanter (1994); Gibson et al. (2002); Barratt (2004); Zineldin (2004) |
| **Relationship management and contracts** | |
| Comparable partners, compatibility, strategic fit | Moss-Kanter (1994); Lambert et al. (1999); Whipple and Frankel (2000); Gibson et al. (2002); Zineldin (2004) |
| Clear expectations | Bowersox (1990); Mentzer et al. (2000); Whipple and Frankel (2000); Zineldin (2004) |
| Leadership | Mentzer et al. (2000); Todeva and Knoke (2005) |
| 'Open' contract | Moss-Kanter (1994); Mentzer et al. (2000); Gibson et al. (2002) |
| Conflict resolution management | Gibson et al. (2002); Zineldin (2004); Todeva and Knoke (2005) |
| Prior cooperative experience | Lambert et al. (1999); Todeva and Knoke (2005) |
| **Information and communication technology** | |
| Message based systems (fax, email, sms, EDI, XML) | Kumar and van Dissel (1996); McLaren et al. (2002); Esper and Williams (2003) |
| Market based systems (hubs, portals, auctions) | McLaren et al. (2002); Granot and Sošić (2005) |
| Collaborative planning based systems (CPFR, CTM) | Kumar and van Dissel (1996); McLaren et al. (2002); Esper and Williams (2003) |
| **Other** | |
| Physical proximity | Lambert et al. (1999) |

Table 2-4. Facilitators of horizontal cooperation

## 2.6 CONCLUDING REMARKS

The purpose of this chapter was to provide a starting point for future research on horizontal cooperation in transport and logistics by reviewing relevant existing academic literature. The great economic significance of this sector and the apparent problems it is facing, contribute to the importance of concepts such as horizontal cooperation. It is widely reckoned that increased economies of scale are necessary to prevent the rising transport costs, increasing congestion and emissions from becoming an even larger burden to welfare than they are at present. Horizontal cooperation seems to be an interesting line of thought in attaining this increased scale. In the heavily congested European logistics centre of gravity (Belgium and the Netherlands) many horizontal cooperation initiatives of various types have already been initiated. Yet, existing literature lacks a general typology to guide practitioners in setting up horizontal cooperations and in any case not all forms of horizontal cooperation are applicable to any given sector or company. As such, the horizontal cooperation that currently exists may not be as effective as it could be. To fill this gap, a tentative typology for horizontal cooperation initiatives will be developed in the next chapter.

It remains to be seen if horizontal cooperation is an intermediate step towards market concentration by means of horizontal mergers, or an organizational structure that is also sustainable in the long run. Hopefully, the described opportunities, impediments and facilitators will both help practitioners to better gauge the potential of horizontal cooperation to their businesses, and inspire researchers to contribute to this fruitful and relevant field.

# CHAPTER 3 A PRACTICAL FRAMEWORK

As stated in Chapter 1, the most frequently cited problems of Logistics Service Providers (LSPs) and logistics departments of shippers are low capacity utilisation, empty haulage, a negative public image and declining profit margins. The main causes for these problems are the stiff competition in global markets, high fixed costs, rising petrol and labour prices, the proliferation of products with shorter life cycles and the increasing expectations of customers. In practice, horizontal cooperation has proven to be a particularly useful option for both shippers and LSPs to cope with these difficult circumstances and to amend their efficiency and competitiveness. Through close cooperation, the partnering logistics companies aim at increasing productivity, e.g. by optimising truck capacity utilisation, reducing empty mileage and cutting costs of supporting (non-core) activities to increase the competitiveness of their logistics networks.

The theoretical rationale for cooperation has extensively been discussed in Chapter 2. We now take a practical perspective. It turns out that in practice a plethora of different types of horizontal cooperations can be found. This chapter therefore develops a typology for these manifestations. It starts with an examination of some typical examples encountered practice.

## 3.1 CONCEPTS ENCOUNTERED IN PRACTICE

This section describes the characteristics of manifestations of horizontal cooperation encountered in practice. Where possible, examples of successful cases from practice are provided. The restriction to successful cases is made for two main reasons. Firstly, success stories best illustrate the potential of a concept. Secondly, some pragmatism was needed because unsuccessful cases tend to be short-lived and usually little information about them is communicated by the stakeholders. Therefore, it is hard to find these cases and discover why they failed.

Most of the described concepts for horizontal cooperation can be applied by both shippers and LSPs. Others are only meaningful for cooperating LSPs. In that case, this will be indicated explicitly in the discussion of the concept. Also, it should be noted cooperation types may overlap. This then results in hybrid forms of horizontal cooperation.

***Lobbying group***

A lobbying group steps up for the common interest of companies active in a certain logistics sector. Obviously, logistics companies have to cope with the influences of many external decision makers. Lobbying groups aim at influencing these decision makers to their interest. For example, regulations introduced by European or national governments can have far-reaching (financial) consequences for logistics companies (e.g. tax deductions of investments in onboard computers and blind spot mirrors, compulsory soot filters, and regulation on working hours for drivers, emission levels, weight of trucks, etc.). Furthermore, a positive image of the sector is important for attracting high quality personnel. Generally, the logistics sector has a low-tech image and therefore it is not a very popular working environment for academic high-potentials. In addition, the thin margins make it difficult for logistics companies to offer new employees competitive salaries. In response to these difficulties, some European governments sponsor initiatives to upgrade logistics skills. An example is the British *Skills for Logistics* (E.R. 27) programme.

*Road Spirit* is a lobbying group cooperation of ten independent Belgian road transport companies. Its goal is to enhance the public image of the transport and logistics sector. This is done by being present at exhibitions, organizing conferences, and initiating campaigns to promote the logistics sector for students and young professionals by listing and describing the ten most rewarding logistics jobs. Road Spirit aspires to raise the quality of employees and to take road transport to the next level.

***Maintenance group***

Especially for road transport companies, maintenance is a very important supporting activity. Maintenance of a fleet of trucks requires special knowledge and capabilities that might not be present in-house at an LSP (or at a shipper that performs transport on his own account). Performing good and regular maintenance by skilled workers can prevent costly breakdowns of trucks and also enhance the reliability of services. It is possible to outsource these activities, but through a maintenance group, the aggregate fleet can be of a size that justifies the installation of a cooperative maintenance facility. Other examples of maintenance activities that can be performed more efficiently in a horizontal cooperation are the cleaning of (office) facilities, fuel tanks, or technical equipment. For a maintenance group to succeed, geographical proximity of the partners is a necessity.

An example of a maintenance group can be found in the field of humanitarian logistics. In third world regions where natural and man-made disasters threaten the ethnic population, many aid organizations are active simultaneously. These can be either governmental, United Nations (UN), or non-governmental organizations (NGOs). The *Fleet Forum* (E.R. 12) is a cooperation of 40 international aid organizations that aims at attaining synergy in humanitarian logistics. It originates from a joint initiative of World Vision International, the International Federation of the Red Cross, and the World Food Program, and is supported by the Dutch LSP TNT. The Forum's goal is to support the logistics activities during the participants' missions in any appropriate way. In 2006, the Fleet Forum launched a project to install a joint maintenance facility under the governance of the UN in Malawi. Especially in developing countries such as Malawi the road infrastructure can be of a very low quality. This accelerates wastage and therefore good maintenance is key for ensuring ongoing reliable service. An explorative study (van der Burgt, 2006) estimates that introducing a maintenance group can reduce aggregate maintenance costs by at least 20%.

***Purchasing group***

Cooperative purchasing is defined as the sharing or bundling of purchasing related information, experiences, processes, resources or volumes to improve the performance of all participating organizations (Schotanus, 2005). Despite the considerable cost savings potential, this type of horizontal cooperation is underutilised in the logistics sector. The most important advantages are: lower prices, stronger negotiation positions, reduced workload for purchasing divisions, and the possibility to specialise in the procurement of specific goods or services. Some disadvantages are the loss of control and visibility and the (possible) need to switch suppliers.

Schotanus (2005) discusses a case study of a purchasing group within the UN. In the original situation, each of the larger UN agencies has its own procurement entities. Many of the agencies also have delegated authority to their respective country offices. Obviously, there are many common goods and services that are purchased by most of the UN agencies. For that reason the UN is continuously looking for cooperative purchasing opportunities. This is done for instance by facilitating e-procurement solutions for cooperative purchasing of UN member organizations (see E.R. 37) or collecting long-term agreements from individual agencies and making them available UN-wide. Cooperative purchasing initiatives are considered to be an important source of cost savings in the UN system. More information on purchasing groups can be found in Gentry (1993).

***Chartering***

Horizontal cooperation by means of chartering occurs when one LSP structurally outsources certain orders to an independent third party that is in principle a competitor. The underlying motivation can be that this competitor has better know-how for certain tasks, has more specialised equipment or can perform the tasks against a considerably lower cost. For chartering cooperations *once is no custom*: incidental chartering because of undercapacity does not qualify as a true cooperation.

An example of horizontal cooperation through chartering is when a large LSP such as DHL structurally outsources the execution of a shuttle service on a single transport link of their network to a small transport company.

***Warehouse sharing***

Warehousing facilities are very expensive, especially if they contain modern technology such as Radio Frequency Identification (RFID) or automated stacking machines. Moreover, the location of warehouses is of great importance for the efficiency of transport processes. By means of warehouse sharing, shippers and LSPs can reduce their warehousing costs (such as investments, conditioning, guarding, handling etc.). Mostly, warehouse-sharing initiatives are long-term horizontal cooperations because they require the merging of logistics processes and joint investments.

In 2005, the Belgian LSP H. Essers initiated a network of shared warehouses of 14 European transport and warehousing companies. The other participants are Heppner (France), Zufall and Cretschmar (Germany), Chemlog (a cooperation of six German warehousing companies), Weiss (Austria), Wim Bosman (the Netherlands), Sifte Berti (Italy) and Ranjel (Portugal). These parties have already been cooperating with each other on a smaller scale for many years before. Now they have intensified their cooperation in the sense that every partner can use each other's warehousing facilities when appropriate. In this way the cooperation encompasses a total of 1.6 million $m^2$ of storage capacity. The network enables the partners to operate on a pan-European scale more easily.

***Freight sharing***

Freight sharing occurs when companies exchange transport orders to better utilise truck capacities or to benefit from a partner's better-developed logistics network in a certain geographical region. Each company has an individual set of shipments to be performed. By means of horizontal cooperation, partners can partition the total set of shipments in such a way that more efficient routes can be composed. Chapter 4 provides a detailed discussion of the expected cost savings of freight sharing and joint route planning. Freight sharing can take place among a limited number of fixed and known partners, but there also exist online freight exchanges where any transport company can search for suitable loads to fill up empty truck space or to acquire backloads. The opportunities of freight sharing to decrease the number of kilometres driven and thereby avoiding external costs due to congestion and emissions, generally creates strong government support for these initiatives. As a result, many European countries have launched subsidy programmes. Examples are the Dutch *Transportbesparing* (E.R. 35) or the Irish *LogisticsXP* (E.R. 17) programme.

Examples of online freight exchanges are Teleroute (E.R. 30, discussed in Section 1.1) and BidSmart (E.R. 25). The latter is an Internet bidding tool developed by Schneider Logistics. BidSmart enables LSPs to browse logistics needs of shippers and to bid on individual lanes or groups of lanes that suit their current clientele and network. Also, the LSPs can enter their tariffs, consolidate shipments and analyse bidding results.

An example of a freight sharing cooperation consisting of a fixed number of known partners is Distribouw (E.R. 6). This is a cooperation of four geographically dispersed Dutch LSPs active in the building materials sector. By means of freight sharing and bundling, the partners are able to serve their customers more timely and at a lower cost. The strong demand for just-in-time delivery at the construction sites is the main driver for the cooperation. The smaller shipments resulting from this make it hard for individual LSPs to fill their trucks to an acceptable level. By means of freight sharing, Distribouw partners can offer their customers guaranteed delivery within 72 hours, something that would not be achievable individually. Another example of freight sharing is the case of joint route planning between Douwe Egberts, Unipro and Masterfoods that will be discussed in Section 4.3.

***Knowledge centre***

A knowledge centre is a type of horizontal cooperation that aims at intensifying knowledge exchange between companies. This can for example be accomplished by jointly organising trainings, company visits, working groups, conferences or exhibitions. Most often, knowledge centres are regionally oriented and consist of a limited number of companies that have strong cultural or personal affiliations. However, sometimes knowledge centres are also larger and more internationally oriented.

Road Spirit (see above) can be considered a knowledge centre. The fact that it is also a lobbying group makes Road Spirit an example of a hybrid form of horizontal cooperation. Another example is the French *Astre* cooperation (E.R. 1): a cooperation of around 130 transport companies that freely exchange knowledge via a protected intranet site. A third example of a knowledge centre is the Dutch *Bouwvervoergroep* (E.R. 3). This group consists of eight transport companies that are, like the participants in *Distribouw*, active in the building materials sector. Although the original driver for setting up the cooperation was to exchange orders to increase efficiency, the group currently functions as a knowledge centre. The subjects discussed include developments in the market, operational information, and freight rates (Verboven, 2005).

***Road assistance***

Road assistance is an easily attainable type of horizontal cooperation where companies provide mutual support in case of truck breakdowns. Transport companies are generally not knowledgeable about e.g. towing services, roadside assistance, local fire brigades etc. in places outside their home region. Therefore, internationally organized horizontal cooperations can be of value. This is especially true in sectors with highly inflammable or otherwise hazardous goods, such as the petrochemical industry. A road assistance group can give directions in case of accidents, or provide backup drivers and material. Typically, road assistance groups are spin-offs of other cooperation types such as knowledge centres or purchasing groups.

***Co-branding***

Co-branding is a marketing term that finds its roots in the American food industry of the 1960s. It is about developing and propagating a joint brand and market image. A well-known example is the cooperation of Heineken and Krups in the development of the beertender, a beer tapping system for use at home. In logistics, co-branding concerns a standardisation of service levels, processes, market approach, pricing etc. (Verstrepen, 2006).

An example from the logistics industry is the above-mentioned French cooperation Astre (E.R. 1). Together, the participating LSPs have 8,500 employees, 14,000 trucks and 1.5 million $m^2$ warehousing space at their disposal. All partners explicitly propagate themselves as Astre-members. This brand name clarifies to customers that this Astre company 1) satisfies Astre's performance criteria, 2) offers real-time tracking and tracing services, 3) has an ISO quality certification, and 4) satisfies certain ethical and quality requirements.

***Tendergroup***

In a tendergroup, participating LSPs share their resources to be able to tender on contracts that would be too large or complex for any of the partners to fulfil individually. If contracts are too large, then the aggregate capacity of transport equipment and/or warehousing facilities can be (temporarily) merged to reach the required level of scale. Another rationale for tendergroups is that they allow disjoint geographical focus areas of LSPs to be merged to offer customers a single and intricate logistics network in a wider region. In cases where the contract is too complex for companies to fulfil individually, then partners may share their respective know-how or capabilities to offer a one-stop-shopping service to the customer together anyway. To summarise, a tendergroup offers small and medium sized companies the ability to jointly compete against large and powerful LSPs or enable large companies to perform mega contracts.

An example of a tendergroup is the cooperation between New Zealand Post and DHL Express. Together, they signed a deal with Air New Zealand to provide all domestic and international postal and courier services for the Air New Zealand group. Although DHL Express has been providing services to a number of business units within Air New Zealand for some time, as part of the new agreement it will now deliver these services across the entire business. This extension of services is greatly facilitated by the cooperation with New Zealand Post (E.R. 36).

***Asset pooling***

In many industries, demand is unstable or subject to seasonal influences. This makes it difficult for companies to fully utilise their assets. To save costs some standardised assets can be pooled between companies. In logistics, these assets can be (conditioned) trucks, forklift trucks, pallets, crates etc.

McKinnon (2004b) discusses the possibilities of asset pooling in the petrochemical industry. This industry is dominated by a small number of large companies that operate very expensive transport equipment (trucks cost around € 100,000). The European PetroChemical Association (EPCA, E.R. 8) facilitates brainstorm sessions about cooperation projects, one of them being the pooling of logistics resources. At present, different companies have their own pools of containers and handling equipment. These must be separately repositioned and maintained. McKinnon (2004b) states that, if industry-wide horizontal cooperation by means of asset pooling would occur, this pool could be utilised much more efficiently. The total pool could then be downsized, cutting the level of capital investment. Furthermore, the operating cost per unit load could be reduced. This will however require standardisation of equipment and the development of new organizational structures.

***Intermodal group***

An intermodal group is a horizontal cooperation of LSPs that specialise in different transport modes. Two obvious combinations are road/rail and road/water. When transported volumes are large, distances are long, and/or time requirements are soft, multimodal transport can offer interesting cost saving opportunities.

The concept of an intermodal group is illustrated by the Dutch Distrivaart initiative. In the Netherlands, 300 million pallets are shipped on a yearly basis. The Distrivaart project aims at constructing a nationwide network for the distribution of non-perishable palletised consumer goods via special pallet-ships on the inland waterways. In the envisioned end scenario, the Distrivaart network will consist of 40 pallet-ships and 17 distribution centres in the Netherlands, Belgium and the Ruhr area. This could then withdraw around 43 million pallets per year from the road network. Horizontal cooperation in this intermodal group takes place between the logistics departments of the participating producers and retailers, the LSP that subcontracts the inland navigation company and the road transport companies that are responsible for the parallel road network and the access and egress transport. More information on the Distrivaart project can be found in NDL (2003).

***Shared crossdock***

Transport costs for individual shipments can be decreased by consolidating them into a single shipment. One way to make this possible is for companies to install a shared crossdock. In such a facility, the many small incoming streams can be merged into larger outgoing streams. A critical success factor of a shared crossdock is the geographical overlap of the distribution areas of the partners. In most of the cases encountered in practice, the operations at the shared crossdock are outsourced to an LSP.

The shared crossdock concept is a special case of asset pooling and was already illustrated by the Zoetwaren Distributie Nederland case described in Section 2.1. Another example is the cooperation between Kimberly Clark en Lever Fabergé (Cruijssen and Verweij, 2006). These companies have installed a crossdock facility to take advantage of their many shared customers. The shipments of these two companies are especially apt for consolidation because Kimberly Clark’s products are voluminous and cheap, while Lever Fabergé’s products are expensive and small. The consolidation processes are outsourced to an LSP.

## 3.2 A TYPOLOGY OF HORIZONTAL COOPERATION IN PRACTICE

The previous section however already indicated that the nature and structure of these cooperations tend to differ widely. As a means to classify and compare different types of horizontal cooperation arising in practice and to offer logisticians support in identifying the type of horizontal cooperation that best suits their situation, this section introduces a typology of horizontal logistics cooperation. Although more research is needed to make this typology exhaustive, this tentative typology currently incorporates four dimensions. These are: Decision level, Competition, Combined assets, and Objectives. In the next four subsections, these dimensions and their role in the typology will be discussed. The dimensions have been identified based on both the constructs found in literature review, and an analysis of similarities and differences between the many horizontal cooperation types encountered in practice.

### 3.2.1 Decision Level

This first dimension indicates the decision level of a cooperation, which can be operational, tactical or strategic. *Operational cooperation* relates to the daily operations within the logistics companies or divisions. It is practical in nature and can be described as ‘joint execution’ or ‘sharing of operational information’. *Tactical cooperation* relates to achieving mid-term objectives and involves more intensive planning and investments. It can be described as ‘joint organizing’, ‘servicing markets together’ or ‘sharing logistics resources’. *Strategic cooperation* is aimed at achieving long-term company objectives. Strategic cooperation can be described as ‘joint learning’, ‘joint development of innovative concepts’ and ‘joint investments’. In most cases, strategic cooperation cannot be achieved without preceding cooperation at the tactical level. Similarly, tactical cooperation generally requires a well-established cooperation at the operational level.

### 3.2.2 Competition

The second dimension in the typology concerns competition. The definition of horizontal cooperation in transport and logistics allows that participants are either competitors or non-competitors. This depends on whether or not partners compete for the same customers. Non-competitive horizontal cooperation occurs for example when transport companies servicing different industries (e.g. tank transport, express services, removal services) set up a knowledge centre. If partners are servicing the same industries and are direct competitors, the cooperation can be referred to as competitive horizontal cooperation.

### 3.2.3 Combined Assets

All types of horizontal cooperation are based on the sharing of tangible or intangible assets. Based on the opportunities of horizontal cooperation listed in Section 2.3 the following six groups of assets that can be combined to the benefit of all participants are identified. These are: Orders, Logistics facilities, Rolling stock, Market power, Supporting processes, and Expertise. The extent to which cooperations are aimed at combining these assets forms the basis of the third dimension of the typology.

### 3.2.4 Objectives

The final dimension is also based on the opportunities of horizontal cooperation (see Section 2.3). Five underlying groups of objectives can be distilled from the list of opportunities. These are: Cost reduction, Growth, Innovation, Quick response, and Social relevance. Below each objective is discussed.

Firstly, the most frequent objective of horizontal cooperation is cost reduction, either of core or non-core activities. Most short-term (operational) cooperation initiatives have cost reduction as their primary goal.

A second possible objective of horizontal cooperation is growth. Through cooperation, LSPs or logistics departments of companies can for example establish financial growth (increased turnover or profit) or geographically extend their coverage by combining their (distribution) networks. Moreover, the bundled forces of LSPs make it possible to tender on large contracts that are normally only reserved for the bigger players.

Thirdly, horizontal cooperation can be aimed at innovation. Innovative service concepts, interorganizational learning, and the introduction of new systems and technologies (e.g. RF tags) can potentially increase the quality of the offered logistics services. These new concepts or technologies will in many cases be too labour or capital intensive to be introduced by a single company. Horizontal cooperation can be a solution to this problem.

As for the fourth objective, horizontal cooperation is often the fastest way to reduce response times, obtain first mover advantages or successfully enter a new market. This is illustrated by the many logistics cooperations of Western European LSPs with partners in Eastern Europe and the Far East. An example of quick response made possible by a cooperative logistics concept, is when courier companies exchange orders to cut lead times down to levels that would be impossible to achieve individually. Most (horizontal) cooperations that aim at shortening response times also require active involvement of customers, so that these cooperations are in fact lateral cooperations. Reliable order forecasts can e.g. be helpful for companies to anticipate and reposition trucks. Coordination and communication are important facilitators of cooperation (cf. Chapter 2 and Dyer and Singh, 1998). In an economy that strongly depends on information flows, obtaining the most accurate and real-time information offers the key to success (Gunn, 1994). Cooperation may enable a company to process information faster, for example by anticipating shifts in the market and responding before competitors do. The shortened response times and the improved ability to react to changes can offer the partners a competitive advantage. To realise this, the organizational structures of the partners need to be harmonized, which also requires far-reaching ICT integration (Gunnarsson and Jonsson, 2003).

Finally, horizontal cooperation can have a social goal. Transport, especially by road, has grown steadily during the last decade. For example, road transport in the former EU-15 increased from 1.12 billion ton-km in 1995 to 1.38 billion ton-km in 2002, corresponding to an annual growth of 2.9% (Eurostat, E.R. 9). The strong growth of freight (and also passenger) transport by road results in increased congestion of the European road network. It is clear that this leads to high social costs (caused by time losses, noise, air pollution etc.). Ceteris paribus, road traffic will further increase in the next decade, which will have a serious negative impact on the accessibility of European economic centres and on the European economy as a whole. A classic solution is modal shift towards more environment-friendly transport modes (rail and inland navigation), but although the potential of these solutions is significant for bulk trades, a large share of the (less-than-truckload) freight market can only be serviced by road. Horizontal cooperation by exchanging loads and equipment between geographically dispersed partners can be an effective way to achieve a higher capacity utilisation. Load exchanges, central planning, shared distribution centres etc. all increase the efficiency of road transport and are a potential remedy for the increased demand for transport. Horizontal cooperation can thus be a means to slow down this increase in ton-kms, even without modal shift.

### 3.2.5 Construction of the Typology

The four dimensions developed in this section allow the construction of a typology aimed at situating and evaluating different forms of horizontal cooperation. This typology is summarised in Figure 3-1. In this figure, the horizontal cooperation concepts described in Section 3.1 are categorized. Note that the typology should be considered a *starting point* for an elaborate research on the dimensions of horizontal cooperation in practice. Figure 3-1 is a first assessment of the four dimensions that appeared during the literature review of Chapter 2 and interviews with eleven industry experts (see Section 5.3.1) that were held in preparation for the empirical research described in Chapter 5. The importance of each of the dimensions for a given type is tentatively indicated by means of a ‘moon’ pictogram. The interpretation of the different moon pictograms is given in Figure 3-2. The main goal of the dimensions and their classifications is to encourage further debate between both researchers and potential partners in a horizontal cooperation. Finally, Figure 3-1 can be used to position new forms of horizontal cooperation, such as the ones discussed in PART III of this thesis.

| | O/T/S | C/NC | OR | LF | RS | MP | SP | E | CR | G | I | QR | SR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lobbying group | S | C | | | | ◕ | | ◔ | ◑ | ● | ◑ | ◑ | ◑ |
| Maintenance group | O | C/NC | | ◔ | ◑ | ◔ | ● | ◔ | ◑ | | | | |
| Purchasing group | O | C/NC | | | ◔ | ● | ◕ | ◑ | ● | | ◔ | | ◔ |
| Chartering | O/T | C | ◕ | | ◕ | | | | ◔ | ◑ | | | |
| Warehouse sharing | O/T | C/NC | ◑ | ● | ◕ | | | | ◑ | ◑ | ◔ | | ◔ |
| Freight sharing | O/T | C | ● | | | ◔ | | | ◕ | ◑ | | | ● |
| Knowledge centre | S | C | | | | ◔ | ◑ | ● | | ◑ | ◑ | ● | ◔ |
| Road assistance | O | C | | | ● | | ◕ | | ◔ | | | | ◑ |
| Co-branding | S | C/NC | | | | ● | ◑ | ◔ | | ◔ | ● | ◔ | |
| Tendergroup | T/S | C | | ◔ | ◑ | ◕ | | ◑ | | | ◕ | | |
| Asset pooling | O/T | C | ◔ | ● | ● | ◔ | | | ◑ | ◑ | | | ◑ |
| Intermodal group | S | NC | ● | ◔ | ◑ | ◔ | | ◔ | ◔ | ◔ | ◑ | ◔ | ● |
| Shared crossdock | T | C/NC | ◕ | ● | | | | | ◑ | | | | ◔ |
| … | | | | | | | | | | | | | |

| | | | |
|---|---|---|---|
| O | Operational | MP | Market power |
| T | Tactical | SP | Supporting processes |
| S | Strategic | E | Expertise |
| C | Competitive | CR | Cost reduction |
| NC | Non-competitive | G | Growth |
| OR | Orders | I | Innovation |
| LF | Logistics facilities | QR | Quick response |
| RS | Rolling stock | SR | Social relevance |

Figure 3-1. Typology of horizontal cooperation forms

| Pictogram | Interpretation |
|---|---|
| ◔ | This is a **side effect** of a horizontal cooperation type. |
| ◑ | This is a **natural aspect** of a horizontal cooperation type. |
| ◕ | This is **important** for a horizontal cooperation type. |
| ● | This is **essential** for a horizontal cooperation type. |

Figure 3-2. Interpretation of moon pictograms

## 3.3 CONCLUDING REMARKS

This chapter instigated a typology of horizontal cooperation types encountered in practice. This typology incorporates four dimensions (Decision level, Competition, Combined assets, and Objectives) and it aims at situating and evaluating different forms of horizontal cooperation. The typology is summarised in Figure 3-1. In this figure, a number of horizontal cooperation concepts are categorized. Descriptions of the most important characteristics of each of these concepts have been given in Section 3.1. This typology is however merely a starting point for future research on the dimensions of horizontal cooperation in practice. More research is needed in order to make it exhaustive and robust.

At this point, we have provided an overview of horizontal cooperation in transport and logistics, from both a theoretical and a practical point of view. To end PART I, the next chapter will quantify the monetary savings that can be attained through horizontal cooperation. This will be done for the most 'basic' form of horizontal cooperation in transport, i.e., freight sharing and joint route planning.

# CHAPTER 4 JOINT ROUTE PLANNING UNDER VARYING MARKET CONDITIONS

## 4.1 INTRODUCTION

In Section 1.1 a number of important trends in logistics have been discussed. They illustrated that the logistics industry as a whole is under pressure. Amongst other things, fierce competition in global markets, the shortening of product life cycles, and the heightened expectations of customers are causing profit margins to shrink. As a result, companies show a strong tendency to decrease the costs of non-value adding activities, such as basic distribution. In addition, the increasing number of mergers and acquisitions give companies an excellent opportunity to rethink and rebuild their logistics processes (Eye for Transport, 2003). As a consequence of these developments, the European logistics market is currently going through a structural reorganization. Furthermore, it seems that nowadays the potential of internal reorganization of logistics processes has been almost completely exploited, and attention is shifting from optimising internal logistics processes to better managing external relations in the supply chain (cf. Skjoett-Larsen, 2000).

Therefore, a fundamental choice that companies face in redesigning their logistics processes is whether they i) keep the execution in-house, ii) outsource the logistics activities, or iii) seek cooperation with colleague companies to exploit synergies. This is again the make/buy/ally decision introduced in Section 2.1. Combinations of these three possibilities may also prove a valid option. The present chapter considers companies opting for choices ii) or iii), i.e., *outsourcing* or *horizontal cooperation*. Horizontal cooperation is the main subject of this thesis and has already been examined elaborately in the previous two chapters. Below, the concept of outsourcing is briefly introduced.

Razzaque and Sheng (1998) define outsourcing (or: third party logistics) as the provision of single or multiple logistics services by a vendor on a contractual basis. It has been estimated that about 40 percent of global logistics is outsourced (Wong et al., 2000), and increasingly many shippers consider it an attractive alternative to the traditional logistics service mode (Hong et al., 2004). Razzaque and Sheng (1998) and Wilding and Juriado (2004) provide literature reviews on outsourcing, investigating which activities are typically outsourced and the main reasons for doing this. The top five reasons found for outsourcing relate to 1) costs or revenue, 2) service, 3) operational flexibility, 4) business focus, 5) asset utilisation or efficiency. Logistics Service Providers (LSPs) are able to achieve economies of scale by providing logistics services to a number of customers This makes cost or revenue related reasons the most important drivers for shippers wishing to outsource logistics processes. The most commonly outsourced processes are Transport and Shipment, Warehousing and Inventory, Information Systems and Value Added Services.

Both outsourcing and horizontal cooperation aim at achieving synergy and economies of scale to increase the competitiveness of their logistics networks. Some examples of specific goals of the horizontal cooperation types discussed in Chapter 3 are: reducing purchasing costs (e.g. onboard computers, storage systems, fuel, etc.), saving on storage costs by using joint facilities, and saving on costs of non-core activities (e.g. safety trainings). All these cost savings can be estimated quite easily by means of basic cost calculations. This is however not the case for savings on distribution costs that result from so-called *joint route planning*, i.e., horizontal cooperation that merges the distribution processes of the partnering companies to obtain scale economies. Here we define the *synergy value* as the (percent) difference between distribution costs in the original situation where all entities perform their orders individually, and the costs of a system where all orders are collected and route schemes are set up simultaneously.

The literature review in Chapter 2 has indicated that problems in quantifying the synergy value constitute a major impediment for horizontal cooperation. Therefore, the aim of the present chapter is to build intuition on and to actually calculate the synergy value that cooperating companies may expect from joint route planning. This remainder of the chapter is organized as follows: in the next section the research framework and the routing model employed are explained. Furthermore, results are given on the synergy value in a benchmark case. In Section 4.3, the results are put into perspective by comparing them to the synergy values attained in a practical case concerning the distribution of frozen goods in the Dutch catering sector. Section 4.4 then describes a sensitivity analysis that is performed on six market characteristics of the benchmark case. Finally, in Section 4.5, some concluding remarks are made.

## 4.2 JOINT ROUTE PLANNING

Consider a system with multiple companies, each having a separate set of distribution orders. These distribution orders are requests for the delivery of goods from a single distribution centre to specified drop-off locations at customers' sites. Such a situation both fits the case of outsourcing of warehousing and distribution processes to an LSP, and the case of horizontal cooperation between shippers or LSPs by means of a joint crossdock. An example of this type of horizontal cooperation (Lever Fabergé and Kimberly-Clark) has been discussed in Section 3.1.

The results also offer a good approximation for the more general situation in which joint route planning is done by a group of companies whose truck depots are located 'sufficiently close' to each other. In this setting whether these companies are shippers, LSPs, or even receivers of goods is of little importance: it is enough that the companies have direct (planning) authority over the flows of goods. Who executes the orders is irrelevant from a synergy point of view. Therefore, in the remainder of this chapter the cooperating companies will be referred to as *flow controlling entities* (FCEs).

### 4.2.1 Research Framework

This section presents the framework that is employed for calculating the synergy value, i.e., comparing the sum of the distribution costs of individual FCEs with the distribution costs under joint route planning. This framework is based on the extended Solomon instance RC110_1 of the Vehicle Routing Problem with Time Windows (VRPTW: Solomon, 1987; Gehring and Homberger, 2001). This specific problem instance and others can be found online (E.R. 23).

The distribution network consists of a set of nodes in a plane, each node representing a drop-off location. Furthermore, there is a single node in the centre of the plane, which represents the distribution centre. Each pair of nodes is connected by an arc. On these arcs, Euclidean distances are assumed. The travel time (expressed in minutes) between each pair of nodes is proportional to the Euclidean distances, and therefore based on a constant speed of 60 distance units per hour. Travel times are relevant for determining synergy values since the distribution orders have time windows and working days of drivers are of limited length.

In the original system without joint route planning, each customer belongs to a single FCE. This is implemented by successively assigning orders from the VRPTW instance to the FCEs, until the pre-set market shares in terms of the number of distribution orders have been reached. Furthermore, it is assumed that FCEs have a sufficiently large homogeneous fleet of trucks that start and end their trips at the distribution centre. These trucks have a capacity of 200 units and operate at a cost of € 1.42 per kilometre, and a € 274 fixed cost per truck. Unloading (or: service time) takes a fixed time of 10 minutes for each customer.

### 4.2.2 Benchmark Case

Problem instance RC110_1 is used to construct the benchmark case. This instance consists of 1,000 orders, the first 250 of which are selected for the benchmark case. The orders have an average size of 17.82, with a standard deviation of 8.08 units. In the benchmark case, there are three FCEs that engage in joint route planning, and their market shares are all equal. Finally, the time window widths equal 30 for all customers, and the distribution area is a square of 500x500. A more detailed description of the problem instances can be found in Solomon (1987) and Gehring and Homberger (2001).

The developed benchmark scenario is summarised in Table 4-1. Seven characteristics are assumed to be significant for the synergy value: number of orders per FCE (1 and 2), average order size (3), standard deviation of order sizes (4), time window width (5), size of distribution area (6), and market shares of FCEs (7). The next section introduces the routing heuristic that is used to determine the synergy values.

| | Characteristic | Benchmark case values |
|---|---|---|
| 1 | Number of orders | 250 |
| 2 | Number of FCEs | 3 |
| 3 | Average order size | 17.82 |
| 4 | Standard deviation of order size | 8.08 |
| 5 | Time window width | 30 |
| 6 | Size of distribution area | 500x500 |
| 7 | Market shares of FCEs | All equal |

Table 4-1. The benchmark scenario

### 4.2.3 Routing Heuristic

In the VRPTW, the objective is to construct routes from a common origin to multiple destination nodes. These routes are performed by identical trucks that start and end at the origin node and must be such that each destination node is visited exactly once, time windows are not violated, and the compound demand of the customers visited along a route does not exceed the truck's capacity.

The customary objective function for the VRPTW is of a step-wise nature. As a first criterion, the number of routes is minimised, and only then the distance travelled (some authors also minimise waiting time as a third criterion). In the current setting however, interest is in the minimum-cost solution based on the cost structure presented in Section 4.2.1. This renders the two-stage objective function inappropriate because the minimum-cost solution is not necessarily the solution with the minimum number of routes. To accommodate this alternative objective function, we developed a new VRPTW heuristic. The heuristic starts with the construction of an initial solution, which it then attempts to improve upon. The initial construction heuristic is based on the modified application of Clarke and Wright's (1964) savings heuristic by Liu and Shen (1999). The difference between the current heuristic and the original is that, when merging two routes A and B, not only positions at the start and end of route A are considered for insertion of route B, but also all other positions in route A. This means that in Figure 4-1, in addition to cases 1 and 2, also cases 3 and 4 are considered.

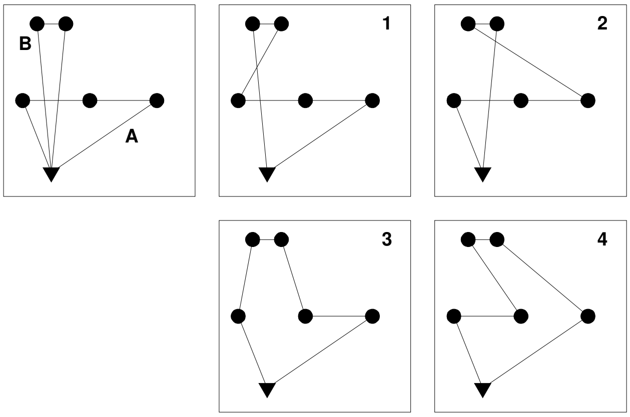


Figure 4-1. Modified savings construction algorithm

Once the initial solution has been generated, the algorithm attempts to reduce the number of routes by looping through all routes, trying to insert the customers one-by-one into other routes. All routes are considered for elimination in a random order. The customers in the route selected for elimination are inserted in partial random order into other routes according to how critical they are. A customer's criticality depends on his demand, time window width and distance from the depot, as formalised below.

$$C_1 = \frac{D_i}{\max_i (D_i)} \tag{4.1}$$

$$C_2 = \frac{TW_i}{\max_i (TW_i)} \tag{4.2}$$

$$C_3 = \frac{Dist_i}{\max_i (Dist_i)} \tag{4.3}$$

$$Crit_i = \alpha + (1-\alpha)\left(\frac{C_1}{C_2} + \beta C_3\right) \tag{4.4}$$

$0 < \alpha < 1, \beta > 0$

| | | |
|---|---|---|
| $D_i$ | = | Demand of customer $i$ |
| $TW_i$ | = | Width of customer $i$'s time window |
| $Dist_i$ | = | Distance of customer $i$ from the depot |
| $Crit_i$ | = | Criticality of customer $i$ |

If a route cannot be eliminated because not all customers could be reinserted into other routes, the successful insertions into other routes are undone. After the route elimination procedure, two local search operators, ICROSS and IOPT, are executed iteratively until no further improvement of costs can be found. ICROSS and IOPT are the same respectively as the well known CROSS (Taillard et al., 1997) and Or-opt (Or, 1976) operators, except that the relocation of segments is also attempted in inverted order. Both operators are described in detail in Bräysy et al. (2004).

### 4.2.4 Benchmark Case Results

For the benchmark scenario developed in section 4.2.2, the synergy value is calculated. Because the algorithm starts with a random seed, 25 replications are performed and the average savings are calculated (see Figure 4-2 and Table 4-2).

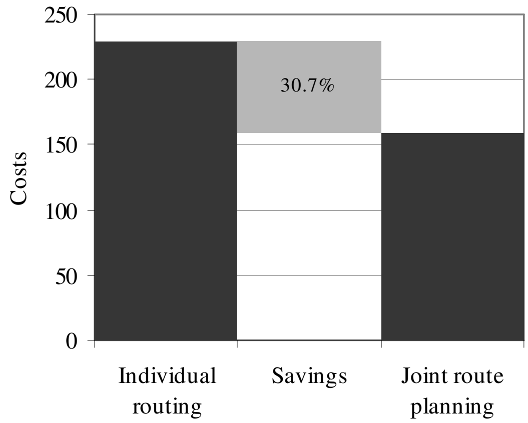


Figure 4-2. Synergy value for the benchmark case

| | **Original** | **Joint route planning** | ***Improvements*** |
|---|---|---|---|
| Costs | 56,884.71 | 39,438.65 | 30.7% |
| # Kilometres | 29,778.87 | 20,595.67 | 30.8% |
| Load factor | 0.43 | 0.62 | 43.2% |
| # Drops per route | 4.72 | 6.76 | 43.2% |
| # Trucks | 53 | 37 | 30.2% |

Table 4-2: Details of benchmark case savings

As expected, in this specific benchmark scenario, the FCEs benefit from joint route planning. The customer base to construct routes has after all been increased so that truck space can be used more efficiently. It turns out that a synergy value of 30.7% is possible as a result of joint route planning. Furthermore, the savings in kilometres driven and trucks used are also around 30%. The average load factor of trucks increases by 43.2% from 0.43 to 0.62. Note that these relatively low levels of truck space usage are a direct result of the structure of the RC110_1 problem instance under consideration, where time window constraints are more restrictive than capacity constraints.

The absolute size of these benefits is of course highly idiosyncratic: it is easy to construct instances where savings are very high or very low. Therefore, the next section discusses a study of a real-life case to underpin the range of savings found in the benchmark case.

## 4.3 JOINT ROUTE PLANNING IN PRACTICE

This section illustrates joint route planning by means of a case study in the Dutch catering sector (Groothedde, 2003). In 2001, three Dutch companies (Douwe Egberts, Unipro and Masterfoods) started a cooperation to increase the efficiency of their distribution networks for frozen products. All three companies supply frozen products to catering outlets at schools, companies, hospitals, government organizations, etc. For Douwe Egberts, these products are mainly coffee extracts, for Unipro bread and pastry, and for Masterfoods mostly ice cream. These products are delivered by means of expensive temperature controlled trucks. This makes that logistics costs constitute a relatively large share of the product price. Given the strong overlap of customers, 68% on average, the companies decided that joint distribution of their products was an interesting opportunity.

The inventory was moved from three private distribution centres in Wolvega, Dongen and Beuningen, to a new purpose-build joint distribution centre in Utrecht, the geographical centre of the Netherlands. In addition, the warehousing and distribution activities were outsourced to LSP C. van Heezik. This shift to a centralised distribution system with joint route planning is illustrated in Figure 4-3.

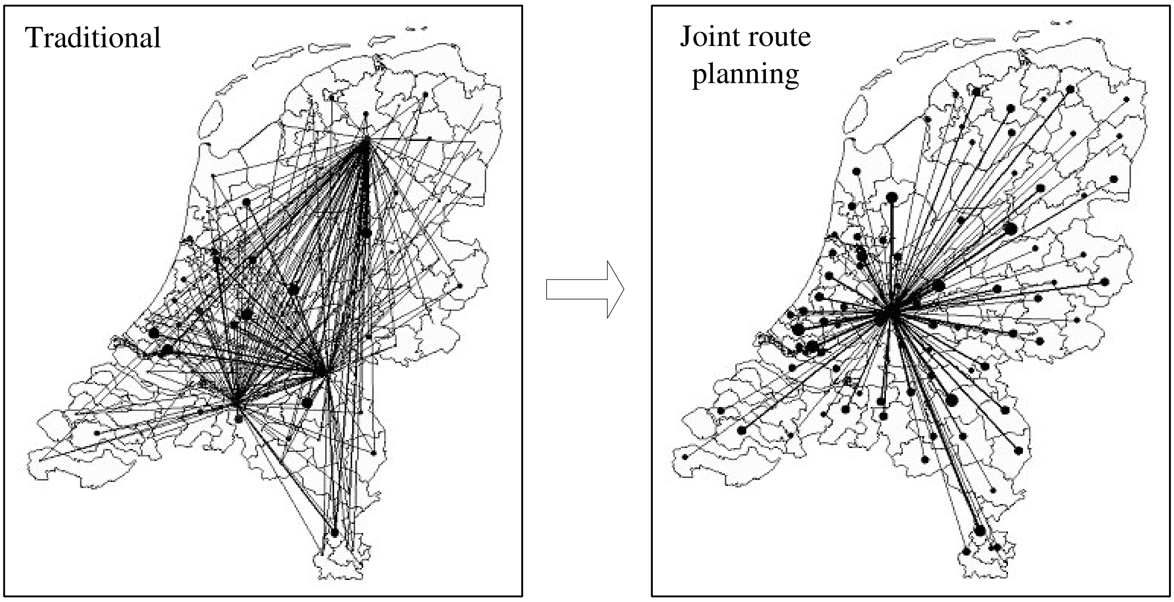


Figure 4-3: Case study: centralisation and joint route planning

Actual routes for weekly order sets were used to compare key performance indicators of the ex-ante and ex-post situations. The results can be found in Table 4-3, and are based on a homogeneous fleet consisting of trucks with a capacity of 26 units. The average drop size improves in the new situation, because Douwe Egberts, Unipro and Masterfoods have a number of joint customers. The orders of these customers are consolidated which improves the efficiency of the distribution process. Additionally, savings are attained because the customers belonging to different companies are located 'close' to each other so that their orders can be combined in one route.

| | **Before** | **After** | ***Improvements*** |
|---|---|---|---|
| # Trucks | 4245 | 2106 | 50.4% |
| Drop size | 2.52 | 3.5 | 38.9% |
| Drops per year | 21,225 | 15,161 | 28.6% |
| Kilometres per year | 1,460,000 | 1,010,000 | 30.8% |

Table 4-3. Results of introduction of central distribution centre

For this case, joint route planning saves 30.8% of distance travelled. In the new situation load factors are very high (over 95%), resulting in a fleet reduction of 50%. The synergy value of 30.8% in terms of kilometres driven in this specific case is well in line with the results of the benchmark scenario in the previous section. This is however not a general rule. The possible reduction in fleet size for example is much higher here. Furthermore, there are several other existing cases of joint route planning, where the savings deviate quite strongly from the 30% attained in the benchmark case. For example, Bahrami (2002) describes the merge of separate distribution networks pertaining to two producers of consumer goods (Henkel and Schwarzkopf) into one joint distribution network. There, distribution costs are estimated to fall by only 15.3% as a result of joint route planning. Furthermore, in later chapters of this thesis two additional case studies will be discussed. Chapter 8 discusses a case relating to the primary transport (i.e., from supplier sites to distribution centres of retailers) of grocery products. Two cases of horizontal cooperation are discussed. Firstly, there can be joint route planning by the suppliers, if they deliver the goods to the retailers' distribution centre. Secondly, joint route planning can occur at the retailers, if they pick up the goods at the suppliers' sites. The first constitutes a traditional situation whereas the second is an example of so-called *Factory Gate Pricing*. The reported savings of joint route planning are 27.1% in the traditional situation, and 11.4% in the Factory Gate Pricing situation. Finally, Chapter 9 will discuss a case of joint route planning in which four grocery retail chains cooperate by performing joint route planning for the distribution of their frozen goods to local supermarkets. The savings in distribution costs reported there amount to 20.3%.

It can be concluded that synergy values in the cases mentioned in this section show quite a strong variability. It is however very important for potential partners to have a reliable estimate of potential savings, before they engage in joint route planning. Since it is not always possible for companies to make a detailed estimate of the distribution costs in the ex-ante and ex-post situations, the next section will develop intuition on the impact of scenario-specific characteristics on synergy values. This can be useful for partners wishing to obtain an indication of the maximum achievable savings quickly. These insights can intensify and speed up negotiations, and increase the probability of the actual start and prosperity of a cooperation.

## 4.4 SENSITIVITY ANALYSIS

The above mentioned variability in synergy values is a direct consequence of operational (routing) characteristics of the sectors in which cooperation takes place. These characteristics were already listed in Table 4-1. In this section, various market situations are resembled by varying one characteristic at a time and fixing the others at their benchmark scenario value. Table 4-4 defines the range for each characteristic and the corresponding step sizes.

| Characteristic | Minimum | Maximum | Step size |
|---|---|---|---|
| Number of orders per FCE | 10 | - | 10 |
| Average order size | 0.2 | 8 | 0.2 |
| Standard deviation of order size | 0 | 4 | 0.1 |
| Time window width | 0 | 20 | 0.5 |
| Size of distribution area | 0.1 | 1 | 0.025 |
| Market shares of FCEs | 0 | 1 | 0.025 |

Table 4-4. Range of characteristics values

In the following subsections the synergy values are plotted for each of the characteristics. Every data point in the plots corresponds to the average result of 25 runs of the VRPTW heuristic described in Section 4.2.3. The data point corresponding to the benchmark scenario is denoted by a larger grey dot. In each plot, the horizontal axis represents the values of the characteristic under consideration. The vertical axis represents the synergy values as the average per cent savings of joint route planning as compared to the benchmark scenario.

### 4.4.1 Number of Orders per FCE

Figure 4-4 shows the sensitivity of the synergy value with respect to the number of orders per FCE. The number of orders per FCE is increased in intermediate steps of 10, until the total reaches 1000. The maximum number of orders per FCE therefore varies from scenario to scenario depending on the number of FCEs. In general, synergy values tend to increase initially, and then, having attained the maximum level, decrease. The rationale behind this is that if there are very few orders available there is not enough scale for a strong efficiency improvement through joint route planning. Isolated drop-off locations have a high probability of remaining isolated also in the joint route planning scenario, even more so if time windows avoid efficient combinations in a single route. On the other hand, when the number of orders per FCE is very large, each individual company has better economies of scale and is able to carry out routes more efficiently. Theoretically, the synergy values will tend to zero if the number of orders per FCE runs to infinity. However, even when only two FCEs cooperate, each having a large individual orderset of 500 orders, joint route planning still offers a good opportunity to reduce costs (synergy value is 17.8%).

Figure 4-4 also indicates that in relative terms, joint route planning is more profitable for small transport companies than for larger ones. This is an important consideration in for example the Netherlands and Belgium, where fragmentation in the road transport industry is high. In these two countries, there are approximately 15,000 transport companies, which means 1 per 1,800 inhabitants. This issue will be revisited in Chapter 6 where the relation between the efficiency and size of a transport company is investigated. Consolidation through joint route planning could therefore prove a promising option. However, it may not be reasonable to expect a very large number of small FCEs to cooperate in joint route planning, since the transaction costs needed for setting up and maintaining such a cooperation will eventually outweigh the absolute cost savings FCEs can attain. An elaboration on the role of transaction costs however lies beyond the scope of this thesis. A discussion of various types of transaction costs in cooperative transport networks can be found in Groothedde (2005).

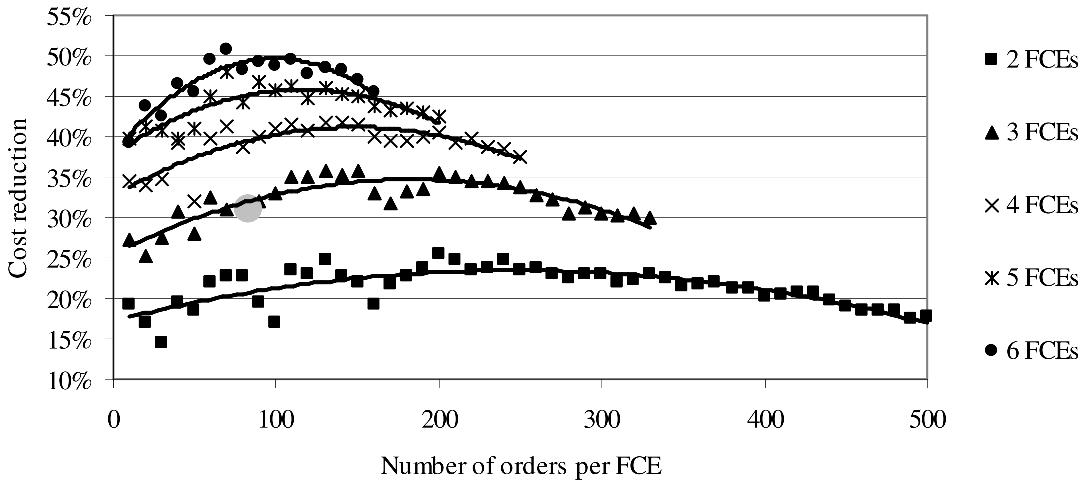


Figure 4-4. Sensitivity: number of orders per FCE

### 4.4.2 Average Order Size

Figure 4-5 depicts the influence of order size on the maximum achievable synergy values. The average demand of the orders is varied by multiplying the size of every order by a factor that is defined per scenario. Fractional demands are rounded to the nearest integer. In the benchmark case, the average demand is 18.82 and the multiplication factor is equal to 1. At the left-most part of Figure 4-5, the factor is 0.1, and capacity restrictions are virtually absent. In this case, time window restrictions are the only restriction in the route construction. With the maximum value however (right-most side of Figure 4-5), even average-sized orders cannot be combined in a single truck, making capacity restrictions most important. In that case the average order size equals 134, and most of the orders are larger than half a truck capacity, rendering opportunities for consolidation in a single truck rare. The interpretation for real world applications is that joint route planning is more profitable in sectors where orders are small (e.g. consumer electronics or fashion), than in sectors where the average order is large (e.g. wood or paper).

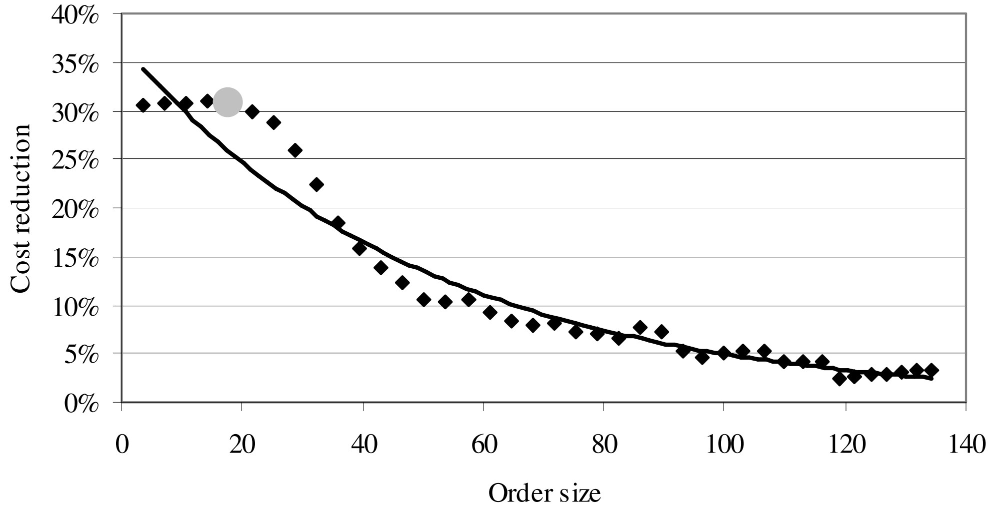


Figure 4-5: Sensitivity: average order size

### 4.4.3 Standard Deviation of Order Size

Figure 4-6 shows the relation between synergy values and the variability in order sizes. The standard deviation of the demand size is adjusted by multiplying an order's deviation from the average order size by a scenario-dependent factor. In this process the minimum order size remains 1, and the maximum order size 200. With the exception of these cut-offs, this standard deviation adjustment leaves the average demand size unaltered. It turns out that there is no apparent relation between order size variability and synergy value. Or, in other words, increased scale is no solution to the operational problems imposed by a strong variability in order sizes.

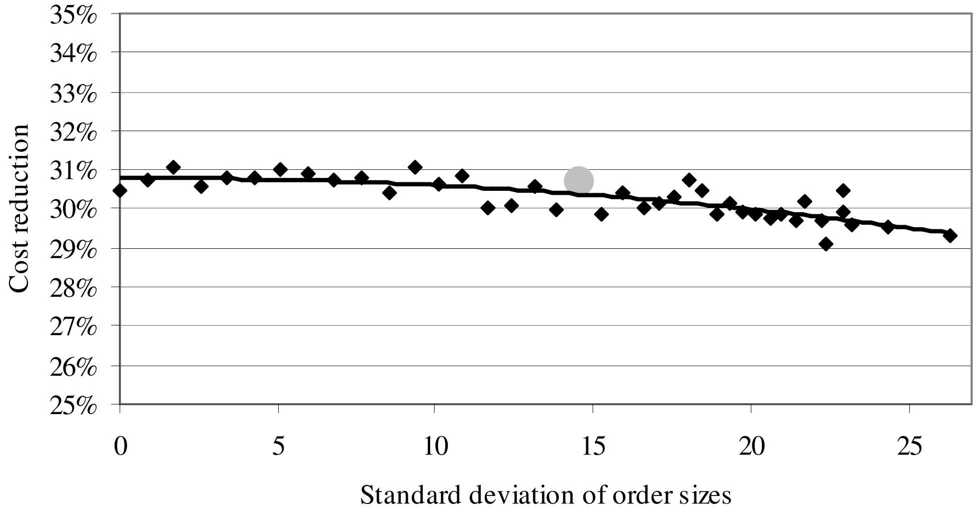


Figure 4-6: Sensitivity: standard deviation of order sizes

### 4.4.4 Time Window Width

In the benchmark case, all time windows have a half-width of 15. In order to study the impact of time window width on the synergy value of joint route planning, the half-width is multiplied by a scenario-dependent factor. For example, a time window of [200, 230] and a factor of 2 result in an adjusted time window of [215-15*2, 215+15*2], or [185,245]. Each time the window is limited however by the earliest and latest possible time at which a truck can leave and enter the depot. Figure 4-7 reveals the results of this sensitivity analysis. It shows that synergy values are highest in a situation with time windows of 'average' width.

The reason for this lies in the fact that if time windows are very narrow there is hardly any flexibility in building the routes and it is thus hard to capitalise on increased economies of scale. On the other hand, if time windows are very wide, the synergy value also tends to decrease. This is because FCEs can already build quite efficient routes individually, because many orders can be combined into a feasible route. This illustrates the strong impact of time window constraints on the solution value for VRPTWs. For example, on the left-most side of the graph, the value of 0 refers to time windows that are in fact single points in time where service at a customer's drop-off location must start. In that case, total distribution costs under joint route planning amount to 55,588.28. If time windows are 'wide' (factor 8; time window width of 240), these costs are only 28,768.55. This means that imposing these strict time windows results in a cost increase of 93.2% in comparison with the case of wide time windows.

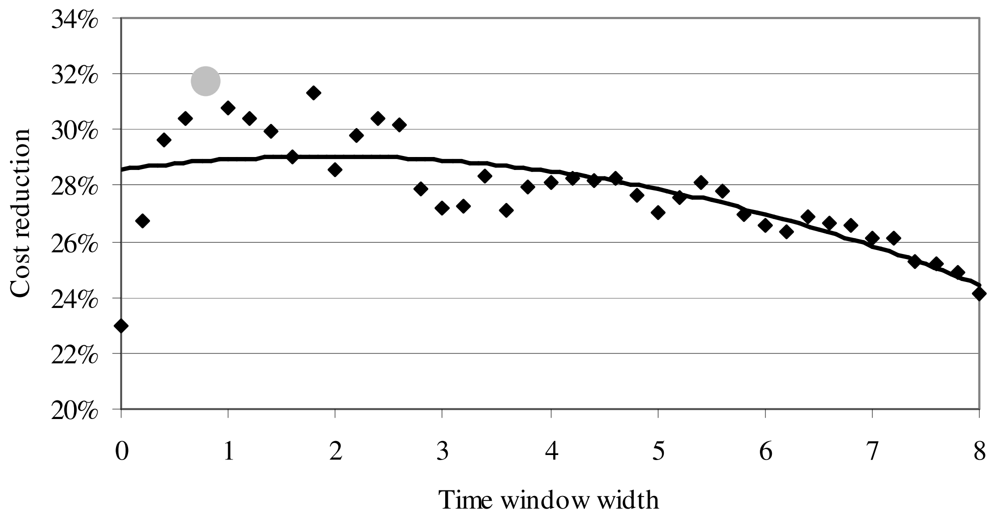


Figure 4-7: Sensitivity: Time window width

### 4.4.5 Size of Distribution Area

The sixth characteristic that potentially influences the level of synergy is the size of the distribution area, since this has direct consequences for the average distance between drop-off locations. To vary the size of the distribution area, the distance of each drop-off location from the depot is multiplied by a scenario-defined factor, and its position relocated on the line that starts at the depot site and crosses the customer's former position. For example, with a factor of 0.5, a customer that was located at coordinates $[300,150]$ in the benchmark scenario, is relocated to: $[250+(300-250)*0.5, 250+(150-250)*0.5]=[275, 200]$.

The results in Figure 4-8 show that the synergy value gradually increases as the average distance between customers increases. This suggests that joint route planning is more profitable in sectors where customers are located across a large region (e.g. Europe), than it is in sectors where customers are located quite close to each other (e.g. regional distribution).

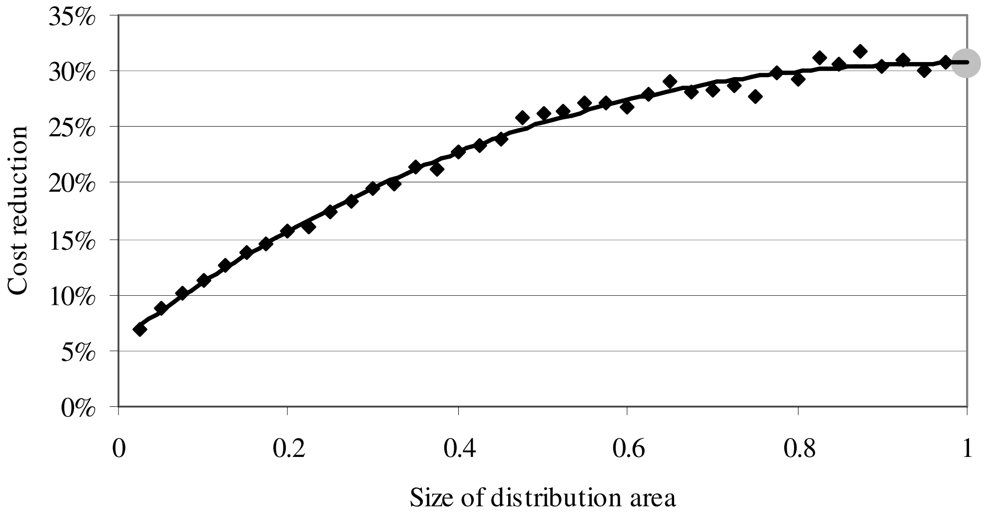


Figure 4-8: Sensitivity: size of distribution area

### 4.4.6 Market Shares of FCEs

The last characteristic that is varied in order to study its impact on the synergy value is the distribution of market shares over the three FCEs present in the benchmark scenario. The market concentration is determined by the Gini coefficient. Although this measure originates from social welfare theory, it can be straightforwardly applied to describe the inequality of market shares of FCEs in the setting of joint route planning. The Gini coefficient is defined as:

$$G = \frac{\sum_{i=1}^{n} x_i \left(2i - n - 1\right)}{n\left(n-1\right)x} \tag{4.5}$$

In (4.5), $x_i$ is the market share of FCE i, and $x$ is the average market share. Without loss of generality, it is assumed that the market share of FCE *i* is smaller than the market share of FCE *j*, if $i < j$. More specifically, $x_i = \beta x_{i-1}$, and $\beta > 1$. Under these conditions and $\sum_{i=1}^{n} x_i = 1$, it is possible to choose the Gini coefficient for the benchmark scenario with three FCEs and construct uniquely defined market shares by means of the following:

$$\beta = \frac{-G - \sqrt{4 - 3G^2}}{2G - 2} \tag{4.6}$$

$$x_1 = \frac{G\sum_{i=1}^{3} x_i}{\beta^2 - 1} \tag{4.7}$$

$$x_2 = \beta x_1 \tag{4.8}$$

$$x_3 = \beta^2 x_1 \tag{4.9}$$

If the Gini coefficient is at the benchmark level of 0, there is perfect equality of market shares and the order set is distributed evenly over the FCEs. On the other hand, a Gini coefficient of 1 indicates that the total market is in the hands of only one FCE. Figure 4-9 shows that the synergy value decreases if the total order set is divided less evenly over the participating FCEs. This is explained by the fact that in a strongly concentrated market, the leading FCE will be able to construct efficient routes, even without joint route planning.


Figure 4-9: Sensitivity: Market concentration in terms of Gini coefficient

## 4.5 CONCLUDING REMARKS

In this chapter the concept of joint route planning is discussed. Joint route planning can essentially be achieved in two ways: outsourcing or horizontal cooperation. The goal of both concepts is to attain larger economies of scale that help to cut down distribution costs. For example, in the benchmark scenario described in Section 4.2.2, the savings as a result of joint route planning are considerable: 30.7% of total distribution costs. Sensitivity analyses were conducted to gain insight into the main drivers for synergy, and how these affect the synergy value. The results indicate that joint route planning is most beneficial in situations where there are a large number of FCEs of a uniform and not too large size. Furthermore, the synergy value increases if order sizes are small compared to a standard truck's capacity, time windows are narrow, and inter-customer distances are large. Finally, the variation in order sizes does not seem to play an important role. The results are easily interpreted and can be used by practitioners to develop intuition on synergy value, should there be no time or budget to go through all the calculations. This intuition allows for a rapid determination as to whether a group of FCEs has a strong synergy potential.

For this analysis a basic distribution setting was chosen. Further research is needed to understand the impact of joint route planning in more complex distribution systems. It would be useful to perform an investigation into how the results of the analysis are influenced by the introduction of e.g. multiple depots or pick up and delivery orders.

This finishes the introductory part of this thesis. In PART II, empirical research on horizontal cooperation in transport and logistics will be discussed.

# PART II EMPIRICAL RESEARCH

*The second part of this thesis focuses on the potential of horizontal cooperation in practice. This is measured by mapping the attitudes of Logistics Service Providers towards the opportunities and impediments for horizontal cooperation. The analysis is based on two questionnaire surveys held in Flanders and the Netherlands. Furthermore, by linking the questionnaire results to financial data of the responding companies, assessments are made about the impact of horizontal cooperation on for example company profitability. At the end of PART II, the relevance of the topic for the logistics industry will be clear. In addition, statements will be made about the differences and resemblances in the attitudes of Flemish and Dutch Logistics Service Providers towards horizontal cooperation. The resemblances serve as the starting point for the formulation of more general, non-regionally restricted statements about horizontal cooperation in transport and logistics.*

# CHAPTER 5 OPPORTUNITIES AND IMPEDIMENTS

## 5.1 INTRODUCTION

This chapter describes the first large scale empirical study on the potential benefits of horizontal cooperation in logistics, as well as on the major impediments for starting and maintaining logistics cooperations in practice. The views of Logistics Service Providers (LSPs) on these issues are tested by means of a number of propositions that are formulated based on the opportunities and impediments for horizontal cooperation identified in Sections 2.3 and 2.4 and also on eleven in-depth interviews (see Section 5.3.1) with knowledgeable Flemish LSPs. Not all opportunities and impediments that arose from the literature study in Chapter 2 are incorporated in the propositions of this chapter for two reasons. Firstly, not all of them have an unambiguous interpretation for logistics practitioners responding to a questionnaire on horizontal cooperation. For example, the development of new products is not a likely goal of horizontal cooperation between LSPs. Secondly, to safeguard an acceptable response rate, it was necessary to keep the questionnaire short and to focus on only those opportunities and impediments that are most relevant to horizontal cooperations between LSPs. The relevance of the propositions was cross-checked by means of some preparatory interviews with industry experts.

The remainder of the chapter is structured as follows. In Section 5.2 the research propositions are formulated for surveying a large sample of LSPs in Flanders, the main logistics region in Belgium. The survey itself is discussed in Section 5.3. Section 5.4 then reports on the results of a factor analytical study based on the gathered data. Section 5.5 concludes with the main results of this chapter and identifies directions for further research.

## 5.2 RESEARCH PROPOSITIONS

This section describes the research propositions regarding opportunities and impediments for horizontal cooperation, as presented to a large number of managing directors of LSPs.

### 5.2.1 Opportunities

Bartlett and Ghoshal (2004) mention three high-level ways in which companies can benefit from cooperation. They can do so by i) pooling their resources and concentrating on core-activities, by ii) sharing and leveraging the specific strengths and capabilities of the other participating firms, and by iii) trading different or complementary resources to achieve mutual gains and eliminate the high cost of duplication. Kogut (1988) summarises the advantages of cooperation in terms of reducing the transaction costs resulting from small number bargaining, enhancing the competitive position of the partners, and fulfilling the partner's quest for organizational knowledge and learning. For a complete overview of the potential opportunities of horizontal cooperation, we refer to Section 2.3. The seven specific propositions formulated based on this overview are subdivided in three groups: Costs and productivity, Customer Service and Market position. They are summarised in Table 5-1.

| Code | Proposition |
|---|---|
| *Costs and Productivity* | |
| O1 | Horizontal cooperation increases the company's productivity for core activities, e.g. decrease in empty hauling, better usage of storage facilities etc. |
| O2 | Horizontal cooperation reduces the costs of non-core activities, e.g. organizing safety trainings, joint fuel facilities, etc. |
| O3 | Horizontal cooperation reduces purchasing costs, e.g. trucks, onboard computers, fuel etc. |
| *Customer Service* | |
| O4 | LSPs can specialise while at the same time broadening their services. |
| O5 | LSPs can offer better quality of service at lower costs, e.g. in terms of speed, frequency of deliveries, geographical coverage, reliability of delivery times etc. |
| *Market Position* | |
| O6 | Horizontal cooperation enables individual LSPs to tender with large shippers on larger contracts. |
| O7 | Horizontal cooperation helps to protect the company's market share. |

Table 5-1: Propositions about opportunities of horizontal cooperation

### 5.2.2 Impediments

When compared to the possible opportunities, literature pays little attention to the burdens and dark sides of logistics cooperation (Zineldin and Bredenlöw, 2003). Horizontal cooperation is often an uncertain undertaking in which it is difficult to plan the required activities or measure the realised output. Therefore, having a trustworthy relationship is vital (Van der Meer-Kooistra and Vosselman, 2000; Tomkins, 2001). A typical source of relational risk is opportunistic behaviour of the partners i.e., actions by a partner that do not comply with the spirit of the cooperation (Williamson, 1985; Das and Teng, 1998). A more elaborate list of impediments can be found in Section 2.4. Here, nine specific propositions are developed relating to impediments for horizontal cooperation between LSPs in four areas: Partner selection, Determining and dividing the gains, Unequal negotiation positions of partners, and Information and Communication Technology. Table 5-2 presents these nine propositions.

| Code | Proposition |
|---|---|
| *Partner Selection* | |
| I1 | It is hard to find commensurable LSPs with whom it is possible to cooperate for (non-)core activities. |
| I2 | It is hard to find a reliable party that can coordinate the cooperation in such a way that all participants are satisfied. |
| *Determining and Dividing the Gains* | |
| I3 | It is hard for the partners to determine the benefits or operational savings of horizontal cooperation beforehand. |
| I4 | Partners find it hard to ensure a fair allocation of the shared workload in advance. |
| I5 | A fair allocation of benefits to all the partners is essential for a successful cooperation. |
| *Unequal Negotiation Positions of Partners* | |
| I6 | When an LSP cooperates with commensurable companies, it becomes harder to distinguish itself. |
| I7 | Over time smaller companies in the cooperation may lose customers or get pushed out of the market completely. |
| I8 | When benefits cannot be shared in a perceived fair way, the larger players will always benefit most. |
| *Information and Communication Technology (ICT)* | |
| I9 | Cooperation is greatly hampered by the required indispensable ICT-investments. |

Table 5-2: Propositions about impediments to horizontal cooperation

This chapter aims at linking characteristics of logistics companies to their attitudes towards the proposed opportunities and impediments for horizontal cooperation. Since this is the first time propositions on this subject are submitted to a large set of LSPs, exploratory factor analysis is used to identify not directly observable factors within the sets of propositions on opportunities or impediments. Based on the resulting factors, a number of hypotheses are developed. The results of the factor analysis and a number of hypotheses are presented in detail in Section 5.4.

## 5.3 THE SURVEY

A questionnaire with the 16 propositions on horizontal cooperation was submitted to a sample of Flemish LSPs. This questionnaire can be consulted online (see E.R. 33).

Respondents were asked to evaluate each proposition by choosing one of the following options: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, (5) strongly agree. This section provides detailed information on the composition of the sample, the questionnaire, the respondents, and the in-depth interviews that were conducted to complement the survey.

### 5.3.1 Questionnaire and Interviews

After fine-tuning the questionnaire by means of five pilot interviews, a personalised questionnaire was sent to 1,537 Flemish LSPs. The survey was sent out on March 12th, 2004, and to increase the response rate a reminder was sent out after one week. Completed questionnaires came in between March 15th and April 14th 2004. In total, 162 useful questionnaires were returned.

Eleven in-depth interviews were then conducted to cross-check and fine-tune the findings from the survey. Companies for these in-depth interviews were selected from the set of respondents. These companies were selected based on their clear answers to the open questions in the questionnaire. Besides, it was made sure that the in-depth interviews took place across multiple sectors. A list of the interviewed companies (either for a pilot interview or an in-depth interview) can be found via E.R. 33.

### 5.3.2 Sample and Response

The BelFirst database (E.R. 2), containing the annual reports of 250,000 companies in Belgium, was used to construct a representative sample of around 1,500 LSPs. The sample included LSPs with the following five NaceBel main activity codes: Freight transport by road, Inland water transport, Cargo handling and storage, Freight forwarding and Courier activities other than national post activities. In the remainder of this chapter, the latter category will be referred to as ’express carriers’.

Kumar et al. (1993) provide suggestions on selecting key informants. To limit the workload for the often small sized logistics companies in the sample, it was decided to select a single key informant. To ensure that each respondent was sufficiently knowledgeable and that responses were not tainted by informant bias, the questionnaire was personalised by addressing the managing director by name for each selected company.

Table 5-3 summarises both the structure of the sample and the response rate. For each cell in the table, the first number refers to the number of companies in the sample and the second to the number of LSPs in the BelFirst database. The sample size was pre-set to approximately 1,500. 25% of the questionnaires were sent to large companies and 75% to small and medium sized companies. This ensures a sufficient representation of the larger companies in view of their economic importance and at the same time offers the possibility to thoroughly survey small and medium sized LSPs. To limit the risk of a zero response rate in the smallest categories, questionnaires were sent to all companies in a category with no more than ten companies, resulting in a total of 1,537 LSPs.

Cases in which questionnaires were returned because the address was unknown, or returned blank because the company stopped its activities, are reported in column 8 (‘invalid’). These respondents were removed from the sample to calculate the net response rates presented in column

10 in Table 5-3. Unfortunately, low response rates of about 10% have become exemplary for large-scale mail surveys (see e.g. Wisner, 2003). Note however, that the true response rates may be somewhat higher because not all companies that ceased to exist can be expected to return the questionnaire.

| **NaceBel main activity** | **0-4** | **5-19** | **20-49** | **50-99** | **100+** | | **Invalid** | **#Resp.** | **Response rate** |
|---|---|---|---|---|---|---|---|---|---|
| *Freight transport by road* | 607 (2,258) | 261 (888) | 132 (374) | 40 (79) | 21 (37) | 1,061 (3,636) | 21 | 124 | 12% |
| *Inland water transport* | 40 (126) | 9 (10) | 3 (3) | 0 (0) | 0 (0) | 52 (139) | 1 | 6 | 12% |
| *Cargo handling and storage* | 92 (286) | 55 (142) | 29 (51) | 15 (25) | 12 (19) | 203 (523) | 3 | 16 | 8% |
| *Freight forwarding* | 58 (187) | 33 (92) | 27 (44) | 14 (15) | 10 (12) | 142 (350) | 7 | 7 | 5% |
| *Express carriers* | 61 (232) | 10 (18) | 6 (6) | 0 (0) | 2 (2) | 79 (258) | 2 | 9 | 11% |
| | | | | | Total | 1,537 (4,906) | 34 | 162 | 11% |

Table 5-3. Response rate and sample composition

The net response rate is highest for companies that are mainly active in road transport, inland water transport and express. The small number of respondents for the activities Inland water transport (6 respondents) and express carriers (9 respondents) however limit the representativeness of the results for these categories. The low response for the Freight forwarders could be due to a low interest in horizontal cooperation. The in-depth interviews (see Section 5.3.1) revealed that these LSPs prefer vertical cooperation. Horizontal cooperation, e.g. by exchanging loads, is sometimes perceived as a threat to existing forwarding activities. The response rate for the LSPs in the category Cargo handling and storage is higher than the response rate for the freight forwarders, but is still quite low (8%).

It was checked whether there exist significant differences between the characteristics of the LSPs that responded to the survey and those who did not, because a systematic difference would compromise the generalisability of the results (Flynn et al., 1990). The reliability of the data is therefore tested in two ways. First, the respondents are compared to non-respondents based on two characteristics: number of employees in full time equivalents and type of annual report (contracted or complete). T-tests did not show any significant difference between the two groups of LSPs. Second, because a reminder was sent out, the potential non-response bias is assessed by comparing early versus late respondents. Respondents are considered late if their form was received later than March 23rd 2004, since this was the indicated end-date for the respondents to return their questionnaires. Again, t-tests did not show any statistically significant difference between the early and late respondents, both with respect to their evaluation of the propositions and their company characteristics. Based on the above it can be concluded that non-response bias is not a serious concern for the analysis in Section 5.4.

## 5.4 ANALYSIS AND FINDINGS

Table 5-4 provides an overview of the respondents' evaluations of the propositions on opportunities and impediments for horizontal cooperation. Note that the propositions in Dutch (see E.R. 33) are formulated in such a way that the respondents evaluate the opportunities and impediments for horizontal cooperation *in their own company*, rather than for the potential of the concept in general.

The numbers suggest that the propositions on the potential benefits of horizontal cooperation are well supported by the respondents. For each proposition, the percentage of respondents that agrees is considerably higher than the percentage that disagrees. This observation also holds for the propositions on impediments for cooperation.

| Code | Mean | Standard Deviation | No. of Obs. (1-5) | Missing (%) | Strongly disagree/ Disagree (%) | Neutral (%) | Strongly agree/ Agree (%) |
|---|---|---|---|---|---|---|---|
| O1 | 4.17 | 0.99 | 152 | 6.2 | 4.9 | 13.0 | 75.9 |
| O2 | 3.65 | 1.00 | 152 | 6.2 | 8.0 | 33.3 | 52.5 |
| O3 | 3.42 | 1.13 | 152 | 6.2 | 16.7 | 35.2 | 42.0 |
| O4 | 3.74 | 1.08 | 152 | 6.2 | 9.9 | 25.3 | 58.6 |
| O5 | 3.56 | 1.10 | 151 | 6.8 | 10.5 | 34.0 | 48.8 |
| O6 | 3.60 | 1.12 | 152 | 6.2 | 13.6 | 29.0 | 51.2 |
| O7 | 3.24 | 1.08 | 152 | 6.2 | 19.1 | 41.4 | 33.3 |
| I1 | 3.84 | 0.96 | 155 | 4.3 | 8.0 | 21.6 | 66.0 |
| I2 | 4.00 | 0.87 | 154 | 4.9 | 5.6 | 17.3 | 72.2 |
| I3 | 3.54 | 0.89 | 153 | 5.6 | 13.0 | 27.8 | 53.7 |
| I4 | 3.73 | 0.89 | 154 | 4.9 | 8.6 | 21.6 | 64.8 |
| I5 | 4.11 | 0.84 | 154 | 4.9 | 3.7 | 15.4 | 75.9 |
| I6 | 3.52 | 0.90 | 153 | 5.6 | 13.6 | 27.2 | 53.7 |
| I7 | 3.95 | 1.01 | 154 | 4.9 | 8.6 | 21.0 | 65.4 |
| I8 | 3.60 | 1.19 | 155 | 4.3 | 19.1 | 20.4 | 56.2 |
| I9 | 3.43 | 0.97 | 154 | 4.9 | 14.2 | 38.9 | 42.0 |

Table 5-4: Evaluations of propositions on opportunities and impediments

The numbers in Table 5-4 indicate that the most supported opportunity of cooperation is the possible increase in a company's productivity on its core activities (O1). More than 75% of the respondents of the survey agrees with proposition O1, while less than 5% disagrees. The in-depth interviews revealed that decreases in empty mileage, better usage of storage facilities and increased load factors are the most common examples.

A large share of the respondents is neutral about the proposition that horizontal cooperation helps to protect market share (O7). Both the in-depth interviews and the literature (Becker et al., 2004) affirmed that shippers do not expect LSPs to cooperate to provide them with a full service concept. Cooperation between LSPs is only encouraged if it brings the shippers significant cost reductions and as long as it does not jeopardise their negotiating position. This, together with the neutral evaluation of proposition O7, suggests that horizontal cooperation in logistics should be regarded as a means for LSPs to increase their productivity, rather than as a reaction to requests from the demand side.

According to the respondents the most severe impediments for cooperation are the problems of finding a reliable party that can coordinate the cooperation in such a way that all participants are satisfied (I2) and the construction of fair allocation mechanisms for the attained savings (I5). The in-depth interviews revealed that LSPs can reduce or circumvent the latter problem in a pragmatic way. In the case of an (informal) freight exchange between road transport companies for example, the company that submits a transport order to the exchange could charge a commission to compensate for its efforts in acquiring the order. If none of the other partners in the cooperation decides to accept the order, the company that submitted the order in the pool has to fulfil the order itself. In this way, difficult issues on the determination and distribution of the savings generated within the cooperation can be avoided. Although this pragmatic solution sometimes works out in practice, it can be considered a little opportunistic. More consistent gain sharing methods will be discussed in Chapter 9 and Chapter 10.

The impediment that received the least support concerns the required ICT-investments (I9). The in-depth interviews affirmed that ICT costs are only an issue for cooperations of a medium size and intensity. The administrative burden of handling the transactions of the cooperation may be too large to handle by phone or fax, but cannot justify investments in an Electronic Data Interchange (EDI) system or a sophisticated web-based exchange system because the cooperation lacks the critical mass.

### 5.4.1 Factor Analysis

This section describes how exploratory factor analysis is used to investigate whether the reactions to the sets of propositions on opportunities and impediments can be summarised in a smaller number of not directly observable factors. The principal components method is used to extract factors, and the varimax method is applied to rotate the component matrix in order to facilitate its interpretation. The Kaiser-Meyer-Olkin measure (Kaiser and Cerny, 1977) is used to evaluate the fit of the model. The resulting measure of sampling adequacy is 0.804, which indicates that the use of factor analysis on this dataset is appropriate.

Three principal components with eigenvalues larger than one can be extracted that together account for 57.2% of the variance in the data. The first factor comprises all seven proposed opportunities of horizontal cooperation and is therefore called Opportunities. The second factor is classified as Partner Selection Impediments and consists of the propositions I1 and I2. The third factor, Other Impediments, contains the seven remaining propositions on impediments for horizontal cooperation. The results of the analysis are reported in Table 5-5. Unidimensionality of the three factors has been cross-checked and affirmed by subjecting each factor to a separate exploratory factor analysis.

| | | **Factor Loadings** | | |
|---|---|---|---|---|
| **Factor (% of Var.)** | **Propositions** | **Factor 1** | **Factor 2** | **Factor 3** |
| Opportunities (24.4%) | O1: Horizontal cooperation increases the company's productivity for core activities, e.g. decrease in empty hauling, better usage of storage facilities etc. | **0.735** | -0.259 | 0.159 |
| | O2: Horizontal cooperation reduces the costs of non-core activities, e.g. organizing safety trainings, joint fuel facilities etc. | **0.769** | -0.086 | 0.061 |
| | O3: Horizontal cooperation reduces purchasing costs, e.g. trucks, onboard computers, fuel etc. | **0.722** | 0.089 | -0.015 |
| | O4: LSPs can specialise while at the same time broadening their services. | **0.787** | 0.170 | -0.063 |
| | O5: Horizontal cooperation enables individual LSPs to tender with large shippers on larger contracts. | **0.727** | 0.102 | -0.037 |
| | O6: LSPs can offer better quality of service at lower costs, e.g. in terms of speed, frequency of deliveries, geographical coverage, reliability of delivery times etc. | **0.766** | 0.057 | 0.002 |
| | O7: Horizontal cooperation helps to protect the company's market share. | **0.531** | 0.391 | -0.047 |
| *Partner Selection Impediments* (11.7%) | I1: It is hard to find commensurable LSPs with whom it is possible to cooperate for (non-)core activities. | 0.056 | **0.818** | 0.225 |
| | I2: It is hard to find a reliable party that can coordinate the cooperation in such a way that all participants are satisfied. | 0.072 | **0.775** | 0.350 |
| *Other Impediments* (21.2%) | I3: It is hard for the partners to determine the benefits or operational savings of horizontal cooperation beforehand. | -0.157 | 0.227 | **0.718** |
| | I4: Partners find it hard to ensure a fair allocation of the shared workload in advance. | 0.061 | -0.039 | **0.705** |
| | I5: A fair allocation of benefits to all the partners is essential for a successful cooperation. | 0.247 | 0.361 | **0.507** |
| | I6: When an LSP cooperates with commensurable companies, it becomes harder to distinguish itself. | -0.248 | 0.275 | **0.569** |
| | I7: Over time smaller companies in the cooperation may lose customers or get pushed out of the market completely. | -0.042 | 0.097 | **0.816** |
| | I8: When benefits cannot be shared in a perceived fair way, the larger players will always benefit most. | -0.036 | 0.230 | **0.706** |
| | I9: Cooperation is greatly hampered by the required indispensable ICT-investments. | 0.263 | 0.010 | **0.650** |

Kaiser-Meyer-Olkin Measure of Sampling Adequacy: 0.804
Bartlett Test of Sphericity: 922.280, Significance: 0.000

Table 5-5: Results of Factor Analysis

### 5.4.2 Hypothesis Testing

This section searches for the elements that determine the LSPs' attitudes towards the three factors that emerged from the above factor analysis. Empirical investigations on the opportunities of horizontal cooperation and on the choice of a suitable partner have been undertaken in a broader context (e.g. Geringer, 1991; Nielsen, 2003; Beckman et al., 2004). These studies have identified a number of company criteria that may influence an LSP's attitude towards cooperation. While most of these studies address vertical cooperation in an international context, a number of criteria that are applicable to both the national and the international context seem to recur. Financial status of the potential partner and its size appeared as two of the most important criteria for partner selection (Nielsen, 2003). Studies focusing on the search for economies of scale and access to technology or markets (Inkpen and Crossan, 1995), the comparison of the firm's market power compared to industry leaders (Hamel et al., 1989) and the initial strengths and weaknesses of the partners (Bleeke and Ernst, 1995) confirm that financial status and size of the partners is relevant. The NaceBel database (E.R. 18) contains information on both characteristics, enabling the use of these data to assess their relation with the evaluations of the three factors by the respondents.

In addition, whether firms already cooperate and how long they have been working with each other is also stressed as an influential factor in the literature (e.g. Heide and John, 1990). Consequently, the effect of existing cooperation on the respondents' assessment of opportunities, partner selection impediments and other impediments is examined.

For the value added and gross return on assets, the most recent year (2002) for which all respondents deposited their annual reports was used. In order to find significant relations between the developed factors and the company characteristics, three regression equations were constructed. In these equations, the three factors have been regressed on the explanatory variables cooperation, size and profitability:

$$\textit{Opportunities} = \beta_{11}\textit{Cooperation} + \beta_{12}\textit{Size} + \beta_{13}\textit{Profitability} \quad (5.1)$$

$$\textit{Partner Selection Impediments} = \beta_{21}\textit{Cooperation} + \beta_{22}\textit{Size} + \beta_{23}\textit{Profitability} \quad (5.2)$$

$$\textit{Other Impediments} = \beta_{31}\textit{Cooperation} + \beta_{32}\textit{Size} + \beta_{33}\textit{Profitability} \quad (5.3)$$

The remainder of this section discusses hypotheses for each coefficient in the above regression equations. Table 5-6 summarises the formulation of these hypotheses and provides the corresponding results. All hypotheses are tested at the 5% significance level.

| | | | | Standardised coef. | Significance | Result |
|---|---|---|---|---|---|---|
| *Opportunities Hypotheses* | | | | | | |
| H1 | EQ1 | Cooperation does not influence the attitude of respondents towards opportunities. | $\beta_{11}$ | 0.108 | 0.193 | Supported |
| H2 | | Size does not influence the attitude of respondents towards opportunities. | $\beta_{12}$ | 0.084 | 0.308 | Supported |
| H3 | | Profitability does not influence the attitude of respondents towards opportunities. | $\beta_{13}$ | -0.237 | 0.004 | Rejected |
| *Partner Selection Impediments Hypotheses* | | | | | | |
| H4 | EQ2 | Cooperation does not influence the attitude of respondents towards partner selection impediments. | $\beta_{21}$ | -0.138 | 0.103 | Supported |
| H5 | | Size does not influence the attitude of respondents towards partner selection impediments. | $\beta_{22}$ | -0.052 | 0.532 | Supported |
| H6 | | Profitability does not influence the attitude of respondents towards partner selection impediments. | $\beta_{23}$ | -0.216 | 0.010 | Rejected |
| *Other Impediments Hypotheses* | | | | | | |
| H7 | EQ3 | Cooperation does not influence the attitude of respondents towards other impediments. | $\beta_{31}$ | -0.067 | 0.437 | Supported |
| H8 | | Size does not influence the attitude of respondents towards other impediments. | $\beta_{32}$ | -0.115 | 0.182 | Supported |
| H9 | | Profitability does not influence the attitude of respondents towards other impediments. | $\beta_{33}$ | -0.011 | 0.898 | Supported |

Table 5-6: Overview of hypotheses and results

***Opportunities Hypotheses***

Hypothesis (H1) states that cooperation does not influence the attitude of the respondents towards opportunities, or in other words: cooperators and non-cooperators value the opportunities offered by horizontal cooperation equally. This hypothesis is supported by the data ($\beta_{11}$: 0.108, significance: 0.193), which indicates that the opportunities expected by the non-cooperators seem to be experienced in practice by the cooperators. This, together with the high average scores of the propositions about opportunities, illustrates the strong potential of horizontal cooperation for LSPs.

The hypothesis stating that size does not influence opportunities (H2) was supported ($\beta_{12}$: 0.084, significance: 0.308). Prior to the analysis, size was expected to affect opportunities in two ways. Since smaller companies have smaller economies of scale and can thus operate less efficiently individually, they could benefit from forming a coalition in order to compete more effectively with larger companies. Therefore size would have a negative relation with opportunities. On the other hand, small companies are likely to operate on market niches where cooperation with other LSPs is not possible or desirable. In contrast to these smaller companies, larger LSPs generally offer a broader service range and have a larger customer base so that they can more easily select suitable activities on which cooperation might be profitable. This argument would in turn predict a positive relation between size and opportunities. Testing the hypothesis shows that these opposite effects might cancel out to result in an insignificant coefficient.

H3 states that profitability does not influence the attitude of firms towards opportunities. This hypothesis is rejected by the survey data ($\beta_{13}$: -0.237, significance: 0.004). A possible explanation of the observed negative relation is that the more profitable an individual company is, the less inclined he is to cooperate with competitors. At the other end of the spectrum, for low-profit or unprofitable LSPs, cooperation can be a surviving strategy to increase efficiency and improve financial results.

***Partner Selection Impediments Hypotheses***

H4 states that cooperation does not influence partner selection impediments. This hypothesis was supported ($\beta_{21}$: -0.138, significance: 0.103). In other words, there is no evidence that cooperators perceive the problems with finding partners differently than non-cooperators do. A priori, the expectation was that cooperators would encounter fewer problems in finding partners than non-cooperators do. This expectation is however not supported by the data. In the survey, respondents were also asked whether it would be better to have an independent third party coordinating the partnership. Table 5-7 shows that the majority of the respondents do not consider independent parties the most adequate candidates to lead and coordinate a cooperation. This suggests that there is little demand for non-asset based Fourth Party Logistics parties or consultants to start up or coordinate horizontal cooperation.

| | **“YES”** | **“NO”** |
|---|---|---|
| *Frequency* | 17 | 50 |
| *Additional remarks* | Provided that the coordinator carries responsibility.<br>A third party can be useful in bringing parties together and exploring the possibilities of a cooperation. | It is preferable to remain in complete control.<br>The third party introduces extra costs.<br>One of the participants should coordinate the cooperation. |

Table 5-7: Is it preferable that a third independent party coordinates the cooperation?

H5 states that size does not influence the way LSPs think of impediments related to partner selection. This hypothesis was supported ($\beta_{22}$: -0.052, significance: 0.532). In advance, it was expected that large LSPs would not be favoured partners for smaller LSPs, because larger firms could misuse their greater economic strength.

H6 states that profitability does not influence partner selection impediments. This hypothesis is rejected at the 5% level ($\beta_{23}$: -0.216, significance: 0.010). The interpretation of the observed negative relation is that very profitable companies experience fewer difficulties in finding partners than less profitable LSPs. An explanation might be that profitable LSPs have more to offer in terms of learning effects and stability of the relationship. Moreover, they generally have a financial buffer to overcome the required initial investment of time and money to start an intensive cooperation. This increases the probability that the cooperation will last and investments are not in vain.

***Other Impediments Hypotheses***

H7 states that cooperation does not influence the view of LSPs on other impediments. This hypothesis was supported by the data ($\beta_{31}$: -0.067, significance: 0.437), suggesting that cooperators and non-cooperators evaluate the other (i.e., non-partner selection) impediments alike. Stated differently, this seems to suggest that the impediments expected by the non-cooperators are in fact experienced by the cooperators. In the questionnaire, respondents were asked to report on additional impediments encountered in practice for structural, long-term cooperation. The answers - as well as the number of respondents providing this answer - are given in Table 5-8. The fact that 14 respondents consider the small size of their company to be an impediment for cooperation puts the conclusions under hypothesis 5 into perspective. These small-sized LSPs (one or two full time equivalent employees) indicate that they either lack the business connections to set up a cooperation or have a small number of customers that fill their capacity entirely.

| **Explanation** | **Frequency** |
|---|---|
| Our company is too small. | 14 |
| Incidental cooperation is OK, but structural cooperation is not desirable because of competition considerations. | 6 |
| Agreements are not complied with in a cooperation. | 5 |
| Competition prohibits cooperation. | 4 |
| We are interested in joining a cooperation, but the Flemish logistics sector lacks the broad vision that is necessary to start such initiatives. | 4 |
| Our company offers services that are too specialised. | 4 |
| We do not yet cooperate horizontally, but we are looking for partners. | 2 |
| Cooperation is impossible in the Flemish logistics sector. | 2 |
| We have not thought about it yet. | 2 |
| Other (lack of top-level and government support, strict customer requirements) | 5 |

Table 5-8: Additional impediments to cooperation

H8 states that company size does not impact other impediments. This hypothesis was supported ($\beta_{32}$: -0.115, significance: 0.182), indicating that there are no significant differences in the way cooperators and non-cooperators evaluate the proposed impediments.

H9 states that profitability does not influence other impediments. This hypothesis was supported ($\beta_{33}$: -0.011, significance: 0.898), which suggests that profitability of an LSP does not help to avoid or overcome the other impediments for cooperation.

## 5.5 CONCLUDING REMARKS

To assess potential benefits of horizontal cooperation between LSPs and the main impediments to its implementation, 1,537 LSPs were contacted in Flanders, Belgium. Together with the Netherlands, Flanders is the centre of gravity of logistics services in Europe, hosting the vast majority of European Distribution Centres. Although this study is exploratory in nature, the survey results provide the logistics sector with some important insights into horizontal cooperation.

The opportunities of horizontal cooperation, introduced in Chapter 2 and further developed into specific propositions in Section 5.2, are widely supported across the Flemish logistics sector. The evaluations show a positive agree/disagree balance for all seven proposed opportunities. O1 ("Horizontal cooperation increases the company's productivity for core activities") receives the strongest support. In particular, it receives more approval than O2 ("Horizontal cooperation reduces the costs of non-core activities"). It can be concluded that cooperation on core activities, although it involves the exchange of customer information, is considered to be more desirable than cooperation on non-core activities because of the higher cost savings potential. Apart from cost and productivity opportunities, the strong support for O4 ("LSPs can specialise while at the same time broadening their services") leads to the conclusion that respondents consider horizontal cooperation to be an interesting possibility for increasing their customer service. The broad support by all respondents for the propositions on opportunities is however negatively related to the profitability of the respondents (Hypothesis 3).

The factor analysis in Section 5.4 subdivided the proposed impediments for horizontal cooperations into two sets: Partner Selection Impediments and Other Impediments. The first set (Partner Selection Impediments) consists of two propositions that are strongly supported by the respondents. Partner choice is vital for the success or failure of cooperations and is well-studied in the organizational science literature, (e.g. Geringer, 1991; Nielsen, 2003; Beckman et al., 2004). The problems with finding suitable partners are less severe for the more profitable respondents (Hypothesis 6). Concerning the other impediments, respondents expect most difficulties from issues relating to bargaining power: I4 ("Partners find it hard to ensure a fair allocation of the shared workload in advance"), I5 ("A fair allocation of benefits to all the partners is essential for a successful cooperation"), I7 ("Over time smaller companies in the cooperation may lose customers or get pushed out of the market completely"), and I8 ("When benefits cannot be shared in a perceived fair way, the larger players will always benefit most"). Potential partners must therefore explicitly take these impediments into account and take actions to overcome them before cooperation starts. Unfortunately, the literature on the distribution of both costs and benefits arising from horizontal cooperation is scarce. To start filling this gap, the gain sharing issue will be revisited in Chapter 9 and Chapter 10.

# CHAPTER 6 EFFICIENCY OF ROAD TRANSPORT COMPANIES

## 6.1 INTRODUCTION

Many logistics companies are facing hard times (see Chapter 1). This chapter will focus on European Road Transport Companies (RTCs) in particular. In the light of this, we will start by taking a closer look at recent trends that are of special importance to RTCs. Low capacity utilisation, significant amounts of empty haulage (although this is not applicable to some markets, e.g. packed goods), declining profit margins, and a negative public image have become symptomatic of the companies over the last years. The main causes for these problems are the fierce competition in the globalizing markets, high fixed costs, rising petrol and labour prices, the proliferation of products with shorter life cycles and the ever-increasing expectations of customers in terms of both service and price. This has caused a strong fragmentation of transport flows, which in turn has led to severe adverse effects on RTCs' business and profitability. Eurostat figures (E.R. 9) show that after an increase in the 1990s, the number of active RTCs has steadily been declining over the last five years in the three largest European economies (see Figure 6-1).

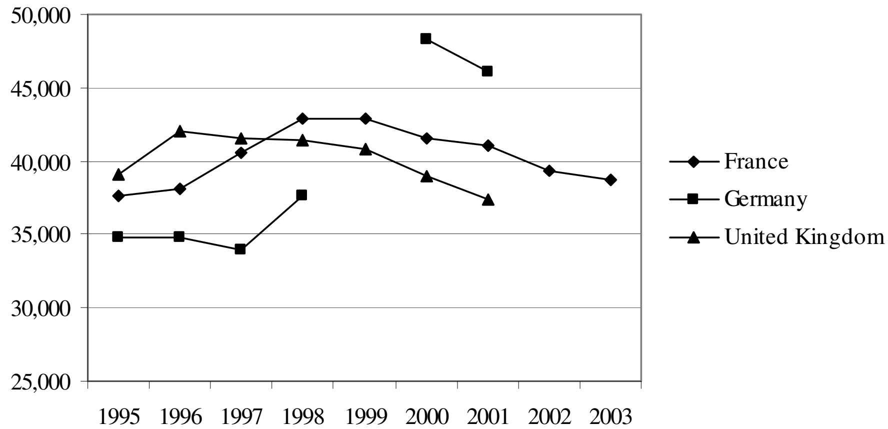


Figure 6-1. Number of RTCs (source: Eurostat, E.R. 9)

Gaining greater insight into the characteristics of those carriers with poor or excellent performance is critical for the long-term competitiveness of the whole sector. This chapter specifically aims at increasing this understanding, and focuses on the potential of horizontal cooperation to improve efficiency and profitability of RTCs. To this end, Data Envelopment Analysis (DEA) is used to test conjectures on efficiency in road transport, based on the survey data described in Chapter 5. The remainder of this chapter is organized as follows. Section 6.2

introduces the conjectures and their rationale. Then Section 6.3 elaborates on the setup of the survey in Flanders and the results. Consequently in Section 6.4, the use of DEA is explained and the results of the DEA are provided in Section 6.5, together with the testing of the conjectures. Finally, Section 6.6 draws the conclusions of this analysis.

## 6.2 RESEARCH QUESTIONS

The first two conjectures relate to the scale at which RTCs operate. It is evident that from an operational point of view, RTCs benefit from a certain level of scale because this enables them to construct efficient (round)trips, reduce inter-drop distances and/or reduce empty mileage. Figure 4-4 in Chapter 4 provides quantitative evidence for this intuition. On the other hand, if companies grow too large, coordination costs may increase disproportionately. Together, these two effects would imply the existence of an 'optimal' size for RTCs. It is hypothesised that in Flanders the sector is too fragmented, i.e., that many RTCs are operating below their optimal size. In 2003 for example, the number of RTCs in Flanders equalled 4,667. With a population of around 6 million people, this means that there is one RTC per 1,285 inhabitants. The following two related conjectures are formulated and tested to gain insight into the optimal firm size:

*C1: Larger companies in Flanders are more efficient.*

*C2: The Belgian transport market is too fragmented.*

Secondly, we are interested in apparent relations between the characteristics, efficiency levels and horizontal cooperation of a firm. It was argued in Chapter 2 that horizontal cooperation is a possible means to improve efficiency of logistics companies such as RTCs. This leads one to expect that RTCs that are in fact engaged in a horizontal cooperation perform better on average than companies that are not.

However, successfully implementing and managing horizontal cooperations is not easy (cf. Verstrepen et al., 2006). A considerable amount of vision, market knowledge, and professionalism is required before a company finds a workable means of cooperating horizontally with potential competitors. It is therefore anticipated that highly inefficient companies have enough trouble managing their own business, and will be less inclined to start up a horizontal cooperation than their more efficient counterparts. Furthermore, we are interested in knowing whether there is a link between the scale of an RTC and horizontal cooperation. This boils down to the following three conjectures:

*C3: Cooperating companies show greater efficiency levels than non-cooperating companies.*
*C4: Companies interested in (intensified) cooperation are more efficient than companies that are not interested.*
*C5: Larger companies cooperate more often than smaller ones.*

Finally, we want to know if the efficiency level of firms has an impact on their attitude towards opportunities of or impediments for horizontal cooperation. If statistically significant relationships are found, these relationships, together with the result of conjecture C4, can tell if horizontal cooperation is primarily a 'defensive' strategy to solve inefficiency problems, or a more 'proactive' strategy to protect the satisfactory current efficiency level of an RTC. To test this, use the following two conjectures are used.
*C6: Less efficient companies value the opportunities of cooperation higher than more efficient companies do.*
*C7: Inefficient companies consider the impediments for horizontal cooperation to be more severe than less efficient firms do.*

## 6.3 THE SURVEY

This study builds upon the results of the survey discussed in Chapter 5. This section briefly elaborates on some results of the survey that are of special importance for the goals of the current chapter. Furthermore, it is explained why certain respondents were excluded from the DEA.

### 6.3.1 Sample Selection and Respondents

The survey included LSPs in the categories freight transport by road, inland water transport, cargo handling and storage, courier activities other than national post activities and freight forwarding. With a few exceptions, see the National Bank of Belgium website (E.R. 35) for details, all Belgian companies are obliged to publish their annual accounts. Whereas large companies must submit a 'complete' annual account, small and medium-sized companies are permitted to submit a short or 'contracted' annual account. A 'large' company is defined as a company that either on average employs more than 100 people during a specific year or exceeds at least one of the following three criteria:

- Average number of employees of 50
- Annual turnover (excluding Value Added Tax) of € 7,300,000.
- Value of total assets of € 3,650,000

The selection of the sample was based on the annual accounts of 2002, which was the most recent year for which all reports had been submitted at the time of the survey (for the setup of the sample and the response, see Table 5-3). Because the sample contained five different types of companies that are generally active in disjunctive markets, it is not possible to objectively compare their efficiency levels. Therefore one focus category is chosen: freight transport by road. With a market share of 75% of the total freight transport volume (Eurostat, E.R. 9), this transport mode is dominant in Flanders. Restricting the analysis to road freight transport respondents reduces the size of the sample to 118.

To calculate company efficiency levels, data on their input and output levels are needed. Due to the fact that information on inputs and output levels are considered confidential by many LSPs, the danger exists that including these questions in the questionnaire would significantly reduce the response rate. Therefore, information is collected on total assets and total hours worked (inputs) and added value and profit or loss (outputs) from the BelFirst database. Since the companies completed the questionnaires in 2004, the most recent input/output data that were available at the time of the analysis are used. These were the data of 2003. Of the 118 responding RTCs however, seven appearing in the 2002 edition did not appear in the BelFirst database of 2003, meaning that they terminated their activities in the period between the survey date and final date on which the 2003 data could have been submitted. These seven companies have been removed from the sample, resulting in a set of 111 companies for which the required financial data are available. Unfortunately, the smallest companies are not obliged by Belgian law to submit a social balance sheet. Since the data on labour input come from these social balance sheets, these companies also have to be removed from the set. After removing these very small companies the sample consists of 83 companies that have filed all relevant data. One extra firm was removed because the total hours worked in that company amounted to only 152 for 2003, which was considered too few for a normally operating company. The next smallest number of hours worked was 1,501, which is close to 1 FTE, so all other responding companies in the set are retained. The final analysis set therefore consists of 82 companies.

### 6.3.2 Short Survey Results

This section provides a summary of the results of the survey that are relevant for the current chapter. More specifically, in order to test conjectures C6 and C7 the respondents' attitudes towards opportunities of and impediments for horizontal cooperation are required. The formulation of these opportunities and impediments can be found in Table 5-1 and Table 5-2.

Table 6-1 indicates that both the propositions on the impediments and on the opportunities of horizontal cooperation are endorsed quite strongly. The most supported opportunity is the possible increase in a company's productivity on its core activities (O1). 79% of the respondents to the survey agreed with this proposition, while only 2% disagreed. The in-depth interviews (see Section

5.3.1) revealed that decreases in empty mileage, better usage of storage facilities and increased load factors are the most common examples. The impediments for cooperation that the respondents consider most prohibitive is the problem of finding a reliable party that can coordinate the cooperation in such a way that all participants are satisfied (I2) and the construction of fair allocation mechanisms for the attained savings (I5).

| **Code** | **Mean** | **Standard deviation** | **#Observ.** | **Missing** | **Str. disagree** | **Disagree** | **Neutral** | **Agree** | **Str. agree** |
|---|---|---|---|---|---|---|---|---|---|
| O1 | 4.26 | 0.83 | 77 | 5 | 1 | 1 | 10 | 30 | 35 |
| O2 | 3.68 | 0.92 | 77 | 5 | 1 | 4 | 31 | 24 | 17 |
| O3 | 3.30 | 1.04 | 77 | 5 | 3 | 11 | 36 | 14 | 13 |
| O4 | 3.71 | 1.05 | 77 | 5 | 4 | 4 | 20 | 31 | 18 |
| O5 | 3.55 | 1.02 | 76 | 6 | 5 | 1 | 31 | 25 | 14 |
| O6 | 3.57 | 1.16 | 77 | 5 | 4 | 9 | 24 | 19 | 21 |
| O7 | 3.29 | 1.06 | 77 | 5 | 3 | 14 | 30 | 18 | 12 |
| *Total* | 3.62 | 1.06 | | | | | | | |
| | | | | | | | | | |
| I1 | 3.92 | 0.97 | 79 | 3 | 1 | 6 | 16 | 31 | 25 |
| I2 | 4.05 | 0.83 | 79 | 3 | 0 | 3 | 16 | 34 | 26 |
| I3 | 3.54 | 0.89 | 78 | 4 | 0 | 11 | 24 | 33 | 10 |
| I4 | 3.72 | 0.88 | 78 | 4 | 2 | 5 | 17 | 43 | 11 |
| I5 | 4.10 | 0.86 | 78 | 4 | 1 | 2 | 13 | 34 | 28 |
| I6 | 3.57 | 0.85 | 77 | 5 | 0 | 10 | 21 | 38 | 8 |
| I7 | 3.97 | 0.94 | 78 | 4 | 0 | 6 | 17 | 28 | 27 |
| I8 | 3.59 | 1.17 | 78 | 4 | 3 | 13 | 18 | 23 | 21 |
| I9 | 3.48 | 0.87 | 77 | 5 | 0 | 8 | 35 | 23 | 11 |
| *Total* | 3.77 | 0.95 | | | | | | | |

Table 6-1. Summary of evaluations of the propositions on opportunities and impediments

### 6.3.3 Categorisations

To support the analysis of the conjectures formulated in the introduction, 3 categorisations of respondents are introduced. These are explained in Table 6-2.

| Categorisation | Explanation |
|---|---|
| Cooperator & Non-cooperator | A respondent is indicated to be a cooperator if he/she regards him/herself as currently cooperating horizontally on either core or non-core activities (questionnaire result, see E.R. 33). |
| Interested & Not-interested | Companies who answered positively to the question "In the current situation, are you interested in (intensifying) horizontal cooperation with colleague companies" are referred to as interested firms, those who negated are labeled not interested firms (questionnaire result, see E.R. 33). |
| Complete account & Contracted account | This categorisation is based on the type of annual account that a company has to submit (result form BelFirst database, E.R. 2). |

Table 6-2. Categorisations of respondents

When the results in Table 6-1 are reorganized into the described categorisation, the numbers in Table 6-3 are produced. The null hypotheses state that there is no difference between the evaluations of different subgroups. In the top-left corner of Table 6-3 for example, the null hypothesis is: "Cooperators and Non cooperators value the opportunities of horizontal cooperation alike". It turns out that Cooperators agree with the opportunities of horizontal cooperation more than non-cooperators do. Similarly, the cooperators consider the impediments for horizontal cooperation to be less severe than the non-cooperators do. Both observations also hold true for the interested vs. the not interested companies. Finally, the companies with a contracted annual account consider the impediments for horizontal cooperation to be more severe than the companies with a complete annual account.

| | Opportunities | | | | Impediments | | | |
|---|---|---|---|---|---|---|---|---|
| | Avg. | Standard deviation | Mann-Whitney | Asymp. Sig. | Avg. | Standard deviation | Mann-Whitney | Asymp. Sig. |
| Cooperator (n=33) | 3.77 | 1.09 | 30264.5 | 0.002 | 3.65 | 0.96 | 52748 | 0.005 |
| Non-cooperator (n=49) | 3.51 | 1.02 | | | 3.86 | 0.93 | | |
| Interested (n=34) | 4.04 | 1.05 | 21011 | 0.000 | 3.6 | 1.06 | 52230 | 0.001 |
| Not interested (n=48) | 3.31 | 0.95 | | | 3.9 | 0.82 | | |
| Contracted account (n=61) | 3.6 | 1.06 | 27811 | 0.547 | 3.84 | 0.9 | 41465 | 0.009 |
| Complete account (n=21) | 3.69 | 1.05 | | | 3.59 | 1.04 | | |

Table 6-3. Breakdown of results according to categorisations

## 6.4 THE USE OF DATA ENVELOPMENT ANALYSIS

The conjectures listed in the introduction assume knowledge about the efficiency level of RTCs. However, this efficiency is not directly measurable, but rather depends on the levels of multiple outputs, relative to the used amounts of multiple inputs. In cases where a set of Decision Making Units (in this case these are RTCs) perform similar tasks under multiple inputs and multiple outputs, DEA is considered an appropriate technique to measure efficiency.

DEA was developed by Charnes et al. (1978), based on work of Farrell (1957). It allows the measurement of the efficiency of firms by benchmarking them with respect to an estimated piece-wise linear production function. This model is known as the CCR model, after its inventors. Banker et al. (1984) further built upon the CCR model to arrive at the BCC model. Whereas the CCR model explicitly assumes that companies are operating at their most efficient scale by imposing constant returns to scale (CRS), the BCC model does not. The BCC model is therefore used for analysing variable returns to scale (VRS) situations. Both the BCC and CCR models are used to calculate relative efficiency scores and scale efficiencies.

The best performance or efficient frontier is the boundary of the convex hull of the set of efficient companies in the input/output space (Charnes et al., 1978; Deprins et al., 1984; Fare et al., 1985; Banker, 1993). Two basic approaches exist in DEA to estimate this frontier. The first is input-oriented, the second output-oriented. In an input orientation, outputs are fixed at their observed levels and companies are expected to proportionally reduce their input levels in the direction of their efficient peers. In this case, an RTC is not efficient if it is possible to increase any output without increasing any input and without decreasing any other output. If, on the other hand, an output orientation is chosen, the input levels are fixed and the possibility of a proportional increase of the created outputs is explored. In this input-oriented model, an RTC is not efficient if it is possible to decrease any input without increasing any other input and without decreasing any output. The latter orientation is considered the most appropriate in the current context, because the assets and workforce of the RTCs are usually rather fixed: in total 96.5% of the hours worked in the Flemish road transport sector is made by employees on a fixed contract. The challenge for these companies lies in generating more profit and/or added value with these given inputs. Measures that can be taken to attain this goal are e.g. increasing marketing activities or engaging in projects such as horizontal cooperation.

Because of its ability to model relationships with multiple inputs and multiple outputs without *a priori* assumptions on the underlying functional form, DEA has been applied in numerous areas (Seiford (1997) provides a DEA bibliography until 1996). One of the main areas of DEA application has been transport and logistics. However, most emphasis in the literature on this domain is on airliners' efficiency (e.g. Adler and Golany, 2001; Chiou and Chen, 2006), seaports (e.g. Pestana Barros and Athanassiou, 2004; Turner et al., 2004), urban transport systems (e.g.

Boame, 2004; Karlaftis, 2004), and traffic safety (e.g. Mejza and Corsi, 1999; Odeck, 2006). As far as logistics is concerned, DEA applications mainly focus on customer-supplier relations (e.g. Kleinsorge et al., 1991; Narasimhan et al., 2001), and in-company logistics processes of production companies (e.g. Clarke and Gourdin, 1991; Ross and Droge, 2004). However, until now little attention has been paid to the efficiency of third parties that perform logistics services for shippers. Taking into account the economic importance of these LSPs, this is an important gap in the literature.

The general output-oriented DEA model is formulated below. This model has to be solved for every RTC in the data set. In the formulation below there are *J* inputs, *I* outputs, and *K* RTCs. $x_{kj}$ represents the amount of input *j* that RTC *k* uses and $y_{ki}$ is the amount of output *i* that RTC *k* produces. $\lambda_k$ is the multiplier with respect to the $k^{th}$ RTC for the RTC under consideration (*k'*). Companies with $\theta = 1$ are considered efficient relative to the other companies. Constraint set (6.2) ensures that the used amount of each input *j* by *k'* is a linear combination of the used amounts of inputs by relatively efficient RTCs plus the possible excess input of RTC *k'*. Constraint set (6.3) states that the output levels of *k'* should be a linear combination of the output levels of relative efficient RTCs. In the output-orientation of DEA, the outputs $y_{k'i}$ should grow to $\theta y_{k'i}$ to achieve relative efficiency taking into account the fixed current input levels of RTC *k'*. The model generates an efficient piece-wise linear frontier of relative efficient RTCs. In the case that *k'* has a $\theta > 1$, a composite RTC could be configured from the RTCs along the efficient frontier that uses the same inputs levels, but produces more outputs than *k'* currently does. Therefore, the larger $\theta$, the more inefficient RTC *k'* is. Constraint set (6.4) is only relevant for VRS case (i.e., the BCC model), and can be ignored in the BCC model with CRS.

$$\text{Max}\,\theta \qquad (6\text{-}1)$$

subject to:

$$x_{k'j} \geq \sum_{k=1}^{K} \lambda_k x_{kj}, \qquad j = 1,2,...,J \qquad (6\text{-}2)$$

$$\theta y_{k'i} \leq \sum_{k=1}^{K} \lambda_k y_{ki}, \qquad i = 1,2,...,I \qquad (6\text{-}3)$$

$$VRS: \sum_{k=1}^{K} \lambda_k = 1 \qquad (6\text{-}4)$$

$$\lambda_k \geq 0 \qquad (6\text{-}5)$$

$$k = 1,2,...,K \qquad (6\text{-}6)$$

The production process of RTCs is represented by the use of multiple inputs to produce several outputs. In general, their total inputs are a combination of

- labour (e.g. total wages, (drivers') experience, total hours worked, number of employees, etc.),
- equipment (e.g. number of trucks, number of trailers, total loading capacity etc.), and
- intangible assets (market information, customer contacts, goodwill etc).

Unfortunately, information on most of these inputs is not available in the Flemish road transport industry, which is generally quite fragmented and under-digitalised. The inputs that are available for each company in this study are the total assets and the number of hours worked. Given the fact that in the road transport sector there are very few unique or scarce technologies that greatly enhance performance and as a result a large share of total assets is represented by basic equipment such as trucks and trailers, these two inputs provide a good approximation of the underlying measures. Outputs can also be subdivided into several categories, such as turnover, added value, profit, truck utilisation, kilometres driven, customer satisfaction, average payload, average price paid per loadmeter, number of deliveries on time, etc. Also on the output side, obviously not all this information is available. Although there are disadvantages of working with monetary figures under DEA, in this specific case it would be incorrect to focus on only a limited number of (physical) outputs, because excluding the remaining ones would not resemble the company's delivered quality of service and would therefore certainly bias the DEA results. For example, it might be possible to retrieve the kilometres driven by a company, but this would give no information about efficiency without knowledge of e.g. truck utilisation or the price paid per loadmeter by the customers. Therefore, the decision was to work with two compound monetary outputs that provide a good summary of the separate output components mentioned above. These are added value and profit.

Significantly positive correlation coefficients are found between inputs and outputs as shown in Table 6-4, confirming that the input/output data of the 82 respondents satisfy the hypothesis of isotonicity underlying DEA. During the whole process of analysis it is therefore assumed that all defined inputs affect production levels.

| | | TA | HOUR | AV | PR |
|---|---|---|---|---|---|
| *Inputs* | | | | | |
| Total assets | **TA** | - | | | |
| Hours worked | **HOUR** | 0.922 (0.000) | - | | |
| *Outputs* | | | | | |
| Added value | **AV** | 0.953 (0.000) | 0.979 (0.000) | - | |
| Profit/loss before taxes | **PR** | 0.599 (0.000) | 0.669 (0.000) | 0.693 (0.000) | - |

Table 6-4. Correlation coefficients between variables (significance levels between brackets)

Table 6-5 shows the average input and output levels of the different categories of responding RTCs. In addition, Flemish road transport market averages are reported in the far right column. It is clear from the table that the larger companies cooperate horizontally or are interested in doing so more often than small and medium sized companies.

| | **Cooperator** | **Non-cooperator** | **Interest.** | **Not interest.** | **Contr. Annual account** | **Complete annual account** | **Overall** | **Flanders** |
|---|---|---|---|---|---|---|---|---|
| *n* | 33 | 49 | 34 | 48 | 61 | 21 | 82 | 2,784 |
| *Inputs* | | | | | | | | |
| *-HOUR* | 84,270 | 28,512 | 91,435 | 22,275 | 17,593 | 147,849 | 50,951 | 28,047 |
| *-TA* | 2,895 | 1,305 | 3,282 | 998 | 750 | 5,414 | 1,945 | 1,823 |
| *Outputs* | | | | | | | | |
| *-AV* | 2,701 | 875 | 2,829 | 746 | 568 | 4,637 | 1,610 | 929 |
| *-PR* | 172 | 33 | 158 | 40 | 24 | 276 | 89 | 51 |

Table 6-5. Average inputs and outputs

## 6.5 PERFORMANCE EVALUATION AND HORIZONTAL COOPERATION

The AIMMS modelling system (version 3.6) is used to calculate CRS and VRS efficiency levels and scale efficiencies for

1. the entire Flemish road transport sector (resulting in 2 DEAs),
2. the complete set of 82 usable respondents (resulting 2 DEAs), and
3. subgroups of these respondents based on the categorisations in Table 6-2 (resulting 12 DEAs).

The results can be found in Table 6-6 and the corresponding explanation is organized as follows: Section 6.5.1 discusses CRS and VRS efficiency scores, Section 6.5.2 focuses on the scale efficiencies, and finally in Section 6.5.3 the conjectures are tested based on the DEA results.

### 6.5.1 CRS and VRS Efficiency Levels

For both the VRS and CRS models, frequencies and cumulative percentage frequencies are tabulated in Table 6-6 for eight groups of RTCs. Six of these groups are subgroups of the set of respondents, being the cooperators, non-cooperators, interested respondents, non-interested respondents, respondents with a complete annual account, and respondents with a contracted annual account. Finally, DEA results are displayed for the complete set of respondents and for the entire population of Flemish RTCs, of which the respondents of course form a subset. To calculate the efficiency levels for responding RTCs, we perform the DEA on the entire Flemish road transport sector and use the thus calculated efficiency levels. This renders the analysis more robust since the sample was constructed randomly from all Flemish RTCs and obviously there is no reason why the efficient frontier would consist of only companies that are respondents to the questionnaire.

The most prominent conclusion to be drawn from the results is that there is ample room for improvement amongst the Flemish RTCs. The far right column of Table 6-6 indicates that only 1.2% in the CRS case and 4.6% in the VRS case comes within reasonable distance (i.e., efficiency scores <1.5) of the frontier formed by the efficient RTCs. For this, note that an efficiency score of 1.5 means that an RTC could have produced 50% more with its current inputs, were it efficient.

Median efficiency scores for (subgroups of) respondents vary from 2.70 to even 2.91 in the CRS case and from 1.73 to 2.74 in the VRS case. Although at this point no final conclusions can be drawn, it would appear that the cooperating respondents are more efficient than their non-cooperating colleague RTCs (median scores of 2.70 vs. 2.91 and 2.30 vs. 2.74). Similarly, for the time being it might be inferred that in the road transport sector, it is ‘good to be big’. This is supported by the higher efficiency levels of companies with a complete annual account, compared to those respondents with a contracted annual account.

To better observe structural differences within the three categorisations of the respondents set, e.g. structural differences in efficiency scores between cooperators and non-cooperators, it is appropriate to apply DEA to each subgroup separately in order to construct efficient frontiers formed by RTCs from the same subgroup. To this end, two separate DEA models are calculated (cf. Ross and Droge, 2004; Johnes, 2006). These models, called “Before Frontier Projection” and “After Frontier Projection” consequently have different dimensions and reference sets. For the “Before” model the subgroups of respondents were analysed both individually and independently.

The efficiency scores that result from these DEAs can be found in Table 6-7 under “Before”. To arrive at the results for the “After” model, we projected the separate subgroups on their respective efficient frontiers. Then the total group of respondents is joined again and an aggregate DEA is conducted to arrive at the “After” efficiency scores in Table 6-7. This procedure is performed three times: for cooperators/non-cooperators, for interested/non-interested respondents and for respondents with a contracted/complete annual account. This frontier projection approach removes the managerial component of inefficiencies, leaving the 'structural' inefficiencies of the subgroups unaltered. Charnes et al. (1981) refer to this as *programmatic (in)efficiency*. Non-parametric tests can then be used to find significant differences in programmatic efficiency. Interpretations of the results follow in Section 6.5.3.

| | **Cooperators** | | **Non-cooperators** | | **Interested** | | **Non-Interested** | |
|---|---|---|---|---|---|---|---|---|
| *CRS Eff.* | n | % | n | % | n | % | n | % |
| 1 – 1.5 | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| 1.5 - 2.5 | 8 | 24% | 13 | 27% | 9 | 26% | 12 | 25% |
| 2.5 - 3 | 18 | 79% | 17 | 61% | 16 | 74% | 19 | 65% |
| 3 – 5 | 7 | 100% | 18 | 98% | 8 | 97% | 17 | 100% |
| > 5 | 0 | 100% | 1 | 100% | 1 | 100% | 0 | 100% |
| Average | 2.83 | | 2.93 | | 2.95 | | 2.85 | |
| St. dev | 0.49 | | 0.69 | | 0.70 | | 0.56 | |
| Median | 2.70 | | 2.91 | | 2.80 | | 2.81 | |
| | **Cooperators** | | **Non-cooperators** | | **Interested** | | **Non-Interested** | |
| *VRS Eff.* | n | % | n | % | n | % | n | % |
| 1 - 1.5 | 9 | 27% | 2 | 4% | 9 | 26% | 2 | 4% |
| 1.5 - 2.5 | 11 | 61% | 16 | 37% | 10 | 56% | 17 | 40% |
| 2.5 - 3 | 7 | 82% | 19 | 76% | 10 | 85% | 16 | 73% |
| 3 - 5 | 6 | 100% | 11 | 98% | 4 | 97% | 13 | 100% |
| > 5 | 0 | 100% | 1 | 100% | 1 | 100% | 0 | 100% |
| Average | 2.27 | | 2.68 | | 2.29 | | 2.67 | |
| St. dev | 0.85 | | 0.71 | | 0.93 | | 0.63 | |
| Median | 2.30 | | 2.74 | | 2.19 | | 2.71 | |
| | **Cooperators** | | **Non-cooperators** | | **Interested** | | **Non-Interested** | |
| *Scale Index* | n | % | n | % | n | % | n | % |
| 0 - 0.25 | 3 | 10% | 9 | 18% | 9 | 26% | 8 | 17% |
| 0.25 - 0.5 | 3 | 19% | 10 | 39% | 10 | 56% | 11 | 40% |
| 0.5 - 0.75 | 2 | 26% | 8 | 55% | 10 | 85% | 7 | 54% |
| 0.75 – 1 | 2 | 32% | 5 | 65% | 4 | 97% | 4 | 63% |
| 1 - 2.5 | 10 | 65% | 12 | 90% | 1 | 100% | 14 | 92% |
| > 2.5 | 11 | 100% | 5 | 100% | 0 | 100% | 4 | 100% |
| Average | 3.69 | | 1.46 | | 4.03 | | 1.16 | |
| St. dev | 5.71 | | 2.46 | | 6.00 | | 1.32 | |
| Median | 1.49 | | 0.70 | | 1.41 | | 0.73 | |

Table 6-6. Efficiency scores with respect to complete population of road transport companies

| | **Complete annual account** | | **Contracted annual account** | | **Respondents** | | **Flanders** | |
|---|---|---|---|---|---|---|---|---|
| *CRS Eff.* | n | % | n | % | n | % | n | % |
| 1 – 1.5 | 0 | 0% | 0 | 0% | 0 | 0% | 33 | 1% |
| 1.5 - 2.5 | 5 | 24% | 16 | 26% | 21 | 26% | 547 | 21% |
| 2.5 - 3 | 11 | 76% | 24 | 66% | 35 | 68% | 737 | 47% |
| 3 – 5 | 5 | 100% | 20 | 98% | 25 | 99% | 1264 | 93% |
| > 5 | 0 | 100% | 1 | 100% | 1 | 100% | 196 | 100% |
| Average | 2.85 | | 2.90 | | 2.89 | | 3.43 | |
| St. dev | 0.55 | | 0.64 | | 0.62 | | 3.20 | |
| Median | 2.76 | | 2.83 | | 2.80 | | 3.06 | |

| | **Complete annual account** | | **Contracted annual account** | | **Respondents** | | **Flanders** | |
|---|---|---|---|---|---|---|---|---|
| *VRS Eff.* | n | % | n | % | n | % | n | % |
| 1 - 1.5 | 9 | 43% | 2 | 3% | 11 | 13% | 127 | 5% |
| 1.5 - 2.5 | 7 | 76% | 20 | 36% | 27 | 46% | 801 | 33% |
| 2.5 - 3 | 4 | 95% | 22 | 72% | 26 | 78% | 697 | 59% |
| 3 - 5 | 1 | 100% | 16 | 98% | 17 | 99% | 1007 | 95% |
| > 5 | 0 | 100% | 1 | 100% | 1 | 100% | 140 | 100% |
| Average | 1.87 | | 2.74 | | 2.52 | | 3.10 | |
| St. dev | 0.65 | | 0.71 | | 0.79 | | 2.54 | |
| Median | 1.73 | | 2.72 | | 2.57 | | 2.82 | |

| | **Complete annual account** | | **Contracted annual account** | | **Respondents** | | **Flanders** | |
|---|---|---|---|---|---|---|---|---|
| *Scale Index* | n | % | n | % | n | % | n | % |
| 0 - 0.25 | 1 | 5% | 13 | 21% | 14 | 17% | 501 | 18% |
| 0.25 - 0.5 | 1 | 10% | 12 | 41% | 13 | 33% | 541 | 37% |
| 0.5 - 0.75 | 1 | 14% | 9 | 56% | 10 | 45% | 379 | 51% |
| 0.75 – 1 | 0 | 14% | 7 | 67% | 7 | 54% | 272 | 61% |
| 1 - 2.5 | 4 | 33% | 18 | 97% | 22 | 80% | 602 | 82% |
| > 2.5 | 14 | 100% | 2 | 100% | 16 | 100% | 488 | 100% |
| Average | 6.39 | | 0.97 | | 2.35 | | 1.85 | |
| St. dev | 6.72 | | 1.08 | | 4.20 | | 4.26 | |
| Median | 4.61 | | 0.67 | | 0.89 | | 0.73 | |

Table 6-6. Efficiency scores with respect to complete population of road transport companies (continued)

| | Cooperator | | | Non-Cooperator | | | Interested | | |
|---|---|---|---|---|---|---|---|---|---|
| *CRS* | Before | After | % | Before | After | % | Before | After | % |
| Average | 1.218 | 1.084 | 11.0% | 1.383 | 1.005 | 27.4% | 1.307 | 1.064 | 18.6% |
| Stand. Dev. | 0.214 | 0.084 | 60.6% | 0.306 | 0.017 | 94.3% | 0.305 | 0.100 | 67.2% |
| Median | 1.177 | 1.059 | 10.0% | 1.350 | 1.000 | 25.9% | 1.214 | 1.016 | 16.3% |
| *VRS* | Before | After | % | Before | After | % | Before | After | % |
| Average | 1.115 | 1.063 | 4.6% | 1.202 | 1.050 | 12.6% | 1.165 | 1.055 | 9.5% |
| Stand. Dev. | 0.170 | 0.155 | 8.9% | 0.242 | 0.095 | 60.6% | 0.240 | 0.156 | 35.0% |
| Median | 1.056 | 1.008 | 4.6% | 1.137 | 1.007 | 11.5% | 1.099 | 1.001 | 8.9% |
| | **Not-interested** | | | **Contracted ann. account** | | | **Complete ann. account** | | |
| *CRS* | Before | After | % | Before | After | % | Before | After | % |
| Average | 1.300 | 1.034 | 20.5% | 1.154 | 1.164 | -0.8% | 1.365 | 1.000 | 26.7% |
| Stand. Dev. | 0.238 | 0.036 | 85.0% | 0.197 | 0.061 | 69.1% | 0.285 | 0.000 | 100% |
| Median | 1.263 | 1.029 | 18.6% | 1.089 | 1.141 | -4.8% | 1.324 | 1.000 | 24.5% |
| *VRS* | Before | After | % | Before | After | % | Before | After | % |
| Average | 1.156 | 1.065 | 7.9% | 1.086 | 1.039 | 4.3% | 1.233 | 1.026 | 16.8% |
| Stand. Dev. | 0.180 | 0.085 | 52.8% | 0.162 | 0.088 | 45.9% | 0.255 | 0.046 | 81.8% |
| Median | 1.072 | 1.052 | 1.9% | 1.003 | 1.000 | 0.3% | 1.175 | 1.005 | 14.5% |

Table 6-7. The “Before” and “After” DEA models

### 6.5.2 Scale Indices

Following Banker (1984) the economic scale of each RTC can be measured by its scale index (i.e., $\sum \lambda_j$ in the CRS model). A company with a scale index of 1 operates at its most efficient scale. If $\sum \lambda_j < 1$, this company experiences increasing returns to scale (IRS) and should expand. If on the other hand $\sum \lambda_j > 1$ there are decreasing returns to scale (DRS), meaning that the company would benefit from downsizing it operations. In line with the procedure for generating VRS and CRS efficiency levels in the previous section, we use the DEA of the total Flemish sector and then use the scale indices of the RTCs in the respondents set (see Table 6-6).

### 6.5.3 Testing of the Conjectures

This section describes the DEA results step by step by discussing and testing the seven conjectures formulated in Section 6.2.

***C1: Larger companies are more efficient***

The first conjecture states that larger RTCs are more efficient than smaller ones. In order to test this conjecture, a measure of the size of an RTC is needed. Since the total hours worked and the total assets together resemble the reasonably fixed working capital of an RTC, the following construct $S(k)$ is used as indicator of the size of RTC $k$ :

$$S(k) = HOUR(k)\big/\overline{HOUR} + TA(k)\big/\overline{TA} \qquad (6\text{-}7)$$

where $\overline{X}$ is the sector average value of input X. Consequently, S(k) is correlated with the vector of VRS efficiency scores of the respondents as calculated when taking the entire population of Flemish RTCs into account. Figure 6-2 shows the corresponding scatter plot. It resembles a statistically significant correlation coefficient of –0.532 (Asymp. Sig. = 0.000). This negative relation means that larger companies are likely to have a smaller θ value, and are therefore more efficient than smaller RTCs. This is in line with expectations, which were based on the fact that being small (e.g. having only a limited numbers of trucks) strongly limits a company’s ability to fulfil today’s strict customer requirements in terms of costs, flexibility and speed. Conjecture C1 is therefore supported.

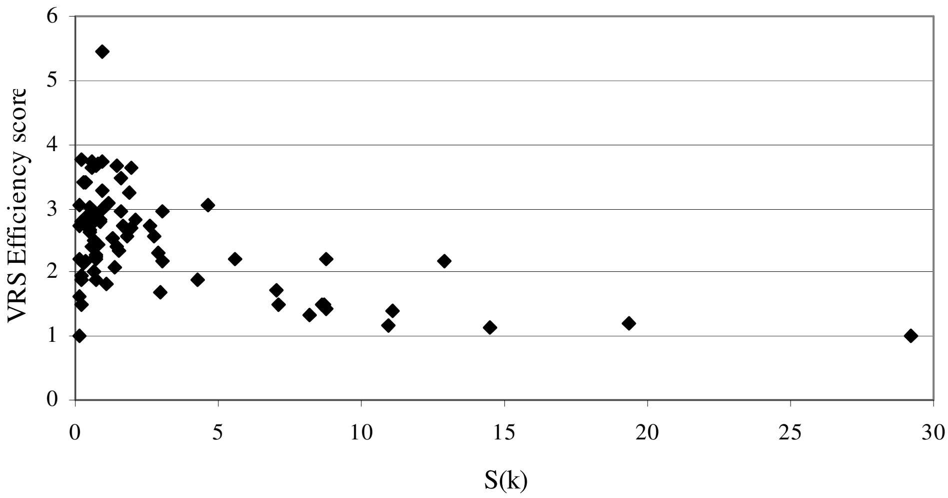


Figure 6-2. Conjecture C1

***C2: The Flemish transport market is too fragmented.***

The Flemish road transport market is said to be too fragmented if a disproportionate share of RTCs is operating below their most productive scale size (mpss). Results by Banker (1984) state that the scale index determines whether a company is operating below, at, or above its mpss. We therefore focus the discussion of the present conjecture on the scale indices at the bottom of Table 6-6. It turns out that in Flanders as a whole, 61% of RTCs are operating below their mpss and the median scale index is 0.73. This suggests that the Flemish road transport sector would benefit from scale expansion of presently active RTCs and as a result conjecture C2, stating that the Flemish road transport market is too fragmented, is supported. The most obvious scenarios for this market consolidation would be mergers, takeovers or horizontal cooperation between existing RTCs.

When taking a further look at the scale indices in Table 6-6, it can be seen that there exist some interesting differences between the various categorisations. It is no surprise that the RTCs with a complete annual account show greater scale indices than the RTCs with a contracted account. As indicated in Section 6.3.1, the latter can be considered 'small' companies while the former fall into the category of 'large'. However, the median scale index of the responding RTCs with a complete annual account is strikingly large (4.61), meaning that these companies operate far above their mpss. This, together with the fact that the respondents with a contracted annual account have a median scale index below 1 (0.67) once again suggests the existence of an ideal firm size somewhere in between the complete and contracted annual account average firm sizes. A second observation is that cooperating RTCs and RTCs interested in setting up or intensifying horizontal cooperation tend to operate above their mpss (scale indices of 1.49 and 1.41, respectively). From this one may conclude that horizontal cooperation is more frequently considered a 'defensive' strategy aimed at rationalizing inputs and defending turnover or market share, rather than an 'offensive' strategy to enter new markets or actively attract additional customers in present markets.

***C3: Cooperating companies show greater efficiency levels than non-cooperating companies***

The third conjecture states that cooperating RTCs are more efficient than non-cooperating RTCs. To test this, we use the efficiency scores of the (non-)cooperating respondents as displayed in Table 6-7. Charnes et al. (1981) refer to the separate sets of companies that make up the efficient boundaries for (in this case) cooperating and non-cooperating RTCs as the $\alpha$-envelopes. Table 6-7 outlines the adjustment of the outputs of both sets of RTCs onto their corresponding $\alpha$-envelope. In this way, each RTC is forced to become as efficient as its most efficient peer in the same subgroup of respondents. This frontier projection removes managerial efficiency (e.g. in the CRS case, leaving out the managerial efficiency improves the average efficiency scores of companies with a contracted annual account from 1.37 to 1.11), and tests for significance of programmatic efficiency differences can be conducted. In the case of conjecture C3, the two 'programs' are 1) Cooperating

RTCs, and 2) Non-cooperating RTCs. The non-parametric Mann-Whitney test is used to compare the “After” efficiency scores of cooperators vs. non-cooperators. If present, this test procedure will find significant differences in the rank distributions of efficiency scores for the (non)cooperating RTCs. The results are at the top of Table 6-8. As it turns out, there is no significant difference between the efficiency levels of cooperating and non-cooperating RTCs, and conjecture C3 is rejected.

Certainly, there are several possible interpretations of our observation that ‘current cooperation’ does not correlate with a company’s efficiency level. It can however be concluded that horizontal cooperation is not a universal remedy for bad (financial) performance of LSPs. Instead, it should be complemented by e.g. managerial restructuring, input rationing, business reorientation, and/or investments in new technologies. Moreover, in line with the result of Hypothesis 3 in Section 5.4.2, companies that are already quite efficient might not feel a strong incentive to cooperate horizontally.

| | **Number of RTCs** | **Average rank of VRS Efficiency level** | **Mann-Whitney U** | **Asymp. Sig.** |
|---|---|---|---|---|
| Cooperators | 33 | 41.24 | 800 | 0.935 |
| Non-cooperators | 49 | 41.67 | | |
| | | | | |
| Interested | 34 | 33.15 | 532 | *0.007* |
| Not interested | 48 | 47.42 | | |

Table 6-8. Conjectures C3 and C4

***C4: Companies interested in (intensified) cooperation are more efficient than companies that are not interested.***

Table 6-6 already suggests that in the VRS case efficient firms are more interested in initiating or increasing the intensity of horizontal cooperation: the median efficiency scores for interested RTCs is 2.19, whereas for non-interested RTCs it is 2.71. In order to get a more reliable comparison between the two subgroups however, the frontier projection procedure outlined under C3 is once again employed to arrive at the results at the bottom of Table 6-8. Indeed, the expected difference between efficiency levels of interested and not interested RTCs is statistically significant at the 0.01 level, and the conjecture is supported. Horizontal cooperation is thus unlikely to find solid ground at companies that are operating very inefficiently. On the other hand, a more efficient company might be in the position where internal processes are more or less optimised and cooperation with colleague companies offers an interesting opportunity to improve the company’s achievements.

***C5: Larger companies cooperate more often than smaller ones.***

To evaluate this conjecture, the Mann-Whitney test is used to compare the S(k) construct of cooperators vs. non-cooperators. Table 6-9 shows that conjecture C5 is supported at the 0.01 level: larger companies cooperate horizontally more often than their smaller counterparts. In response to open questions in the questionnaire (see E.R. 33), many respondents indicated that they considered themselves too small to engage in a horizontal cooperation. The rationale behind this is that many RTCs in the smallest category have 5 trucks or less. This means that often the director/owner also drives a truck, which limits his time for managerial tasks, including research into novel business opportunities such as horizontal cooperation. In contrast, the large companies generally have a more mature backoffice organisation formed by well-educated professionals to look into new business opportunities. This facilitates a more open-minded attitude towards innovative projects such as horizontal cooperation.

| | **Number of RTCs** | **Average rank of S(k)** |
|---|---|---|
| Cooperator | 33 | 49.85 |
| Non-cooperator | 49 | 35.88 |
| | | |
| Mann-Whitney U | 533 | |
| Asymp. Sig. | 0.009 | |

Table 6-9. Conjecture C5

***C6: Less efficient companies value the opportunities of cooperation higher than more efficient companies do.***

For the assessment of this conjecture the VRS efficiency scores of the respondents are correlated with their evaluations of the propositions about opportunities of horizontal cooperation, which are listed in Table 6-3. The results in Table 6-10 indicate that this conjecture must be rejected: none of the advantages shows a significant correlation with efficiency. It can be concluded that respondents subscribe to the advantages, irrespective of their efficiency level. This puts the discussion under conjecture C4 into a broader perspective: (heavily) inefficient RTCs admit that horizontal cooperation can bring value to their business, but they are simply not ready for it yet.

| Proposition | Correlation Coef. | Sig. (1-tailed) |
|---|---|---|
| O1 | -0.002 | 0.494 |
| O2 | 0.045 | 0.348 |
| O3 | 0.098 | 0.199 |
| O4 | 0.138 | 0.116 |
| O5 | -0.004 | 0.487 |
| O6 | -0.027 | 0.408 |
| O7 | 0.050 | 0.334 |
| | | |
| I1 | 0.123 | 0.140 |
| I2 | 0.025 | 0.412 |
| I3 | 0.223 | *0.025* |
| I4 | 0.038 | 0.371 |
| I5 | 0.137 | 0.116 |
| I6 | 0.151 | 0.095 |
| I7 | -0.010 | 0.466 |
| I8 | 0.339 | *0.001* |
| I9 | -0.042 | 0.359 |

Table 6-10. Conjectures C6 and C7

***C7: Inefficient companies consider the impediments for horizontal cooperation to be more severe than less efficient firms do.***

Table 6-10 shows that this conjecture is not supported in general. The evaluations of two disadvantages however, show a significant positive correlation with the VRS efficiency of RTCs, meaning that inefficient RTCs consider these disadvantages to be more severe. They are I3 ("It is hard to determine the benefits or operational savings of horizontal cooperation beforehand.") and I8 ("Benefits cannot be shared in a fair way; the larger players will always benefit most."). A factor common to these two impediments is that they are the ones that might occur first to those RTCs who have no experience to date with horizontal cooperation. Inefficient RTCs are appropriately very cautious about unfair gain sharing and about the expected payoff of such a project, since some of them will not have the financial buffer required to survive a failed project.

## 6.6 CONCLUDING REMARKS

The goal of this chapter was to employ DEA on the empirical data of Chapter 5 and to draw conclusions regarding 1) the efficiency of the Flemish road transport sector and 2) the potential of horizontal cooperation to improve its competitiveness. DEA proved to be a useful tool in empirically identifying frontiers of efficient companies and measuring the relative efficiency levels of the remaining companies.

Based on the respondents' answers to survey questions, respondents were categorised three times, depending on 1) whether or not they are currently cooperating horizontally, 2) whether or not they are interested in (intensifying) horizontal cooperation, and 3) the respondent's type of annual account, the latter being an indicator of firm size. Following Ross and Droge (2002), in order to make reliable statements about efficiency differences between such groups, ordinal ranks and the Mann-Whitney procedure were used. The analysis set contained 82 road transport companies, which accounts for 1.8% of the total Flemish road transport sector (only companies in which at least 1,500 hours were worked in 2003 were incorporated). Although this percentage is relatively low, the random manner is which the surveyed sample was constructed, strengthens the belief that the results presented provide a good indication of the situation across the entire Flemish road transport sector, as far as companies that are of a size that oliges them to submit a social balance sheet are concerned.

The main contributions of this chapter come from the results of the conjectures formulated in Section 6.2. Most importantly, the Flemish road transport sector turns out to be highly inefficient: less than 5% of the responding companies come within a reasonable distance of the efficient frontier. Still, it is an interesting observation that this inefficient sector for a large part facilitates the dominant position of Flanders as a preferred location for European Distribution Centres (Sleuwaegen et al., 2002).

Conjectures C1 and C2 revealed that an important reason for inefficiency lies in the strong fragmentation of the sector. This is illustrated by the fact that Flanders houses 4,667 RTCs, or one RTC per 1,285 inhabitants. Horizontal cooperation is put forward as a possible resolution, by benefiting from its potential to rationalise on inputs and to boost a company's efficiency. The scale inefficiency found in the research can be considered strong enough to expect that severe future market consolidation will be needed in order for the sector to remain competitive with foreign (Eastern-European) RTCs. The main lesson learned from conjectures C3 to C5 is that horizontal cooperation is not easy. A minimum degree of efficiency and scale is needed before the impediments can be overcome and rewards can be reaped. Finally, conjectures C6 and C7 examined the relation of RTCs' efficiency levels with their attitudes towards opportunities of and impediments for horizontal cooperation. It turned out that inefficient companies consider some of the impediments for horizontal cooperation significantly more severe than the more efficient companies do. However, no significant difference in the evaluations of the opportunities between efficient and less efficient companies could be found. This means that even the inefficient transport companies think that horizontal cooperation can improve their business, but their bad (financial) performance makes it problematic. They cannot afford to spend time and money on starting up a horizontal cooperation project and/or run the risk of a failed project. This is also the most likely explanation for the fact that inefficient companies consider the impediments to be more severe than their more efficient counterparts.

# CHAPTER 7 A COMPARATIVE ANALYSIS OF DUTCH AND FLEMISH LSPS' ATTITUDES

## 7.1 INTRODUCTION

Chapter 5 discussed a large-scale survey that was sent out to Flemish LSPs to map their attitude towards many aspects of horizontal cooperation. It showed that generally LSPs strongly believe in the potential of horizontal cooperation. However, most often they do not capitalise the benefits because the impediments are considered too severe as to actually start a cooperation with potential competitors. This survey is the first large-scale empirical research on the attitude of LSPs towards horizontal cooperation. Since the surveyed population is restricted to Flemish LSPs, it is hard to determine to what extent the outcomes are influenced by regional factors. Therefore, to check the validity of the survey results of Chapter 5 for other European countries, this chapter discusses a second survey that was undertaken in the Netherlands. The same questionnaire was sent out in the fall of 2004 to 2,500 Dutch LSPs.

The Netherlands was selected for the second survey because interestingly, when asked for examples of horizontal cooperation, many Flemish respondents came up with Dutch cases. Also in the supporting in-depth interviews, it was more than once stated that Dutch LSPs are more inclined to start a pilot cooperation with colleague companies, than the Flemish LSPs. Considering the strong similarities in the logistics infrastructure of the Netherlands and Flanders, this is an intriguing observation. This chapter further examines this observation by testing two claims.

Firstly, based on the remarks of Flemish LSPs, it is conjectured that
*(CLAIM 1) Flemish LSPs consider the impediments for horizontal cooperation more severe than their Dutch colleagues do.*

To check the validity of the results of the Flemish survey for other countries as well, the second conjecture states that
*(CLAIM 2) the highest (lowest) rated propositions on opportunities and impediments are the same in both Flanders and the Netherlands.*

Section 7.2 will briefly comment on the sample and response rates of both surveys. After that, the research propositions and their evaluations by the respondents will be reported and discussed in Section 7.3. To evaluate claim 1, Section 7.4 then incorporates a comparative analysis of the attitudes of Dutch and Flemish LSPs towards the research propositions. In Section 7.5 the propositions on opportunities and impediments are ordered based on their evaluations in both the Flemish and the Dutch survey. These lists are then compared to check claim 2. Finally, some concluding remarks are formulated in Section 7.6.

## 7.2 TWO SURVEYS

Dutch and Flemish data have been collected in two separate stages. In March 2004, a survey was sent to 1537 Flemish LSPs. The sample consisted of companies in the NaceBel categories *Freight transport by road*, *Inland water transport*, *Cargo handling and storage*, *Freight forwarding* and *Courier activities other than national post activities*. Detailed information on both the sample and the results of this survey can be found in Chapter 5. Here, the sample composition and the response rates for the Flemish questionnaire are briefly repeated in Table 7-1.

| **NaceBel main activity** | **0-4** | **5-19** | **20-49** | **50-99** | **100+** | | **Invalid** | **#Resp.** | **Response rate** |
|---|---|---|---|---|---|---|---|---|---|
| *Freight transport by road* | 607 (2,258) | 261 (888) | 132 (374) | 40 (79) | 21 (37) | 1,061 (3,636) | 21 | 124 | 12% |
| *Inland water transport* | 40 (126) | 9 (10) | 3 (3) | 0 (0) | 0 (0) | 52 (139) | 1 | 6 | 12% |
| *Cargo handling and storage* | 92 (286) | 55 (142) | 29 (51) | 15 (25) | 12 (19) | 203 (523) | 3 | 16 | 8% |
| *Freight forwarding* | 58 (187) | 33 (92) | 27 (44) | 14 (15) | 10 (12) | 142 (350) | 7 | 7 | 5% |
| *Express carriers* | 61 (232) | 10 (18) | 6 (6) | 0 (0) | 2 (2) | 79 (258) | 2 | 9 | 11% |
| | | | | | Total | 1,537 (4,906) | 34 | 162 | 11% |

Table 7-1. Sample and response of the Flemish survey

To ensure a fair and consistent comparison with the Dutch sample consisting exclusively of road transport companies (see below), a restriction is made to the Flemish respondents of the categories *Freight transport by road* and *Express carriers*. The joint response rate for these two categories is 11.7%.

The second survey was sent out in June 2004 to Dutch LSPs, again by means of personalised questionnaires. These companies were selected from a database maintained by Holland Transport (E.R. 11). This database contains information of all Dutch road transport companies (around 12,000 in 2004). The companies are subdivided into 6 categories based on the number of truck permits (see Table 7-2).

The sample size was pre-set to approximately 2,500 companies. Subsequently, companies were randomly selected from the six categories in such a way that the sample had the same category distribution as the database. Of the sample sizes that fulfilled this condition, 2,486 came closest to the desired sample size of 2,500. This sampling procedure guarantees that the sample is a good representation of the sector.

Unfortunately, the database suffered from some inaccuracies. In 95 cases, questionnaires were returned blank as a result of wrong addresses or compan shut-downs. This resulted in a net sample size of 2,388, but it should be noted that the real net sample size might be even smaller, since it is expected that not all ex-entrepreneurs will have contacted us to communicate the shut-down of their business. With a total of 183 respondents, the overall response rate amounted to 7.7%. As already stated in Section 5.3.2, these low response rates have become symptomatic for large-scale mail surveys (cf. Wisner, 2003). Table 7-2 gives an overview of the sample and the response to the Dutch survey. Note that for ten respondents, their category could not be traced back because the company name was not filled in.

| **Category** | **#Permits for nat. transport** | **#Companies in database** | **#Companies in sample** | **#Invalid** | **#Resp.** | **Net response rate** |
|---|---|---|---|---|---|---|
| *A* | 1-2 | 5,256 (48.6 %) | 1,199 | 48 | 82 | 7.1% |
| *B* | 3-5 | 2,225 (20.6 %) | 522 | 19 | 34 | 6.8% |
| *C* | 6-10 | 1,476 (13.6 %) | 352 | 16 | 26 | 7.7% |
| *D* | 11-25 | 1,204 (11.1 %) | 258 | 14 | 17 | 7.0% |
| *E* | 26-50 | 427 (3.9 %) | 100 | 1 | 10 | 10.1% |
| *F* | Over 50 | 227 (2.1 %) | 51 | 0 | 4 | 7.8% |
| *?* | | | | | 10 | |
| *Total* | | 10,815 | 2,482 | 98 | 183 | 7.7% |

Table 7-2. Sample and response to the Dutch questionnaire

## 7.3 RESEARCH PROPOSITIONS AND RESULTS

Besides other (open) questions, both questionnaires contained 3 groups of propositions regarding opportunities, impediments and general issues related to horizontal cooperation, respectively. These were based on both formal literature and a number of in-depth interviews with industry experts (see Section 5.3.1). The purpose of the propositions was to analyse the subject of horizontal cooperation from multiple perspectives, while keeping the number of propositions small to limit the workload for respondents and safeguard an acceptable response rate. Table 7-3 lists the three sets of propositions that were included in both questionnaires.

| | |
|---|---|
| | **Propositions on opportunities of horizontal cooperation** |
| O1 | Horizontal cooperation increases the company's productivity for core activities, e.g.: decrease in empty hauling, better usage of storage facilities etc. |
| O2 | Horizontal cooperation reduces the costs of non-core activities, e.g.: organizing safety trainings, joint fuel facilities etc. |
| O3 | Horizontal cooperations reduce purchasing costs, e.g. trucks, onboard computers, fuel etc. |
| O4 | LSPs can specialise, while at the same time broadening their services. |
| O5 | LSPs can offer better quality of service at lower costs, e.g. in terms of speed, frequency of deliveries, geographical coverage, reliability of delivery times etc. |
| O6 | Tendering on larger contracts with large shippers becomes possible. |
| O7 | Forming cooperations helps to protect market share. |
| | **Propositions on impediments for horizontal cooperation** |
| I1 | It is hard to find commensurable LSPs with which it is possible to cooperate for (non-) core activities. |
| I2 | It is hard to find a reliable party that can coordinate the cooperation in such a way that all participants are satisfied. |
| I3 | It is hard to determine the benefits or operational savings of horizontal cooperation beforehand. |
| I4 | Partners find it hard to ensure a fair allocation of the shared workload in advance. |
| I5 | A fair allocation of the benefits is essential for a successful cooperation. |
| I6 | When an LSP cooperates with commensurable companies, it becomes harder for it to distinguish itself. |
| I7 | Over time smaller companies in the cooperation may lose customers or get pushed out of the market completely. |
| I8 | Benefits cannot be shared in a fair way; the larger players will always benefit most. |
| I9 | Cooperation is greatly hampered by the required indispensable ICT-investments. |
| | **General propositions on horizontal cooperation** |
| G1 | LSPs that are mainly active in coordination, rather than in the actual transport itself, benefit less from horizontal cooperation. |
| G2 | Cooperation with distant (foreign) colleague companies generates a wider geographical coverage and minimises competitive conflicts. |
| G3 | Customers ask you to engage in horizontal cooperation. |
| G4 | In the present situation, you are interested in (intensified) horizontal cooperation. |
| G5 | When the most important impediments are removed, horizontal cooperation has great potential. |

Table 7-3. Propositions included in the questionnaire

The rationale behind the first two groups of propositions (opportunities and impediments) has already been discussed in detail in Chapter 5. The third group does not relate to specific advantages or disadvantages of horizontal cooperation, but addresses some additional issues regarding horizontal cooperation. Proposition G1 is based on the expectation that logistics companies already active in (vertical) transport coordination, are less inclined to put their coordinating position at stake by engaging in horizontal cooperation. Secondly, G2 is founded on the literature study in Chapter 2. Amongst others, Bleeke and Ernst (2005) indicate that horizontal cooperation is useful for extending a company's geographical coverage. An additional beneficial circumstance is that two far-away companies face less competitive pressure, because customer bases are generally disjunctive. The third general proposition regards the impetus for cooperation: it is interesting to know if the initiative for engaging in horizontal cooperation comes from the LSP itself, or from his customers. Finally, G4 and G5 are incorporated to assess the overall potential of horizontal cooperation in the logistics industries of Flanders and the Netherlands.

The respondents were asked to indicate on a 5-point Likert scale (1=Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree) to what extent they agreed with the propositions. Table 7-4 shows the evaluations of the propositions by the respondents. Columns 2 to 5 present the mean and standard deviation per proposition for the Flemish and the Dutch survey. Because testing claim 1 requires identifying any significant difference in the attitudes towards horizontal cooperation between the Flemish and the Dutch transport sector, two independent-samples tests were performed to compare the evaluations of both groups for each individual proposition listed in Table 7-3. Because the data are ordinal, the Mann-Whitney U test statistic is used to test for each proposition the following hypotheses:

$H_o$: The Dutch and Flemish samples come from identical populations

$H_a$: The Dutch and Flemish samples come from different populations.

The last two columns report on the hypothesis testing. *Italic* numbers indicate that statistically significant differences are observed between both questionnaires (at the 5% level).

| | VL | | NL | | | |
|---|---|---|---|---|---|---|
| | **Mean** | **Standard deviation** | **Mean** | **Standard deviation** | **Mann-Whitney U** | **Asymptotic Sig. (2-tailed)** |
| *O1* | 4.16 | 1.00 | 4.01 | 0.98 | 9,558.0 | 0.096 |
| *O2* | 3.65 | 1.00 | 3.60 | 0.99 | 10,381.5 | 0.792 |
| *O3* | 3.45 | 1.12 | 3.57 | 1.03 | 9,853.5 | 0.267 |
| *O4* | 3.70 | 1.12 | 3.53 | 1.01 | 9,426.0 | 0.098 |
| *O5* | 3.56 | 1.11 | 3.37 | 1.13 | 9,536.5 | 0.147 |
| *O6* | 3.68 | 1.10 | 3.52 | 1.08 | 9,738.0 | 0.233 |
| *O7* | 3.18 | 1.09 | 3.36 | 1.08 | 9,381.0 | 0.086 |
| *I1* | 3.81 | 1.01 | 3.54 | 0.97 | *8,874.0* | *0.009* |
| *I2* | 4.02 | 0.89 | 4.02 | 0.95 | 10,676.5 | 0.863 |
| *I3* | 3.58 | 0.87 | 3.51 | 0.95 | 10,131.0 | 0.584 |
| *I4* | 3.77 | 0.88 | 3.79 | 0.85 | 10,581.0 | 0.921 |
| *I5* | 4.13 | 0.81 | 3.72 | 0.90 | *7,401.5* | *0.000* |
| *I6* | 3.52 | 0.92 | 3.33 | 0.91 | 9,357.0 | 0.091 |
| *I7* | 4.00 | 1.00 | 3.75 | 1.03 | *9,168.5* | *0.033* |
| *I8* | 3.67 | 1.19 | 3.26 | 1.15 | *8,112.5* | *0.002* |
| *I9* | 3.50 | 0.93 | 3.19 | 0.91 | *8,429.5* | *0.010* |
| *G1* | 3.12 | 0.89 | 3.17 | 0.93 | 9,743.0 | 0.607 |
| *G2* | 3.55 | 0.97 | 3.32 | 0.98 | 8,616.0 | 0.067 |
| *G3* | 2.72 | 1.06 | 2.45 | 0.91 | *6,472.5* | *0.025* |
| *G4* | 3.33 | 1.15 | 3.04 | 1.08 | *8,599.0* | *0.027* |
| *G5* | 3.54 | 1.14 | 3.50 | 0.86 | 9,266.5 | 0.303 |

Table 7-4. Evaluations of the propositions

The first thing that strikes in Table 7-4 is the strength with which the opportunities of horizontal cooperation are endorsed, Flemish and Dutch transport companies alike (no significant differences). This illustrates the great potential of horizontal cooperation for the Benelux. This observation is reconfirmed by the evaluations of proposition G5, and also by Ruijgrok and Groothedde (2005).

When the evaluations of the impediments for horizontal cooperation are compared, some interesting observations can be made. As was already suggested in the in-depth interviews, Flemish LSPs seem to structurally experience more difficulties with horizontal cooperation than their Dutch colleagues do. Five of the nine impediments show a difference that is statistically significant on a 5% confidence level. These differences are discussed in detail in the next section. The fact that Flemish road transport companies consider impediments to be more severe does not mean that the Dutch think lightly about them. Generally, they also agree with the propositions, but in contrast to their Flemish peers, more of them tend to ‘see light at the end of the tunnel’.

The general propositions also show statistically significant differences between the two countries. Curiously, the Flemish transport companies feel a stronger assignment from their customers to actively engage in horizontal cooperation. Moreover, and maybe as a result, Flemish companies are also more interested in (increased) horizontal cooperation (Proposition G4).

Finally, as an additional question, companies were asked if they thought that it would be preferable if an independent third party would coordinate the cooperation. Only 17 % responded positively (scores 4-5) to this question, 48 % reacted negatively (scores 1-2), and 35% was neutral (score 3). This indicates that both in the Netherlands and in Flanders, there is only limited immediate demand for consultants or Fourth Party Logistics service providers (4PL) to start up or manage horizontal cooperation between companies.

## 7.4 CLAIM 1: LSPS' ATTITUDES IN THE NETHERLANDS AND FLANDERS

In this section, claim 1 is evaluated by discussing those propositions that show a statistically significant difference between Dutch and Flemish respondents.

***It is hard to find commensurable LSPs with whom it is possible to cooperate for (non-) core activities (I1).***

Flemish LSPs consider it more difficult to find colleague companies with whom they can cooperate to the benefit of both. The average evaluation of proposition I1 by the Flemish LSPs is 3.81 and for the Dutch 3.54. This difference is significant at the 1% confidence level. Although the transport sector in Flanders suffers from roughly the same difficulties as the Dutch (low capacity utilisation, frequent empty hauling, negative public image, low profit margins etc.), LSPs are more reluctant to cooperate in Flanders as compared to the Netherlands. As a result of this difference in attitude, in contrast to Flanders, in the Netherlands there are many reported examples of horizontal cooperation. A selection of them is presented in Table 7-5.

| Name | |
|---|---|
| Bouwvervoer Groep | E.R. 3 |
| Dailyfresh | E.R. 5 |
| Distribouw | E.R. 6 |
| Euromovers | E.R. 10 |
| Fritom | E.R. 11 |
| IDS | E.R. 14 |
| IJmond transport groep | E.R. 16 |
| Mondial movers | E.R. 20 |
| Nedvan | E.R. 22 |
| System Alliance | E.R. 29 |
| Teamtrans | E.R. 30 |
| Topmovers | E.R. 32 |
| Transport Groep Gelderland | E.R. 32 |

Table 7-5 Some Dutch horizontal cooperation initiatives

In Flanders, such cooperations are much harder to find and if they arise, more than often Dutch partners are involved (e.g. Octo Logistics and Transmission). The interviews with industry experts indeed indicated that the Dutch have a more proactive attitude towards industry threats and innovative logistics concepts involving a high degree of cooperation. On the other hand, the opportunities are valued likewise by the Dutch and the Flemish respondents. Therefore, a possible explanation for the fact that the number of Flemish cases lags behind could be the more conservative commercial attitude in Flanders. Moreover, it is also possible that a reluctance to large-scale publicity for horizontal cooperations plays a role in Flanders.

***A fair allocation of the benefits is essential for a successful cooperation (I5),***
***Smaller companies in the cooperation may lose customers or get pushed out of the market completely (I7), and***
***Benefits cannot be shared in a fair way, the larger players will always benefit most (I8)***

The impediments related to gain sharing and market positions were considered most severe by the Flemish. The differences between both surveys are quite strong, given the average of 3.93 for the Flemish, and 3.58 for the Dutch. I7 has a difference that is significant at the 5% confidence level, I5 and I8 even at the 1% level. Respondents had the possibility to comment on why they do not cooperate in the current situation, and the linking pin in these explanations was that companies are too self-focused. Small companies fear that the larger ones will exploit them, while the large companies hesitate to put their individual market dominance at stake. However, the Dutch cases of horizontal cooperation mentioned in Table 7-5 however illustrate that successful cooperation is possible.

Gain sharing issues are crucial to cooperations, but can be tackled when crystal clear arrangements are agreed upon *before* starting the cooperation. Especially in the beginning, pragmatism is the best concept. Clear rules of thumb that are supported by all partners provide a fruitful starting point. Once the cooperation becomes more established and stable, more advanced gain sharing rules can be installed that guarantee fairness. Possible allocation rules will be discussed in more detail in Chapter 9 and Chapter 10.

***Cooperation is greatly hampered by the required indispensable ICT-investments (I9).***

Cooperation cannot occur without the exchange of information. Since the transport sectors in both the Netherlands and Belgium predominantly consist of small and medium sized companies, customer and order administration is still mostly done via telephone, fax and/or email. These companies lack the critical mass to install an EDI or web-based information exchange platform, which makes the sharing of information difficult and labour intensive. Successful implementations of horizontal cooperation frequently have a small number of employees whose prime job is to support and coordinate the cooperation. All partners together pay the salary of these ‘cooperation champions’. This of course requires the cooperation to be quite intense to make the human capital investment profitable. Again, the data show that Flemish LSPs are the most reluctant.

***Customers ask you to engage in horizontal cooperation (G3) and***
***In the present situation, you are interested in (intensified) horizontal cooperation (G4).***

Since both propositions expose differences that are significant on the 5% level, it is hypothesised that the Flemish LSPs experience stronger internal and external drives to cooperate horizontally than the Dutch. Open questions in the Flemish questionnaire indicated that there is a growing interest of LSPs in cooperation with competitors. However, the subject is still relatively taboo. A number of respondents state that they are, sometimes pushed by customers, interested in horizontal cooperation, but do not know how to start. There seems to be only limited communication within the sector and therefore suitable partners are hard to find. The survey indicates that customers that actively encourage LSPs to participate in horizontal cooperation are mainly active in the (petro-) chemical industry. The reasons for this are the enormous volumes handled by the shippers and the relatively small capacities of LSPs capable of serving these shippers. Also, the specialised trucks and tankers active in this industry are very expensive pieces of equipment. By means of order exchange, pooling of resource pooling, and backloads improvement, the total fleet needed by the few transport companies that are qualified for the transport of chemicals can be downsized. For an analysis of the potential of horizontal cooperation in the petrochemical industry, see McKinnon (2004b). Industries with small numbers of shippers and carriers, such as the chemical industry, provide promising fields for horizontal cooperation, because this simplifies communication and visibility. The fact that shippers sometimes ask LSPs to cooperate horizontally once again illustrates the potential of horizontal cooperation in logistics for Flanders.

## 7.5 CLAIM 2: VALIDITY OF THE RESULTS

Now that the significant differences have been discussed, we turn to the similarities in both surveys to get a qualitative feel for the validity of the Flemish survey results in other countries. It turns out that, to a large extent, Flemish and Dutch respondents have similar beliefs about the relative importance of the individual opportunities and impediments. Table 7-6 shows the ranks for both the Flemish and the Dutch survey. The sixth column gives the rank differences. It turns out that out of the two groups of propositions, only three have a rank difference larger than two. Nine of the sixteen propositions show a rank difference of zero or one. Although this is by no means a proof for the validity of the survey results for other countries, the empirical data do provide some confidence that the listed opportunities and impediments for horizontal cooperation are valued by the Dutch and Flemish respondents in more or less the same way. Therefore, it is conjectured that the relative importance of the opportunities and impediments in Flanders and the Netherlands, as indicated by the numbers in the rightmost column of Table 7-6, gives a good estimate of the importance of the relative importance in other countries.

| | **Flanders** | | **The Netherlands** | | | |
|---|---|---|---|---|---|---|
| | **Average** | **Rank** | **Average** | **Rank** | ***Rank difference*** | ***Average rank*** |
| O1 | 4.16 | 1 | 4.01 | 1 | *0* | 1 |
| O2 | 3.65 | 2 | 3.60 | 4 | *2* | 3 |
| O3 | 3.45 | 3 | 3.57 | 6 | *3* | 4.5 |
| O4 | 3.70 | 4 | 3.53 | 2 | *2* | 3 |
| O5 | 3.56 | 6 | 3.37 | 5 | *1* | 5.5 |
| O6 | 3.68 | 5 | 3.52 | 3 | *2* | 4 |
| O7 | 3.18 | 7 | 3.36 | 7 | *0* | 7 |
| I1 | 3.81 | 5 | 3.54 | 4 | *1* | 4.5 |
| I2 | 4.02 | 1 | 4.02 | 2 | *1* | 1.5 |
| I3 | 3.58 | 6 | 3.51 | 7 | *1* | 6.5 |
| I4 | 3.77 | 2 | 3.79 | 5 | *3* | 3.5 |
| I5 | 4.13 | 4 | 3.72 | 1 | *3* | 2.5 |
| I6 | 3.52 | 7 | 3.33 | 8 | *1* | 7.5 |
| I7 | 4.00 | 3 | 3.75 | 3 | *0* | 3 |
| I8 | 3.67 | 8 | 3.26 | 6 | *2* | 7 |
| I9 | 3.50 | 9 | 3.19 | 9 | *0* | 9 |

Table 7-6. Validity of the survey results

Table 7-6 shows that the two impediments that have a rank difference of three are related to gain sharing issues (I4: partners find it hard to ensure a fair allocation of the shared workload in advance; I5: a fair allocation of the benefits is essential for a successful cooperation). This provides additional evidence for the observation made in the previous section that Flemish LSPs consider gain sharing impediments to be more severe than their Dutch counterparts do.

## 7.6 CONCLUDING REMARKS

The discussions in Section 7.4 provide evidence for Claim 1, which states that Flemish LSPs consider the impediments for horizontal cooperation more severe than their Dutch colleagues do. At the same time, they value the opportunities alike. The explanation for this is not unambiguous. It is possible that there are clear-cut economic reasons for the reluctance of Flemish LSPs. For example, Eurostat data (E.R. 9) show that between 1995 and 2003, the EU-15 countries have shown only a very small increase of 0.6% in the total freight volume. Belgium and the Netherlands both contributed negatively to this growth. While the volume dropped with 4.8% in Belgium, the Netherlands transport sector showed an even stronger decrease in volume of 10.7% over the same period of eight years. Maybe this stronger financial threat has led Dutch LSPs to be more willing to accept the potential dangers of horizontal cooperation. Another possible explanation is of a more cultural nature. Flemish entrepreneurs may be more inclined to first see where the cat jumps before implementing innovative or otherwise far-reaching concepts. Considering the results of both the interviews and the surveys, the latter seems to be the most probable explanation. If this is true, the Flemish may learn from both the successful and unsuccessful cooperation projects in the Netherlands.

Claim 2, stating that the highest (lowest) rated propositions on opportunities and impediments are the same in both Flanders and the Netherlands, is also supported. This is based on the analysis of rank differences in Table 7-6. Therefore, it can be expected that the relative importance of the opportunities and impediments in Flanders and the Netherlands, gives a good estimate of the relative importance in other Western European countries.

# PART III SOME ENABLING CONCEPTS

*The third part of this thesis focuses on the way in which horizontal cooperation can be put into practice. In many cases, horizontal cooperation is not a 'stand alone' measure to be incorporated in a company's business processes. Rather, as a result of changes in the company's environment, current business processes are gradually reconsidered. To make these changes successful, horizontal cooperation can provide a promising tool. Therefore, the introduction of new logistics concepts frequently paves the way for horizontal cooperation. Three such concepts will be discussed in detail. The first is Factory Gate Pricing. Basically, this means that retailers pick up their ordered goods at suppliers, instead of having them delivered. Secondly, Insinking is discussed. In this concept, a Logistics Service Provider implicitly enforces horizontal cooperation by simultaneously targeting a group of possibly competing shippers. Finally, a method is presented to develop Joint Hub Networks.*

# CHAPTER 8 FACTORY GATE PRICING

## 8.1 INTRODUCTION

This chapter discusses a first enabling concept for horizontal cooperation. As will be explained below, cooperation is in this case facilitated by a shift in the orchestration of transport flows. The concept will be illustrated by means of a case study from the food retail industry.

The difficulties of logistics companies discussed in Chapter 1 are especially true for the retail sector: margins are getting thinner, customer requirements in terms of product freshness and product assortment are growing and product life cycles are becoming shorter. In response to this, retail logistics is going through drastic changes. In the early 1980s, it was common practice for suppliers to deliver products directly to the shops (Mercer, 1993). In the mid-eighties, retailers gradually moved towards central warehousing: suppliers delivered to a retailer distribution centre (DC), enabling retailers to supply their own shops more efficiently. As a result of this change, the retail supply chain was split into two parts:

- Primary distribution: from the supplier to the retailer distribution centre
- Secondary distribution: from the retailer distribution centre to the shops

In most cases, suppliers remainded in control of the primary distribution. The retailer on the other hand, controls the secondary distribution. As a result, logistics has become part of the day-to-day business environment of the retailer. According to Fernie and Staines (2001), since the nineties logistics is even one of the crucial determinants of success in the retail sector. *Factory Gate Pricing* (FGP) is one of the latest trends in retail logistics. Under FGP, the retailer also takes over the orchestration of the primary distribution from the supplier. Specifically, this means that the cost of transport is no longer included in the price that suppliers charge to the retailer. Instead, the retailer buys the products 'at the factory gate' and takes care of the transport on his own account (FGP is also referred to as 'ex-works ordering'). Figure 8-1 presents a graphical overview of a general retail supply chain and the shift from the original situation to FGP.

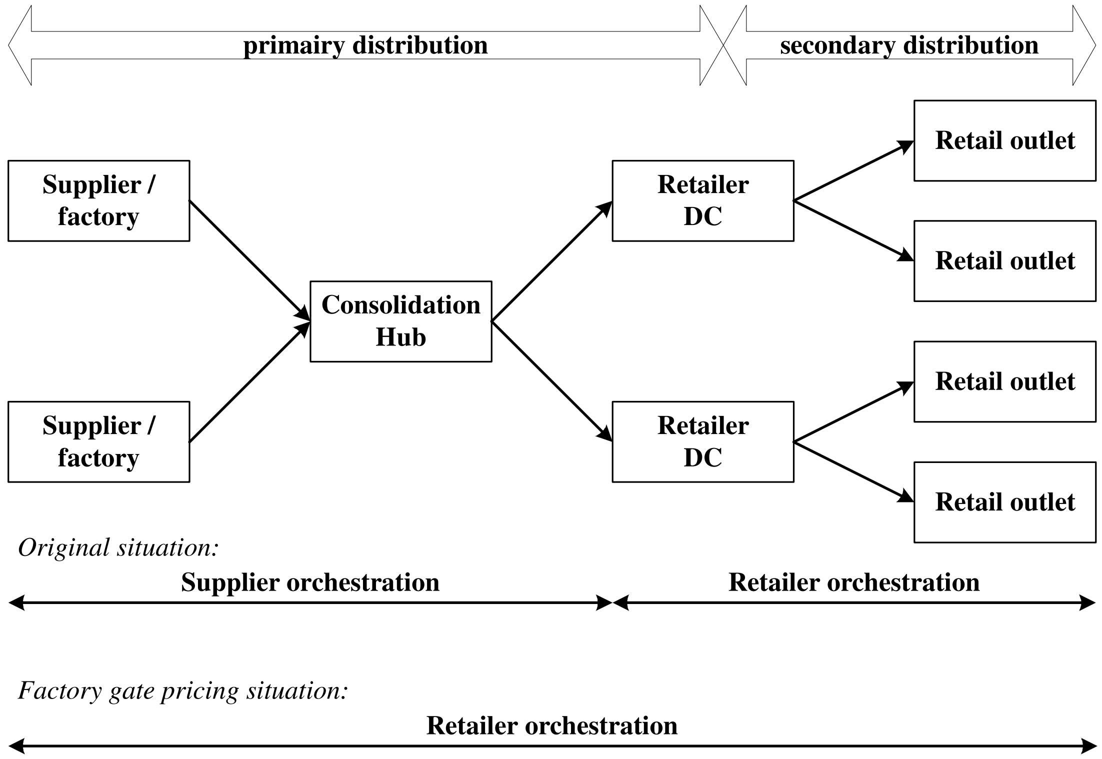


Figure 8-1. The retail supply chain

The increasing product range and demand variability are forcing retailers to focus on inventory reductions. In recent years, this has resulted in more frequent and smaller replenishment orders delivered by the suppliers to the retailer DCs. To manage this efficiently, suppliers introduced consolidation hubs where many small orders for the same retailer DC are combined (see Figure 8-1).

Suppliers only incur the costs of primary transport and therefore they are negatively affected by many small replenishment orders. The retailers on the other hand, only incur inventory costs and therefore have an incentive to decrease their order sizes. Because of this lack of a helicopter view on logistics costs, the optimal balance of transport and inventory costs in the replenishment policy of retailers is seldom achieved. The retailer is not directly charged for the higher transport costs that are a consequence of the increased frequency of delivery. Bringing the control of primary transport and inventory under the control of one supply chain entity by means of FGP is therefore likely to generate cost savings.

In addition to the savings resulting from coordination of transport and inventory, FGP offers three other sources for savings. Firstly, retailers generally have a vast product range for which they can make the transport-inventory trade-off simultaneously. This means that orders from suppliers located close to each other may be synchronised in time, such that they can be combined in the same route. Secondly, under FGP, primary and secondary distribution can be integrated. For example, on the backhaul of a delivery trip to a shop, the same truck may, if this is efficient, visit a supplier to pick up a shipment destined for a retailer distribution centre. Finally, FGP facilitates horizontal cooperation because less decision makers are involved.

A well-known concept that is related to FGP is Vendor Managed Inventory (VMI, see e.g. Cheung and Lee, 2002; Disney et al., 2003). This type of vertical cooperation also concentrates the control of inventory and primary transport, and sometimes even secondary transport, at a single supply chain entity. The difference with FGP is that under VMI the supplier instead of the retailer is in control. VMI is typically implemented in situations where a few large suppliers deliver a substantial volume to retailers, but it becomes unmanageable if hundreds of small suppliers frequently visit the retailer’s distribution centre to deliver new supplies. Moreover, it is unlikely that small suppliers have the logistics and ICT capabilities to carry out VMI. With FGP, this problem is less severe since in most retail supply chains there are many more suppliers than retailers. Furthermore, the logistics capabilities of retailers and their Logistics Service Providers (LSPs) seem to be well enough developed to take over the transport from the suppliers. Which concept is more suitable depends for a large part on product characteristics (like size, weight, temperature conditioning, vulnerability) and the capabilities of both the supplier and the retailer.

The promising future of FGP has already been demonstrated in the UK where leading retailers such as Tesco and Sainsbury’s have implemented FGP for a part of their product range. Other British retailers such as Asda, Somerfield, Safeway, and Waitrose have announced plans for FGP (E.R. 15; Finegan, 2002). Potter et al. (2003) report significant potential kilometre reductions through FGP for Tesco.

This chapter aims at quantifying the expected benefits of FGP for the Dutch retail sector for dry grocery goods, with and without horizontal cooperation. To achieve this goal, route planning scenarios down to the operational level of execution are constructed. For each product group/distribution centre combination, the size of the shipments, the frequency of delivery of the products, the safety stock, and the *delivery mode* (i.e., direct or via a consolidation hub) are determined. Then, the operational vehicle routing problem is solved. Although this study is of a strategic nature, the detailed operational problem is solved to get a good estimation of transport costs and performance indicators. The reason for this is that the small nuances in different scenarios go back to the operational level and cannot be adequately expressed in strategic models.

The chapter is further organized as follows. Section 8.2 discusses the literature on optimisation problems that are relevant for FGP. Section 8.3 includes a detailed description of the case study in the Dutch retail sector and a discussion of issues such as consolidation, cooperation, and supply chain orchestration. The solution methodology is elaborated on in Section 8.4. In Section 8.5, the results of the case study are discussed. Then, in Section 8.6 practical barriers for FGP implementations and directions for further research are identified. Finally, conclusions are presented in Section 8.7.

## 8.2 RELATED LITERATURE

Perhaps because of the relative novelty of Factory Gate Pricing, there is little literature on the subject as such. Moreover, because of its many aspects and enormous size, it is very hard to develop efficient algorithms for what is called the *Factory Gate Pricing optimisation problem* (this problem will be discussed in detail in Section 8.4). To cope with this, a two-phase heuristic is constructed. Firstly, by determining the frequency of delivery for each product, a good balance between inventory and transport costs can be made. Secondly, transport orders are combined into routes by solving a vehicle routing problem. During these two phases, some general optimisation problems occur. This section presents a brief survey of the literature on these problems. They are: periodic routing, routing with a consolidation hub, combined inventory and route planning, and routing with a large customer base.

### 8.2.1 Periodic Routing

Since the dataset (see section 8.3) contains frequencies of delivery for each transport order, the routing problem has a periodic character. The Periodic Vehicle Routing Problem (PVRP) is identical to the classical vehicle routing problem, except that the planning period consists of $M$ days instead of one day. Each customer $i$ must be visited $k_i$ times during this period where $1 \le k_i \le M$. $k_i$ is called the frequency of delivery to customer $i$ and sets of daily routes are generated to minimise transport costs. Some references on periodic vehicle routing are Christofides and Beasley (1984), Tan and Beasley (1984), Russell and Gribbin (1991), Chao et al. (1995), Cordeau, et al. (1997), Drummond et al. (2001) and Baptista et al. (2002).

### 8.2.2 Routing with a Consolidation Hub

The routing of products through a network may improve if a consolidation hub is introduced (see also Chapter 10). One of the first papers on transport systems in which both direct shipping and shipping via one or more hubs is allowed, is due to Aykin (1995). The problem consisted of determining the best hub locations and the best delivery modes for customers. The objective was to minimise total transport cost. Four heuristic algorithms were proposed to solve the problem. Unfortunately, the problem instances solved were limited to 5 hubs and 20 demand points. Liu et al. (2003) showed that, when compared to a pure hub-and-spoke system or a pure direct shipment system, allowing both delivery modes results in roughly a 10% saving. Again, problem sizes were relatively small: the largest solved instance consisted of 5 suppliers and 25 customers.

Irnich (2000) introduced a problem with multiple depots in a pickup and delivery setting. In this problem, all requests are to be picked up at or delivered to one central location that has the function of a consolidation hub. A two-phase set-covering algorithm based on column generation was proposed. This approach again severely limits the maximum size of the instances since it is assumed that all possible routes can be enumerated. The largest instances solved consist of 130 orders and 22 depots.

### 8.2.3 Combined Inventory and Route Planning

An important aspect of FGP is that decisions on replenishment orders influence the transport and handling costs as well as the inventory costs. Improving supply chain efficiency thus requires an integrated approach to inventory control and transport planning. The literature mentioned in this subsection provides a good understanding of how transport costs and inventory costs interact.

Daganzo and Newell (1985) conducted a study on the simultaneous routing and inventory problem. They illustrated how the nature of the objects carried (e.g. cheap/expensive) affects the optimal configuration of a distribution system. The results also depend on factors such as the inventory carrying cost per item per unit of time, the transport cost per unit distance, the demand per unit area and unit time, the average distance from the depot, the average speed, and the time per stop. Other references for the simultaneous minimisation of transport and inventory costs in various settings are Bell et al. (1983), Dror and Levy (1986), Blumenfeld et al. (1987), Dror and Ball (1987), Chien et al. (1989), Anily (1990), Anily and Federgruen (1993), Herer and Levy (1997), and Viswanathan and Mathur (1997). Qu et al. (1999) deserves special attention since they come closest to the FGP situation. In their setting, the control of the supply chain lies with one central distribution centre that collects products from a set of suppliers. Again, problem sizes are small: the heuristic was tested on instances with a maximum size of 50 items.

For issues concerning inventory policies for the retail sector in particular, see Kapalka et al. (1999) and Dubelaar et al. (2001).

### 8.2.4 Routing with a Large Customer Base

Because of the large instances at hand, most of the standard optimisation techniques cannot be applied. In literature, little attention is given to huge vehicle routing problems. However, some research has been done on very large instances of the generalised assignment problem, a problem that can be reformulated as a basic vehicle routing problem (Higgins, 2001). To our knowledge, routing problems that incorporate characteristics such as periodicity and consolidation hubs have not yet been discussed in the literature for the very large instances at hand.

### 8.2.5 Discussion

No papers were found in literature that incorporate all the problem characteristics of the FGP situation. Nevertheless, there is extensive literature on some of the discussed building blocks of the FGP optimisation problem. Some ideas and concepts are readily usable for FGP. The biggest challenge is the enormous problem size: compared to the FGP optimisation problem, most problems solved in the literature are fairly small.

## 8.3 CASE DESCRIPTION

Three participants (CoopCodis, Dekamarkt, and Jumbo) of *SuperUnie*, a Dutch horizontal cooperation initiative, provided the data for the case study described here. Until now, SuperUnie mostly acted as a purchasing group. SuperUnie represents approximately 25% of the Dutch food retail market. The dataset consists of 355 slow moving dry grocery product groups of 340 suppliers that (almost) all retailers have in their assortments. These product groups consist of on average 16 individual products. This already takes a certain level of consolidation by the suppliers into account. Some suppliers have more than one product group due to the fact that some of their product groups have different characteristics. The product group volumes are for a representative period of 24 working days without seasonal and promotional effects. The retailers consider a product group to be a 'slow mover' if the turnover in a distribution centre is less than 66 pallets a week. Product groups with a larger volume are assumed to be distributed by full truckloads and are therefore excluded from the analysis. For a discussion of the effect of combining the distribution of slow and fast movers, we refer to Fleischmann (1999).

For a fair comparison between the current situation and Factory Gate Pricing, the data of the SuperUnie members do not suffice. This is because restricting the case to the SuperUnie retailers would bias the current situation by underestimating the economies of scale present at the suppliers. To avoid this, the dataset is scaled up on the basis of the market shares of the other Dutch food retailers and the known locations of their distribution centres. This results in a dataset with the characteristics listed in Table 8-1. The hubs are the sites of LSPs that currently work for multiple suppliers.

| **Dataset characteristic** | **Value** |
|---|---|
| Number of suppliers | 340 |
| Number of product groups | 355 |
| Number of retailer distribution centres | 47 |
| Number of hubs | 25 |
| Number of productgroup – DC relations | 11,980 |
| Number of monthly orders | Appr. 60,000 |

Table 8-1. Size of the problem

The cost and time data for handling activities (like truck loading, unloading, storing), transport (driving, stopping), and administration (ordering) come from a sector-specific database (see Stichting Ketenmoduul, 2000) and have been verified by the three participating retailers (see Figure 8-2). Since the constructed dataset covers a representative period of a year, the results of the study can be used to estimate yearly cost.

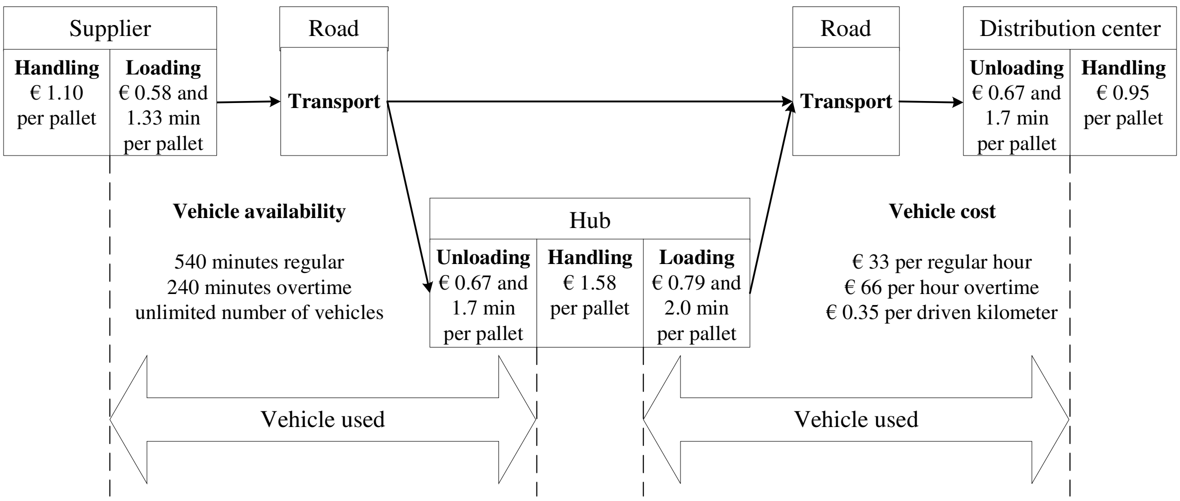


Figure 8-2. Overview of processes with data

Inventory costs can be directly derived from the values per pallet. These are obtained from the retailers' databases and the cost per pallet position in a distribution centre (Stichting Ketenmoduul, 2000). In general, inventory costs are not dominant for the product groups under consideration, as the average pallet value is only € 784.

In order to assess the potential of FGP, seven scenarios are defined, corresponding to different *supply chain orchestrators*, *degrees of cooperation* and *flow synchronisation*. An overview of the scenarios is presented in Figure 8-3.

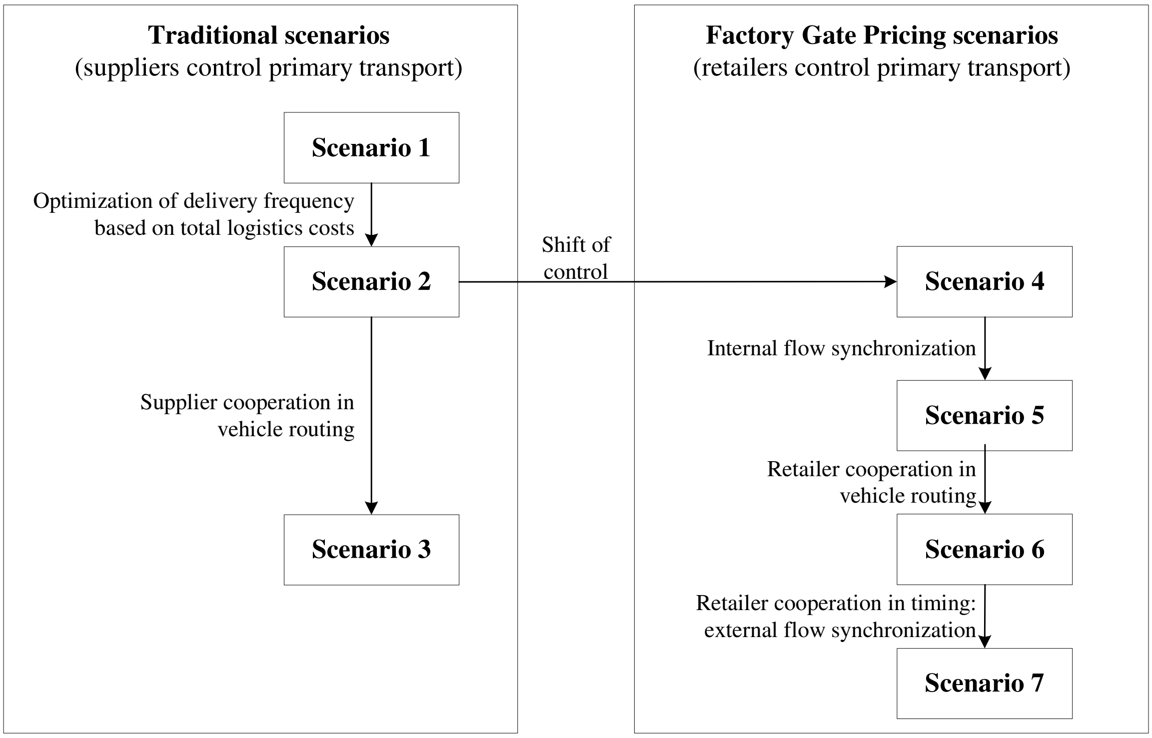


Figure 8-3. Overview of the interrelation of the scenarios

Below, we explain the scenario's in Figure 8-3. First of all, there is an important distinction between *flows* and *orders*. A flow is a productgroup – DC relation with a given constant demand per unit of time. The number of orders corresponding to a flow is equal to its frequency of delivery and it is assumed that they are equally spread over the planning horizon. The supply chain orchestrators have the planning authority over the transport flows and are thus responsible for the corresponding orders. In the original situation, the supplier is the supply chain orchestrator for the primary distribution. Under FGP however, the retailers take over this role. 'Cooperation' means that there is horizontal cooperation between orchestrators by means of joint route planning for all their transport orders for a certain day (cf. Chapter 4). Finally, synchronisation is the process of moving orders within the time horizon to obtain better flow combinations. Two types of flow synchronisation exist: internal and external synchronisation. Internal synchronisation means that the supply chain orchestrators can only shift their own flows over time. With external synchronisation, the supply chain orchestrators cooperate in synchronizing their flows. Note that external synchronisation can only take place if there is cooperation.

Based on the different possibilities described above, seven scenarios are defined in Figure 8-3. Scenario 1 is the original situation, where the suppliers are in control of the transport. Scenario 2 is equal to Scenario 1, except that frequencies of delivery are optimised based on total supply chain costs.. Scenario 3 extends scenario 2 with horizontal cooperation between suppliers. Scenarios 4 and 5 are basic FGP situations. Retailers are the orchestrators and the frequencies of delivery are optimised on the basis of total supply chain costs. Scenario 5 adds internal flow synchronisation to scenario 4. Finally, Scenarios 6 and 7 are FGP situations with different degrees of retailer cooperation. In Scenario 6, the retailers jointly plan their transport orders (i.e., the situation analysed in Chapter 4). In Scenario 7, the timing of the replenishment flows is also tuned between the retailers (i.e., external flow synchronisation). Section 8.5 develops statements about the impact on the total cost of each transition from one scenario to another.

In assessing the value of FGP, the primary distribution is concentrated on. The reason is that the current case consists solely of slow moving (grocery) products. Given the trend of central warehousing as described in Mercer (1993) and the inherently small volumes of slow movers, it is unlikely that these products will be transported directly from the supplier directly to the shops. It is furthermore assumed that an infinite number of trucks is available (this is in fact an assumption that will be made in all enabling concepts for horizontal cooperation discussed in PART III of this thesis). Other restrictions on trips are the maximum (legally allowed) working time of a driver and the truck capacity expressed in $m^2$ footprint.

## 8.4 METHODOLOGY

This section describes the methodology for solving the Factory Gate Pricing optimisation problem. Considering the huge size of the problem (see Table 8-1), we adopted a two-phase heuristic approach. This section discusses phase 1 in detail and sketches at phase 2.

### *8.4.1* Phase 1: Mode of Transport and Frequency Optimisation

Throughout, four cost factors are distinguished. They are: transport, handling, order processing, and inventory costs (see Figure 8-2). For each product group ( $pg$ ) - distribution centre ( $dc$ ) combination these so-called total logistics costs, as formalised in (8.1), are minimised.

$$\begin{aligned} TC_{pg,dc} = {} & InventoryCosts_{pg,dc}(Freq_{pg,dc}) + \\ & OrderingCosts_{pg,dc}(Freq_{pg,dc}) + \\ & HandlingCosts(Freq_{pg,dc}, Mode_{pg,dc}) + \\ & TransportCosts_{pg,dc}(Freq_{pg,dc}, Mode_{pg,dc}) \end{aligned} \tag{8.1}$$

The main goal of the first phase of the heuristic is to find the right balance between inventory costs and transport costs. This balance can be influenced by means of two decision variables. Firstly, there is the frequency of delivery ( $Freq_{pg,dc}$ ) with which productgroup $pg$ is delivered to distribution centre $dc$. The planning period consists of four weeks (24 working days). After consulting SuperUnie experts, six possible frequencies of delivery that occur in practice during a

24-day period are defined (see Table 8-2). However, for some products certain frequencies may not be feasible because of restrictive product characteristics. When this was the case, this was added to the model as an extra flow-specific restriction. Choosing a high frequency of delivery for a given flow generally increases transport, order processing, and handling costs, but it decreases inventory costs.

| $Freq_{pg,dc}$ | **Interpretation** |
|---|---|
| 1 | Delivery once every four weeks |
| 2 | Delivery once every two weeks |
| 4 | Weekly delivery |
| 8 | Delivery twice a week |
| 12 | Delivery three times a week |
| 24 | Daily delivery |

Table 8-2. The allowed frequencies

The second decision variable is the delivery mode ($Mode_{pg,dc}$). $Mode_{pg,dc} = 1$ means that productgroup $pg$ travels directly from the supplier to distribution centre $dc$, while $Mode_{pg,dc} = 0$ means that product $pg$ is consolidated at a hub before it goes to distribution centre $dc$.

Demand is constant over the 24-day period, so the order sizes can be straightforwardly adjusted according to the frequency of delivery. For the currently used frequencies of delivery, the safety stocks of each product are given in the dataset. These are then adjusted for changes in the frequency of delivery, using the formula as discussed in Simchi-Levi et al. (2000), page 53:

$$InventoryCosts_{pg,dc}(Freq_{pg,dc}) = \left( \frac{2WeeklyVolume_{pg,dc}}{Freq_{pg,dc}} + CurSafetystock_{pg,dc}\sqrt{\frac{CurFreq_{pg,dc}}{Freq_{pg,dc}}} \right) * Value_{pg,dc} HoldingCosts\%_{dc} \tag{8.2}$$

Furthermore, the ordering and handling cost are estimated using formulas (8.3) and (8.4). Total order processing costs exhibit a one-to-one relation with the frequency of delivery, while handling costs depend on both the frequency of delivery and the mode of transport, i.e., the number of loading/unloading activities for each flow. Therefore, estimating these three cost factors is relatively straightforward.

$$OrderingCosts_{pg,dc}(Freq_{pg,dc}) = CostPerOrder_{pg,dc} * Freq_{dc,ag} \tag{8.3}$$

$$HandlingCosts_{pg,dc}(Freq_{pg,dc},Mode_{pg,dc})=$$
$$Freq_{pg,dc}\left\lceil \frac{4\cdot WeeklyVolume_{pg,dc}}{Freq_{pg,dc}} \right\rceil \cdot$$
$$\left(handlingcosts^{sup,dc}_{pg,dc}+loadingcosts^{sup}_{pg,dc}+unloadingcosts^{dc}_{pg,dc}+\right. \tag{8.4}$$
$$\left.(1\text{-}Mode_{pg,dc})\left(unloadingcosts^{cc}_{pg,dc}+handlingcosts^{cc}_{pg,dc}+loadingcosts^{cc}_{pg,dc}\right)\right)$$

The last cost factor is transport costs. These are unfortunately harder to estimate, since they depend on the possible combinations of orders in trucks. This problem is tackled by analysing a large set of pick-up and delivery routes, calculated by the routing heuristic (see description of Phase 2 in Section 8.4.2) on selected instances of the periodic pick-up and delivery problem in the case study. The cost of each route was then assigned to the orders according to truck space usage per kilometre from pick-up to delivery address. This routine leads to an estimate of the transport costs for each order. Finally, a formula for the transport costs is estimated by means of three regression models with a number of order characteristics as explanatory variables. The three different regression models relate to three types of transport links:

1. From supplier to distribution centre
2. From supplier to hub
3. From hub to distribution centre

Link 1 represents the direct mode, links 2 and 3 correspond to the indirect mode. For each type of link $s$, a set of characteristics with the corresponding parameter estimations $\beta_s$ is determined.

The explanatory variables are formed by a number of order characteristics. These characteristics are indicators for the level of synergy and are based on the analysis in Chapter 4. They relate to:

- Driving time in minutes from the pick-up to the delivery location
- Distance in kilometres from the pick-up to the delivery location
- Volume to be shipped
- Volume within 30, 45, 60 minutes of driving time from the pick-up (delivery) location
- Number of DCs within 30, 45, 60 minutes of driving time from the pick-up (delivery) location
- Number of suppliers within 30, 45, 60 minutes of driving time from the pick-up (delivery) location

$X_s(Freq_{pg,dc}, Mode_{pg,dc})$ specifies the values of the explanatory variables in each of the three regression equations. It is now possible to estimate the transport cost for a given $(pg, dc)$-combination:

if $Mode_{pg,dc} = 1$ (direct mode), then

$$TransportCosts_{pg,dc}(Freq_{pg,dc}, Mode_{pg,dc}) = \sum_{s \in S^{sup,dc}} \beta_s \cdot X_s(Freq_{pg,dc}, Mode_{pg,dc}) \quad (8.5a)$$

if $Mode_{pg,dc} = 0$ (via a hub), then

$$TransportCosts_{pg,dc}(Freq_{pg,dc}, Mode_{pg,dc}) = \sum_{s \in S^{sup,cc}} \beta_s \cdot X_s(Freq_{pg,dc}, Mode_{pg,dc}) + \sum_{s \in S^{cc,dc}} \beta_s \cdot X_s(Freq_{pg,dc}, Mode_{pg,dc}) \quad (8.5b)$$

Here, $S^{X,Y}$ is the set of links from location type $X$ to location type $Y$. The explained variance of this regression model is 90%. This level of precision suffices to make a reasonable estimate of the transport costs that can be used for the frequency and delivery mode optimisation in phase I. Later, in phase II, detailed Periodic Pickup and Delivery Problems are solved to obtain the precise transport cost figures for the chosen frequency and delivery mode.

Now that estimates are available for each cost factor, we are able to make a choice on the frequency of delivery and mode of transport for each order. Since there are only twelve possible combinations (six frequencies of delivery and two modes of transport), costs are estimated for every possible combination. Finally, the cheapest feasible possibility is selected.

Phase 1 is now finished by constructing an instance of the Periodic Pick-up and Delivery Problem based on the generated transport orders, corresponding to the chosen combination of frequency of delivery and mode of transport.

### 8.4.2 Phase 2: Periodic Pick-up and Delivery Problem

To get reliable distribution cost estimates, a very large Periodic Pick-up and Delivery Problem (PPDP) must be solved. Like many other routing heuristics, ours consists of a construction part and an improvement part. Since this PPDP heuristic uses classical techniques only i.e., an adaptation of the savings method (Clarke and Wright, 1964) for construction and re-insertions in the improvement part, it will not be discussed in detail. It should however be noted that, to the best of our knowledge, this heuristic is the first that is able to deal with very large instances of the PPDP. Instances that cover all Dutch food retailers (for slow movers) consist of up to 60,000 transport orders. Instances are solved within thirty minutes to twelve hours of calculation time on a Pentium 2,200 MHz processor with 512 MB of RAM.

### 8.4.3 Verification and Validation of the Model

In order to verify internal consistency of the model, test runs and sensitivity analyses are performed. Parameters are varied between their extreme values to check if the behaviour of the models is in line with expectations and whether the outcomes are correct. Then, in the validation process, the external correctness of the model is tested to check if the model gives a good representation of the real world. Several organizations helped to validate the model, amongst them the three participating SuperUnie retailers, a consultancy firm specialised in retail distribution, and academics. After this, we are confident that the model and its assumptions are representative.

## 8.5 RESULTS

This section discusses six statements derived from the numerical results of the case study. All numbers are yearly cost figures. Table 8-3 provides a detailed overview of the costs of the scenarios 1 to 7.

| | **Scen. 1** | **Scen. 2** | **Scen. 3** | **Scen. 4** | **Scen. 5** | **Scen. 6** | **Scen. 7** |
|---|---|---|---|---|---|---|---|
| Transport | 76,921 | 59,894 | 43,627 | 49,996 | 48,468 | 42,923 | 41,776 |
| Inventory | 21,063 | 28,279 | 28,279 | 28,279 | 28,279 | 28,279 | 28,279 |
| Handling, loading and unloading | 53,533 | 43,321 | 43,215 | 42,969 | 42,799 | 43,059 | 42,824 |
| Ordering | 12,003 | 6,204 | 6,204 | 6,204 | 6,204 | 6,204 | 6,204 |

Table 8-3. Costs of the different scenarios (in k€ )

***Statement I: Optimisation of frequencies of delivery can create large costs savings (transition from scenario 1 to scenario 2).***

Figure 8-4 represents a comparison of the supply chain cost under the present frequencies of delivery used by the retailers and the cost under optimised frequencies. With the optimised frequencies of delivery, the transport, handling, and order processing costs decrease at the expense of slightly higher inventories and the overall cost reduction amounts to 15.8%. Beside this cost effect, it can be observed that the use of the consolidation hubs is drastically reduced. The reason is that, as a result of the lower frequencies of delivery, the average size of the shipments increases. Furthermore, the average load factor of the trucks increases by 3.0% and the number of empty kilometres per route decreases by 9.5%.

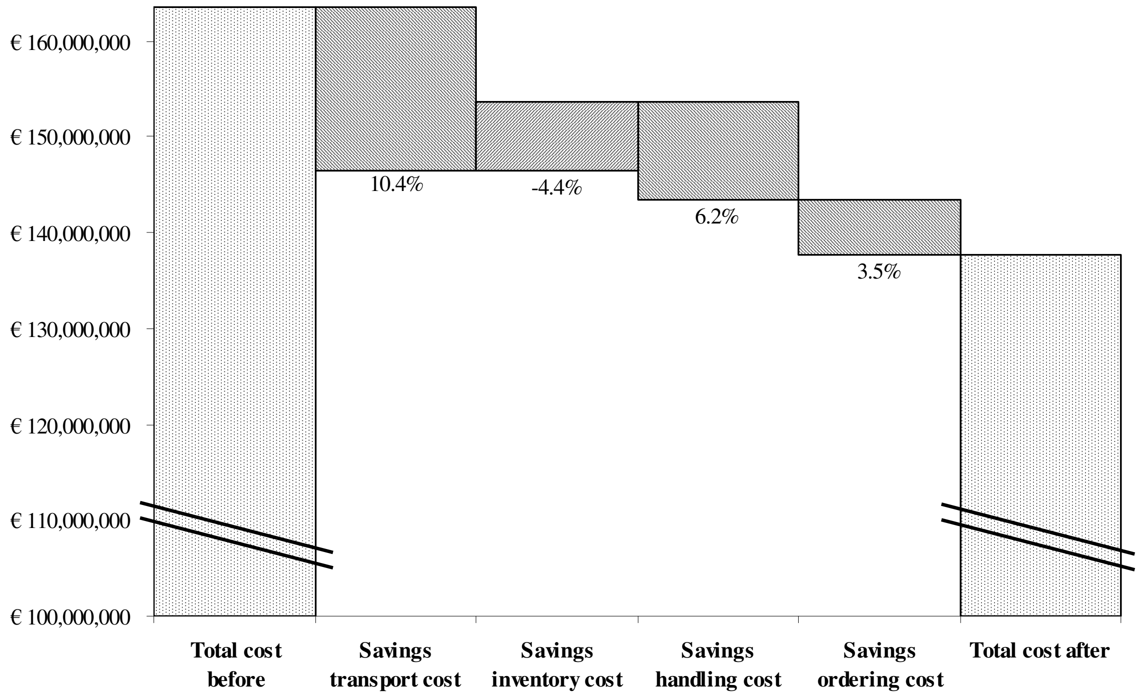


Figure 8-4. Statement I: The optimisation of frequencies

***Statement II: Shifting to Factory Gate Pricing decreases the supply chain costs (transition from scenario 2 to scenario 4).***

Figure 8-5 illustrates Statement II: in the Dutch retail supply chain for slow moving dry grocery goods, FGP is beneficial. By shifting the flow orchestration from the suppliers to the retailers, supply chain costs go down by 7.5%. This shift of control changes the transport process from a delivery system to a collection system. Since the supplier sites strongly outnumber the retailer distribution centres, the collection network of the retailers is denser than the delivery network of the suppliers. Therefore, more efficient route schemes can be created (see the discussion of Figure 4-4 in Chapter 4). Under FGP, the total number of kilometres driven exhibits a decrease of 21% from over 65 million to less than 52 million kilometres. These results are in line with the observations of an FGP study undertaken by Tesco in the UK where a kilometre reduction of 25% for ambient products and 23% for fresh products was reported (Potter et al., 2003).

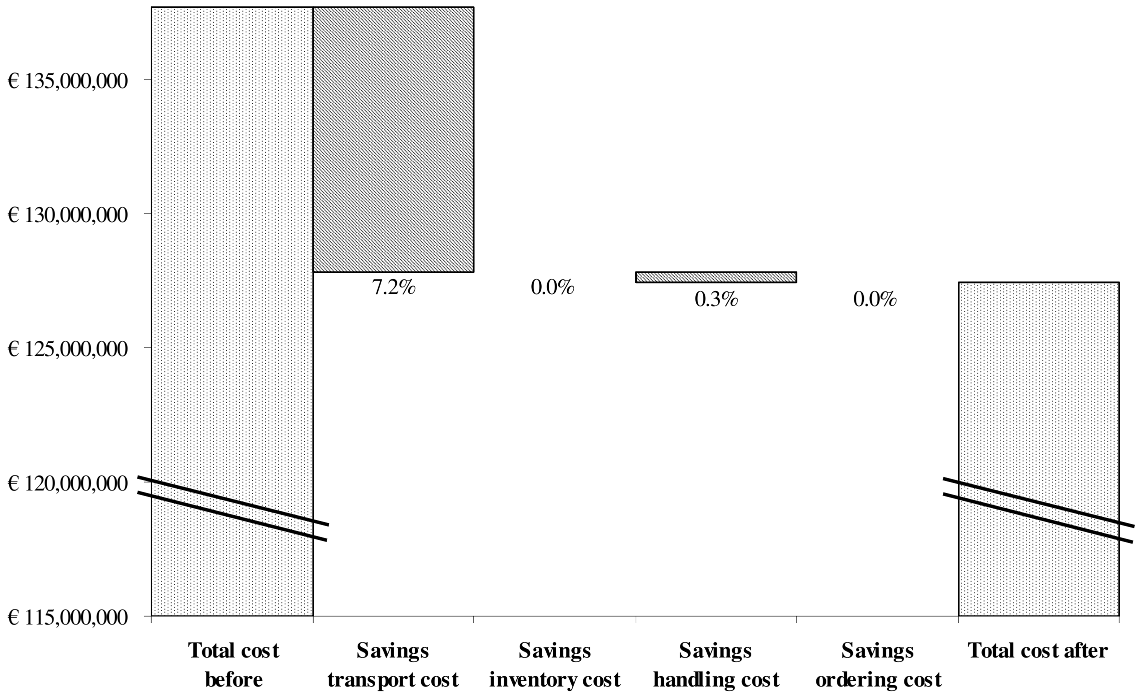


Figure 8-5. Statement II: Shifting to Factory Gate Pricing

***Statement III: Internal flow synchronisation creates value (transition from scenario 4 to scenario 5).***

Under FGP, internal flow synchronization can enhance planning decisions of an individual retailer. As explained above, flow synchronization means the shifting of orders belonging to the same transport flow over the planning horizon to attain more suitable combinations of orders. Note that this does not influence the frequency of delivery and the time between two consecutive visits. Although the resulting decrease of 1.3% of total logistics costs is relatively small (see Figure 8-6), this reduction is interesting because it can be easily attained without any organizational changes.

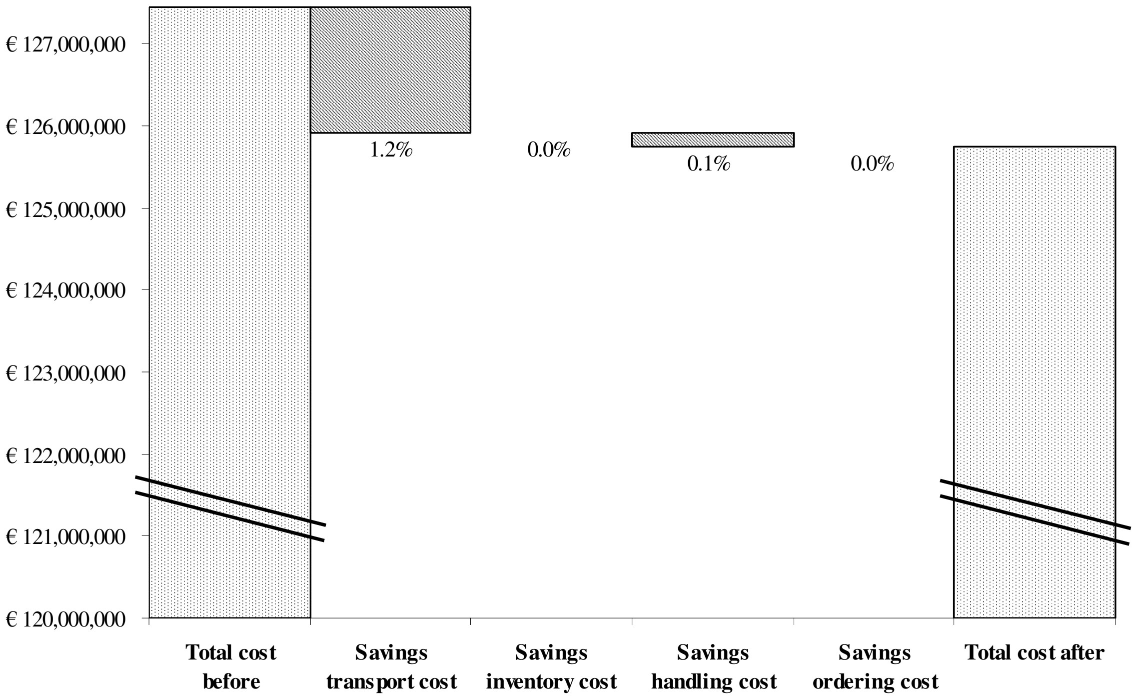


Figure 8-6. Statement III: Internal flow synchronisation

***Statement IV: Cooperation is profitable regardless of the orchestration (transition from scenario 2 to scenario 3 and the transition from scenario 5 to scenario 6).***

Statement IV is of special importance in the context of this thesis. Figure 8-7 shows the effect of horizontal cooperation between either the suppliers or the retailers. The upper part of the figure illustrates cooperation between suppliers in the original situation; in the lower part retailer cooperation under FGP is illustrated. Although cooperation is profitable regardless of the orchestration, in the original situation the cost savings from cooperation are much larger than in the FGP situation, 11.9% and 4.2%, respectively. This is explained by the fact that in the FGP situation the retailers already have a dense collection network that enables them to construct quite efficient routes. This is in line with the observation made in Section 4.4.6 that synergy values are negatively related to market concentration.

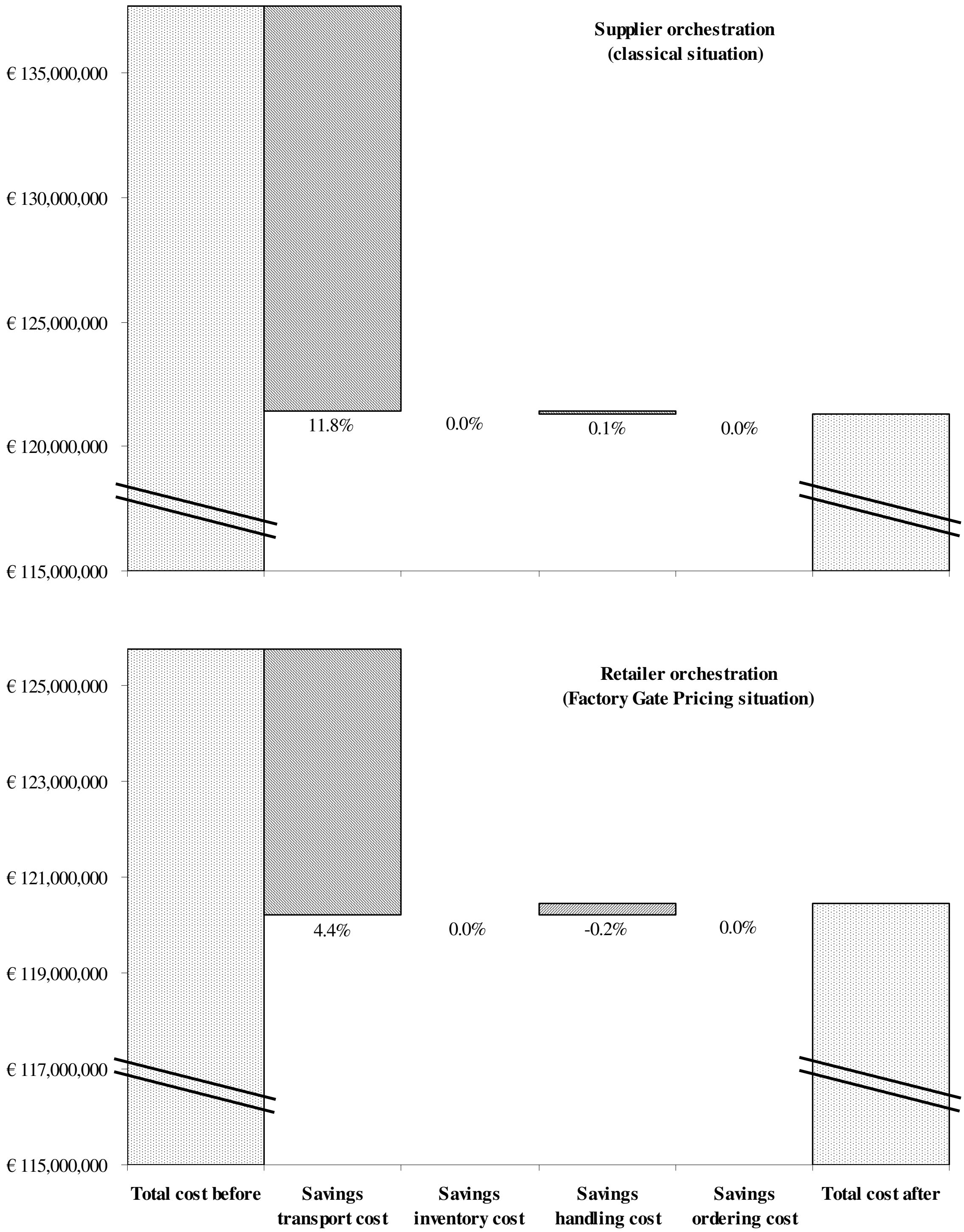


Figure 8-7. Statement IV: Cooperation

***Statement V: External flow synchronisation creates value (from scenario 6 to scenario 7).***

The results of combining cooperation between retailers with external flow synchronisation are shown in Figure 8-8. Besides combining transport orders in the same truck, retailers also cooperate in determining the timing of the transport orders. It turns out that this results in an additional cost benefit of 1.2%. Taking into account the significant organizational cost that is needed to externally synchronise orders and the small benefit of this, external flow synchronisation does however not seem to be a very attractive option.

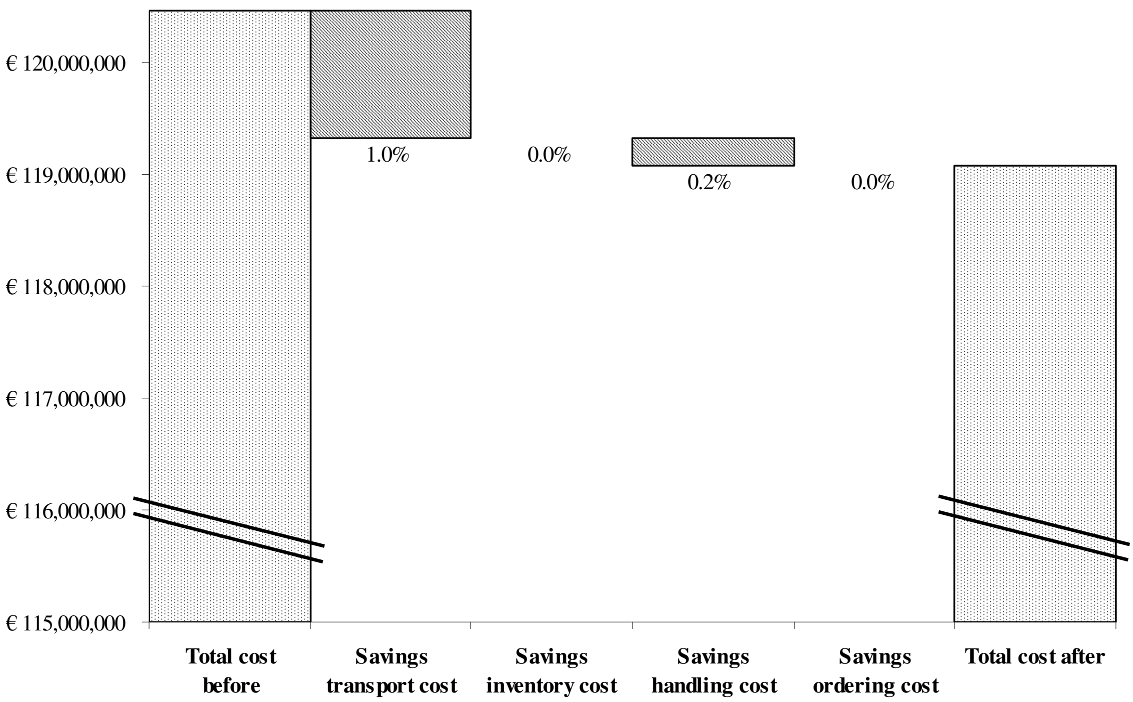


Figure 8-8. Statement V: External flow synchronisation

***Statement VI: When a small subset of the retailers engage in FGP, adverse cost effects due to the reduced network density for the suppliers are small.***

In practice, it is unlikely that all retailers in the sector will change their logistics structure at the same time. Also, it may be expected that only retailers that are already in some way organized will cooperate horizontally. Statement VI is illustrated by showing the cost effects of a shift to FGP of only the retailers participating in this study. This group, referred to as JuDeCo, operates five distribution centres in the Netherlands. Figure 8-9 gives a comparison of the total transport costs in the sector before and after the JuDeCo retailers moved to FGP. A restriction is made to transport costs because this is the only cost group that is affected by the reduction in network density of the suppliers delivering to the other retailers. The reduction in total transport costs of the system amounts to 1.1% for the total system, which is brought about by a strong transport cost saving of over 20% for JuDeCo. The transport costs for the other retailers increase by 1.5%.

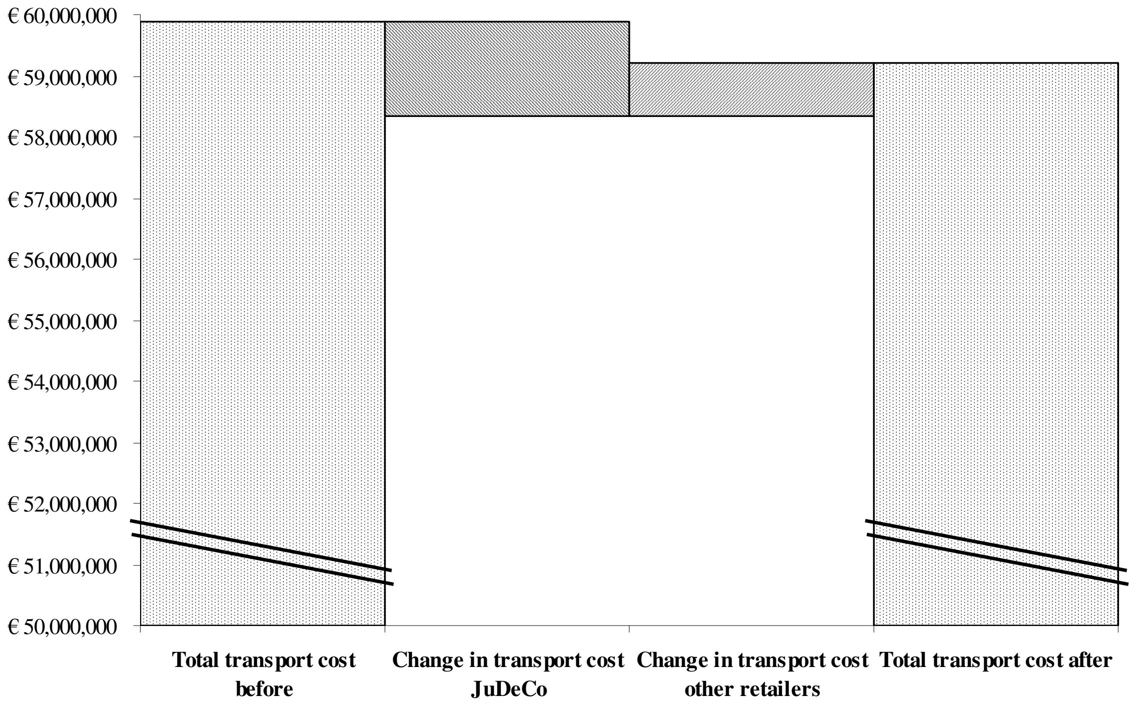


Figure 8-9. Statement VI: Factory Gate Pricing of JuDeCo retailers

## 8.6 POINTS OF ATTENTION

The preceding sections have shown that Factory Gate Pricing potentially is a promising concept for optimising logistics operations. However, there are some points of attention that practitioners and researchers should take into account. This section discusses practical barriers to FGP implementation (Section 8.6.1) and some directions for further research (Section 8.6.2).

### 8.6.1 Practical Limitations and Points of Attention

The case study indicates that FGP is attractive for slow moving dry grocery products. From a logistics point of view, these products are easy to handle. They have a long storage life, low value per unit, small volumes, and temperature-controlled transport is not required. For other products or industries, the savings reported here may therefore not be attainable.

Suppliers may be concerned about the decreased density of their distribution network caused by the shift to FGP of some of their customers. Obviously, this makes their distribution networks less dense. The results presented in section 8.5 however show that this effect does not cause dramatic cost increases if only a small number of retailers apply the concept.

Finally, there is the core assumption behind the FGP concept that retailers can buy products from their suppliers at a price from which transport costs are filtered out. This requires that suppliers have both the ability and the willingness to provide insight into their price structure. Moreover, suppliers might not have the flexibility to allow retailers to pick up products because of limited dock capacity or long-term contracts with LSPs for the transport of their products. However, if a retailer is a very important customer for a supplier, as is often the case, he might simply be able to enforce FGP.

### 8.6.2 Directions for Further Research

In this section we discuss five directions for further research. First, in its present form, the model only incorporates primary transport. It is possible to also incorporate secondary transport in the routing problem. For certain (large) flows, it may be optimal to bypass the retailer's DC and travel directly from the supplier to a retail outlet. This would create a higher degree of freedom and possibly increase the total cost savings of FGP. Second, when retailers cooperate to achieve a cooperative planning, they all contribute to the benefits that this cooperation yields. In order to provide good incentives for retailers considering participation, a fair allocation mechanism of the total gain is needed. This topic will be discussed in detail in Chapter 9 and Chapter 10. Third, consolidation hubs can be of great use for combining small loads in order to increase load factors and cut down on empty kilometres. Clearly, the locations of the consolidation hubs are of great importance for the performance of the system. It is worthwhile to calculate the optimal locations from real data and compare the present savings to the simulated savings with the consolidation hubs at their optimal locations. Moreover, it would be interesting to calculate the cost advantages in case cooperating retailers open their distribution centres for consolidation activities. Chapter 10 will study the development of such a cooperative hub network in detail. Fourth, it is assumed throughout the calculations that a planning period of four weeks gives a good representation of a whole year. This may not be true for products other than dry grocery goods. Finally, to cross-check the validity of the results, it would be very interesting to perform the analysis for other countries as well.

## 8.7 CONCLUDING REMARKS

This chapter introduced the concept of Factory Gate Pricing. A model was developed that is capable of simulating different scenarios for a distribution system in terms of the orchestration, cooperation, and flow synchronisation. Results have been generated for a Dutch retail supply chain of slow moving dry grocery goods.

The cost savings with respect to the original situation are mainly caused by three factors. Firstly, the frequencies of delivery are optimised based on total supply chain costs. This is facilitated by FGP because it brings the coordination of inventory and transport under the control of the retailer. Secondly, there is the synchronisation of replenishment orders: the retailer can determine the timing of replenishment orders so that nearby suppliers can be combined in one route. Finally, the asymmetry in the network is exploited to save costs. In the case studied, the suppliers outnumber the retailers' distribution centres.

The experiments show that compared to the original situation, FGP results in a 22% decrease in supply chain costs. If there is also horizontal cooperation, savings up to 26% are possible. These savings are based on a transition of all retailers in the market to FGP. However, experiments with the transition of only a small number of retailers to FGP still result in considerable savings for the participating retailers.

More research on the subject is needed. The model was developed to assess the potential of FGP on a strategic level, focusing on the primary distribution part. Combining primary and secondary distribution is appealing since this may increase the savings resulting from FGP even more. Although there is extensive operations research literature on subproblems of the FGP optimisation problem, there are no models that tackle the complete problem. Since FGP is being implemented more and more in practice, this offers an interesting challenge for researchers.

# CHAPTER 9 INSINKING

## 9.1 INTRODUCTION

This chapter introduces a second enabling concept for horizontal cooperation. In this concept, a Logistics Service Provider (LSP) implicitly enforces horizontal cooperation by simultaneously targeting a group of possibly competing shippers.

In recent years, LSPs have had to cope with stricter requirements of shippers in terms of speed, flexibility and price (cf. Chapter 1). In addition, because of broader product assortments and shorter life cycles, streams through the LSPs' networks became fragmented. This causes load factors and, by consequence, profit margins to drop. To cope with these difficult market conditions, LSPs are on a continuous search for opportunities to increase their efficiency and discern themselves from competitors.

### 9.1.1 Insinking versus Outsourcing

Razzaque and Sheng (1998) define logistics outsourcing or *third party logistics* as the provision of a single or multiple logistics services by a vendor on a contractual basis. It has been estimated that about 40% of global logistics is outsourced, and increasing numbers of shippers consider it an attractive alternative to the traditional logistics service mode (cf. Wong et al., 2000; Hong et al., 2004).

For their turnover, LSPs heavily depend on the extent to which industrial shippers outsource their logistics activities. Wilding and Juriado (2004) provide a literature review of empirical papers on outsourcing, investigating which activities are typically outsourced and what are the most important reasons for doing so. Table 9-1 shows the top-5 reasons for outsourcing.

| Rank | Reason |
|---|---|
| 1 | Cost or revenue related |
| 2 | Service related |
| 3 | Operational flexibility related |
| 4 | Business focus related |
| 5 | Asset utilisation or efficiency related |

Table 9-1. Reasons for outsourcing logistics activities

The outsourced activities can be related to transport, warehousing and inventory, information systems and value added services. It turns out that the most basic logistics functions of transport, warehousing and inventory are outsourced most frequently.

The general idea behind outsourcing is a focus of companies on their core businesses. For example, customers of an LSP benefit from the LSP's larger economies of scale that enable him to perform transport and warehousing more efficiently than his customers. In this context, outsourcing and horizontal cooperation aim at achieving the same goal. Traditionally, the initiative for outsourcing lies with the shippers: once it is reckoned by management that logistics activities can better be performed by a third party, an invitation to submit a tender is sent out to a number of pre-selected LSPs. Based on this invitation, the LSPs then propose a price for their services.

The subject of this chapter is the reverse mode of operation, where the initiative for a contract lies with the LSP. To stress the contrast between the traditional *push* approach of outsourcing, and the here proposed *pull* approach where the LSP is the initiator of the shift of logistics activities from the shipper to the LSP, this phenomenon will be referred to as *insinking*, the antonym of outsourcing.

The advantage of insinking over outsourcing is that it enables LSPs to gain maximum synergetic effects by tendering for multiple shippers whose distribution networks can be merged very efficiently. Therefore, there exist promising business opportunities for insinking in practice. One example is the introduction of the so-called transport-arrangements in the Dutch Randstad metropolis (E.R. 19). In this project, a Dutch LSP offers prominent shippers in the fashion sector to perform the distribution to their shops in the city centres against very competitive tariffs. These tariffs are low because of the strong synergies the LSP can benefit from in case he replenishes multiple fashion outlets in the same city centre. The Dutch branch organization for fashion companies, actively participates in this project by stimulating their members to accept the offer. Engaging in the transport-arrangements project is beneficial for the individual producers because transport costs are reduced and customer satisfaction is likely to increase since the number of visits per shop decreases when multiple shippers make use of the transport-arrangements. As a result, trucks interrupt store personnel less frequently. Moreover, congestion in the city centre will decrease as a result of the smaller number of truck movements. Apart from the time investments that all partners in this project are making, the financial risk rests solely with the LSP. After all, the tariff offers are based on the *expectation* that a certain minimum number of shippers will participate. So if only one or two shippers accept the offer, the synergies required to break even may not be attained. When the behaviour of potential customers is highly unpredictable, this risk might be prohibitive for the LSP. To resolve this issue, this chapter offers a methodology for LSPs to apply insinking while eliminating this financial risk.

### 9.1.2 Co-opetition

Shippers who are active in the same sector, such as the fashion producers in the transport-arrangements example, will sell products with roughly the same characteristics and ordering dynamics (time windows, order sizes, conditioning, etc.). This creates strong synergy potential for an LSP, because he can operate the same truck types and sometimes even the same routes to serve multiple shippers. When shippers are served on the same route, insinking creates a special type of horizontal cooperation: so-called ‘co-opetition’ (cf. Section 2.2). Although the shippers are competitors on their core businesses, they tacitly cooperate with each other on the non-core domain of transport since they agree that their products are distributed in a single shipment with their competitors’ products. Transport, the area where the cooperation takes place, is not visible to customers. It was already argued is Section 2.2.1 that this is a beneficial circumstance for horizontal cooperation. Particularly in transport and logistics, where there are almost no unique technologies, companies must often rely on applying innovative concepts such as co-opetition to achieve growth. In practice, co-opetition is quickly gaining momentum in the grocery industry. In this sector, profit margins are thin and demand variation is strong. Examples of co-opetition in the consumer goods industry can be found in Bahrami (2003), and Chapter 8 of this thesis.

### 9.1.3 Gain Sharing

In Chapter 2 it was argued that there exist important barriers that can prevent horizontal cooperation initiatives from prospering. Nine specific potential impediments for horizontal cooperation have been presented to Flemish LSPs. Table 5-4 presents the evaluations of these impediments (5-point Likert scale).

Because impediments for LSPs will supposedly also hold for horizontal cooperation between shippers, the assumption is made that the evaluations by the LSPs provide an indication for the attitude of shippers. It turned out that the impediments about the fairness and stability of cooperation (impediments 1, 3, 5, and 6) rank high. In particular, guaranteeing a fair allocation of the achieved benefits is the most important impediment for horizontal cooperation. 80% of the respondents (strongly) agreed with this proposition, 16% was neutral, and as little as 4% (strongly) disagreed. Mistrust about the fairness of the applied allocation rule for the savings has caused many horizontal logistics cooperation initiatives between shippers, and/or LSPs to marginalise or disintegrate.

It was already discussed in Section 2.4.2 that gain sharing is a difficult problem that in general cannot be solved to the satisfaction of all partners by applying simple proportional rules. On the contrary, to ensure a fair gain sharing mechanism, the marginal contributions of each shipper to the total gain have to be accurately quantified. The insinking approach uses the true contributions to the group’s synergy to calculate customised prices that fairly distribute the monetary savings attained by consolidating flows of shippers. The applied methodology is explained to the shippers and the LSP’s cost structure is deliberately made transparent.

Instead of practical rules of thumb, we propose to employ solution procedures from cooperative game theory. Cooperative game theory models the negotiation process within a group of cooperating agents (in this case shippers) and allocates the generated savings. This field has proved capable of solving fairness issues in many fields. Some logistics related examples are: (Vertical) Supply Chain Coordination (cf. Vos et al., 2002; Cachon and Lariviere, 2005; Hub-and-Spoke network formation (cf. Matsubayashi et al., 2005), Outsourcing (cf. Elitzur and Wensley, 1997), and Inventory pooling (cf. Anupinidi et al., 2001); Bartholdi and Kemahlioğlu-Ziya, 2004; Sošić, 2005). Other sectors where game theoretical methods have been successfully applied in practice include amongst others: Automotive (cf. Cachon and Lariviere, 1999), Retail (cf. Sayman et al., 2002), Telecommunication (cf. van den Nouweland et al., 1996), Aviation (cf. Adler, 2001), and Health Care (cf. Ford et al., 2004). Cooperating companies in these sectors benefit from game theoretical methods that objectively take into account each player's impact within the group as a whole and produce compromise allocations that distribute the benefits of cooperation based on clear cut fairness properties. Different fairness properties are represented by well-known allocation rules such as the Shapley value (Shapley, 1953), the nucleolus (Schmeidler, 1969) and the tau-value (Tijs, 1981). As will become clear in the remainder of this chapter, cooperative game theory offers a solution to the four gain sharing related impediments for horizontal logistics cooperation in Table 5-2. For a discussion of the performance differences between game theoretical solution concepts on the one hand, and rules of thumb on the other, we refer to Frisk et al. (2006).

### 9.1.4 Price setting

With the insinking procedure, the LSP establishes fair gain sharing by means of customised pricing. This enables the LSP to explicitly take into account the participants' marginal contributions to the group's synergy value. The business opportunities offered by intelligent pricing strategies are being increasingly recognised in Marketing (cf. Desiraju and Shugan, 1999) and Psychology (cf. Hermann et al., 2004). The advent of Information and Communication Technology (ICT) in the last decade has opened up a vast array of new pricing possibilities (cf. Dixit et al., 2005). The most important challenge of such information enhanced pricing strategies is to be perceived by customers as fair. Perceived fairness depends on comparisons to past prices, competitor prices, and perceived cost of the product or service (cf. Bolton et al., 2003). Although these factors come from a Business-to-Consumer setting, it is hypothesised that the same constructs are relevant for the Business-to-Business situation that is considered in this chapter.

An important aspect of fair pricing is the principle of dual entitlement (cf. Kahnemann et al., 1986). This means that a profit increase by the selling firm (the LSP) is only accepted if it does not harm the customer's interest. This egalitarian principle sometimes conflicts with the utilitarian principle of cost-based pricing. Under cost-based pricing, an LSP will charge the total costs plus a 'reasonable' percentage. Dixit et al. (2005) argue that dissatisfaction about fairness of prices could be avoided by proper and clear communication about the price composition. Therefore, this openness is an important aspect of insinking and, as will become clear in the next section, both the egalitarian and utilitarian principles mentioned above are satisfied.

Despite its obvious business opportunities, only few firms take full advantage of intelligent pricing. The vast majority still uses pricing strategies based on historical cost benchmarks, whereas more forward-looking and clientele-oriented pricing is likely to be more promising (cf. Noble and Gruca, 1999). Especially in the very competitive and low-margin transport sector, smart pricing offers LSPs an excellent opportunity to gain a competitive edge.

The remainder of this chapter is organized as follows. In the next section the insinking procedure for exploiting synergy in transport will be explained and illustrated by means of a small hypothetical example. In Section 9.3, the applicability of the procedure is established by means of a practical example based on real-life data from the Dutch grocery transportation sector. Finally, Section 9.4 concludes.

## 9.2 THE INSINKING PROCEDURE

The insinking procedure builds on customized pricing by an LSP. These prices (or: *tariffs*) are induced by the varying claims of the shippers' order sets on the LSP's resources. Among other properties, order sets may differ in the number of orders, the geographical spread of the drop points, the location of the shipper's warehouse(s), the narrowness of time windows, and the average and standard deviation of the order sizes. In Chapter 4 it was shown that each of these aspects has a clear influence on the synergy value when the order sets are combined. In this section we introduce the insinking procedure by describing its three steps:

1. Target group selection,
2. Cost reductions, and
3. Negotiation and structure of sequential offers.

These steps will be successively discussed in the three subsections below and necessary notation will be gradually introduced. At the end of this section, a comprehensive overview of the insinking procedure will be provided.

### 9.2.1 Target group selection

As a first step, the LSP has to select the group of shippers $M$ he wishes to serve from the total set $N$ of potential customers. It was mentioned in the introduction that opting for a group of shippers from the same industry comes at the advantage of having similar product characteristics and ordering dynamics. It also fits in the current trend of (sectoral) specialization in the logistics sector: having multiple customers in e.g. the chemical, consumer electronics, paper or textile sector strengthens the market position of an LSP and offers a safeguard for future survival.

Four necessary ingredients of successful market targeting are: information, the LSP's capabilities and capacity, synergy, and a sustainable path towards the end solution. First, the LSP must have enough market information to assess its chances to obtain the required amount of contracts. In some cases this information is publicly available, such as in the grocery case discussed in Section 9.3, but for other markets obtaining this information will require a more thorough market analysis. The second condition is the good match between the market and the LSP's capabilities. If for example an LSP's past experience involves predominantly unconditioned palletized transportation, it might not be advisable to target the specialized petrochemical industry. Furthermore, the LSP must have sufficient capacity or the possibility to increase his capacity to the level required to serve the target group. Thirdly, when market information is available and the LSP has the capabilities and capacity to serve the market, the attractiveness of a target group depends on the synergy potential that exists between them. Gupta and Gerchak (2002) have studied operational synergies for mergers and acquisitions, which can be seen as an upper bound for the synergy under horizontal cooperation. In this paper we assume that the LSP is able to make a reliable estimate of the monetary synergy value, which we define as the sum of the costs that individual shippers make in the present situation minus the costs when the whole set of shippers would be serviced collectively by the LSP. Besides these operational considerations however, often also relational issues play an important role. For example, it may be the case that an LSP already has (informal) contacts with a group of shippers of whom he knows they are interested in the service. Although this group may not be optimal from a synergy perspective, this can be outweighed by the group's cohesion and their established contacts with the LSP. In fact, applying an innovative concept such as insinking requires a considerable amount of trust between the LSP and the shippers, which will benefit from positive past business experiences. Finally, the existence of a beneficial (i.e., *Shapley monotonic*, see Section 9.2.3) path towards the end solution is a very important characteristic of beneficial target groups.

### 9.2.2 Cost reductions

When the LSP has identified the group of shippers targeted, he is ready to calculate the cost reductions for each of the shippers involved. Since we use cooperative game theory in this step, we first recall some basic notions from game theory. Myerson (1991) defined game theory as "the study of mathematical models of conflict and cooperation between intelligent and rational decision-makers. Game theory provides general mathematical techniques for analyzing situations in which two or more individuals make decisions that will influence one another's welfare". Cooperative game theory focuses on cooperative behaviour by analyzing the negotiation process within a group of players in establishing a contract or joint plan of activities, including an allocation of collaboratively generated revenues. In particular, the possible levels of cooperation and the revenues of each possible coalition (a subgroup of the cooperating players) are taken into account so as to allow for a better comparison of each player's role and impact within the group as a whole. In this way, players in a coalition can settle on a compromise allocation in an objectively justifiable way. Having this in mind, the game underlying the insinking methodology is evidently a cooperative game. The problem of allocating the jointly generated synergy savings is critical to any logistics cooperation (cf. Thun, 2003).

Let $N$ be a finite set of players and denote by $2^N$ the collection of all subsets of $N$. Elements of $2^N$ are called *coalitions, N* is the *grand coalition*. The cost savings that a coalition $S$ can jointly generate without the players in $N \setminus S$ is called the *value* of coalition $S$. The values of all coalitions $S$ are captured in the so-called characteristic function $v: 2^N \to \mathbb{R}$. The Shapley value (Shapley, 1953) is a well-known solution concept that constructs a vector $\Phi(N,v) \in \mathbb{R}^N$ that allocates the value $v(N)$ of the grand coalition based on the values $v(S)$ of all coalitions $S$. The idea behind the Shapley value can be explained as follows. Consider the creation of a coalition $S$ to which $i$ does not belong. First, a set size $|S|$ is chosen at random out of $\{0,1,2,...,|N|-1\}$, each having a probability $\frac{1}{|N|}$ to be drawn. Then a subset of $N \setminus \{i\}$ of size $|S|$ is chosen, each with a probability $\frac{|S|!(|N|-1-|S|)!}{(|N|-1)!}$. After $S$ has been drawn, player $i$ is allocated his so-called *marginal contribution* $v(S \cup \{i\}) - v(S)$. Then, the Shapley value is the expected payoff for player $i$ in this random procedure, as indicated in formula (9.1):

$$\Phi_i(N,v) = \sum_{S \subset N: i \notin S} \frac{|S|!(|N|-1-|S|)!}{|N|!} \left[ v(S \cup \{i\}) - v(S) \right], \text{ for all } i \in N. \tag{9.1}$$

For a coalition $S$ the subgame $(S, v|_S)$ is given by the restriction of $v$ to $2^S$, with for all $T \subset S$, $v|_S(T) = v(T)$. In particular, the Shapley value $\Phi(S,v) := \Phi(S, v|_S) \in \mathbb{R}^S$ is defined as follows:

$$\Phi_i(S,v) = \sum_{T \subset S: i \notin T} \frac{|T|!(|S|-1-|T|)!}{|S|!} \left[ v(T \cup \{i\}) - v(T) \right], \text{ for all } i \in S. \tag{9.2}$$

The Shapley value possesses a number of fairness properties. Below we will briefly discuss four of these properties that are useful in our context. First, the *efficiency* property of the Shapley value ensures that the total value of the grand coalition is distributed among the players, i.e., no value is lost. The Shapley value is also *symmetric*, meaning that two players that create the same additional value to any coalition receive the same share of the total value. The *dummy* property states that players that do not contribute anything to any coalition except their individual value indeed receive exactly their individual value as a final share of the total value. Finally, we mention the Shapley value's property of *strong monotonicity*. This guarantees that if all of the player's marginal contributions increase, his payoff will increase. Since these four properties make perfect sense from a practical perspective, we make use of the Shapley value in this paper.

Having introduced the necessary terminology, we are now ready to formulate the cooperative game that forms the basis of the insinking procedure: the *insinking game*. In the current step, the LSP knows his target group of shippers (from now on called the *players*) and faces the problem of distributing the group's synergy value, i.e., the value $v(N)$ of the grand coalition.

In order to cover the extra overhead costs needed to service the players and to gain profit, the LSP claims a pre-determined share of the synergy value. This claim is called the *synergy claim* and is denoted by $p \in [0,1]$. In choosing the value of the synergy claim the LSP faces a trade-off between a higher prospected profit by setting $p$ high, and a larger probability that the players will indeed accept by choosing a smaller value. The LSP can make this decision based on a qualitative assessment of his bargaining power in the market.

The value $v(S)$ of a coalition $S$ in the insinking game is now determined as follows:

$$v(S) \quad = \quad (1-p)\max\left\{\sum_{i\in S} C_0(i) - C(S), 0\right\} \tag{9.3}$$

Here, $C_0(i)$ are the costs of player $i$ in the status quo situation, i.e., when player $i$ privately performs his transportation orders $O_i$, while $C(S)$ represents the costs of the LSP to collectively execute the orders $\bigcup_{i\in S} O_i$ of the players in $S$. Obviously, a coalition $S$ can only be established when the LSP can serve the players in $S$ at a lower cost than the sum of the costs that the players in $S$ incur when they would all perform their own orders individually. Whenever this it not the case, the players in $S$ will not accept the LSP's service, and this coalition is left out of consideration. $v(S)$ is then set to 0, which explains the use of the maximum with 0 in (9.3).

We will illustrate the procedure by means of a hypothetical 3-player example, for which the relevant information is summarized in Table 9-2. For convenience of calculations, we assume that $p = 0$.

| $S$ | $\sum_{i\in S} C_0(i)$ | $C(S)$ | $v(S)$ | $\Phi(S,v)$ |
|---|---|---|---|---|
| {1} | 350 | 300 | 50 | (50; . ; . ) |
| {2} | 300 | 260 | 40 | ( . ;40; . ) |
| {3} | 100 | 120 | 0 | ( . ; . ;0) |
| {1,2} | 650 | 500 | 150 | (80;70; . ) |
| {1,3} | 450 | 390 | 60 | (55; . ;5) |
| {2,3} | 400 | 370 | 30 | ( . ;35;-5) |
| {1,2,3} | 750 | 570 | 180 | (95;75;10) |

Table 9-2: A hypothetical 3-player example

The last column of Table 9-2, which is calculated using formula (9.2), shows that the coalition consisting of only players 2 and 3 will certainly not occur since in this case both players receive a value that is lower than the value they would be able to get individually.

### 9.2.3 Negotiation and structure of sequential offers

Despite the fact that in the example in Table 9-2 all possible coalitions have a positive value, the LSP still has to select an effective way to establish the grand coalition. He does so by choosing the most suitable sequence in which he proposes offers to players. The total set $\Pi$ of such paths consists of $|N|!$ different paths $\pi$ . $\pi(i)$ is used to refer to the rank of player $i$ on path $\pi$ .

Every time a player from the selected target group is approached with an offer, the method that the LSP will consistently use is clearly explained to this player. By communicating openly, the player's involvement in the project increases and the LSP has better possibilities to cross-check the assumptions and data he used to calculate the proposals. Sequentially, a player $i$ receives an opening offer based on $\Phi_i(S \cup \{i\}, v)$, if $S$ is the coalition of players that have already committed before. Moreover, it is explained to player $i$ that his offer may further improve when more players consign to the LSP's service. The possible cost reductions $g(i,\pi,s)$ are defined as:

$$g(i,\pi,s) = \frac{\Phi_i\left(\bigcup_{\pi(k)\le s} k, v\right)}{C_0(i)}, \pi(i) \le s \le |N| \tag{9.4}$$

Here, $s$ is the current step in the procedure. All cost reductions $g(i,\pi^*,s)$ along the chosen path $\pi^*$ are also announced to player $i$, together with the accompanying scenarios for commitment of the players $j$ that are not yet contacted (i.e., those players $j$ for which $\pi^*(j) > \pi^*(i)$ ). Figure 9-1 graphically shows the offered percentage cost reductions with respect to the costs of in-house execution by the players. This figure comprises all $g(i,\pi,s)$ values, defined for the three players, the six different paths along which they can be approached, and the steps along these paths where an offer is made to a player. We use the percentage reduction of the current costs of the players rather than the absolute reduction, because the players may differ in size.

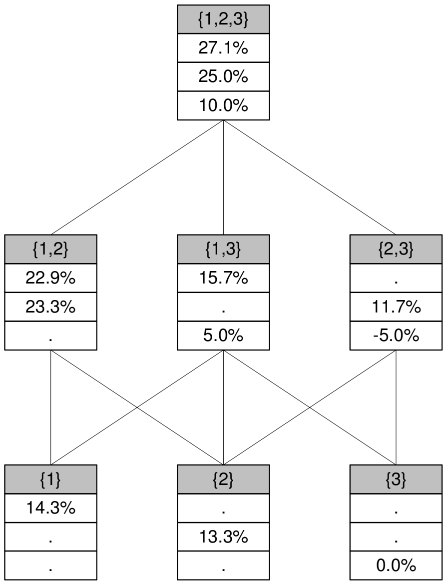


Figure 9-1: Percentage cost reductions in the 3-player example

In the example, when players are contacted in the sequence $\pi = 123$, during the negotiations player 1 knows that he is sure to save 50 (14.3%), and that his cost reduction will increase to 80 (22.9%) if later on player 2 consigns, and even to 95 (27.1%) if besides player 2 also player 3 commits. Or, more formally: $g(1,123,1) = 0.143$, $g(1,123,2) = 0.229$, and $g(1,123,3) = 0.271$. Together, the opening offer and the prospected future cost reductions should persuade the player to accept the offer.

Based on Figure 9-1, the LSP has to decide on the path $\pi^*$ along which he can best contact the players. Compared to a simultaneous approach, the one-by-one modus operandi offers the benefit that the obtained commitment of one or more players leverages the value proposition that can be made to the remaining players, since a certain level of scale and synergy is already attained. Moreover, performing $|N|$ one-on-one negotiation rounds based on reliable information about the attained commitment of other players can be preferred over a single negotiation with all players simultaneously, because of the reduced risk of strategic behavior, and the prevention of mutual envy. Finally, in the sequential procedure the LSP will be better able to preserve anonymity of the targeted players.

The usage of a fixed synergy claim $p$ makes that the LSP's profit is maximized when the grand coalition is attained. Therefore, the LSP is indeed interested in finding the path $\pi^*$ through Figure 9-1 that gives the highest 'probability' that all players will accept his insinking offer. To this end, we introduce the notion of a *Shapley Monotonic Path* (SMP). Along such a path all committed players will be better off when the coalition grows through the decision of the next player to accept the insinking offer:

DEFINITION 1:
$\pi$ is a Shapley Monotonic Path if and only if $g(i,\pi,j) < g(i,\pi,k), \forall j < k \leq |N|, \forall i \in N$

In the example above, 123, 132, 213 and 312 are SMPs. The others are not because one player's offer worsens during at least one of the steps.

Games $(N,v)$ do not in general possess an SMP. Loosely speaking, an insinking game will have an SMP if the target group is carefully selected based on a high synergy value among the players. The problem of finding conditions for the existence of SMPs in general games is however hard, as is the problem of finding conditions for uniqueness of an SMP, may it exist (Borm et al., 2006).

On the one hand, it is easy to construct games where none of the paths $\pi \in \Pi$ is an SMP. On the other extreme, if it holds that the savings allocated to a committed player $i$ are consistently higher in case more companies accept the insinking offer, all paths $\pi \in \Pi$ will be an SMP. In game theoretic terms this condition means that the game is *strictly convex*: for all $S,T,U \subset N$ such that $S \subset T \subset N \setminus U$ it holds that $v(S \cup U) - v(S) < v(T \cup U) - v(T)$.

THEOREM 1: $(N,v)$ is strictly convex if and only if every $\pi \in \Pi$ is an SMP

The proof is as follows. Let $(N,v)$ be strictly convex and consider two coalitions $T$ and $S$ for which there exists a single $j \in N \setminus T$ such that $S = T \cup \{j\}$. Then for all $i \in T$:

$$
\begin{aligned}
\Phi_i(T,v) &= \sum_{U \subset T, i \notin U} \frac{|U|!(|T|-1-|U|)!}{|T|!}\big(v(U \cup \{i\}) - v(U)\big) \\
&= \sum_{U \subset T, i \notin U} \frac{(|T|+1)|U|!(|T|-1-|U|)!}{(|T|+1)!}\big(v(U \cup \{i\}) - v(U)\big) \\
&= \sum_{U \subset T, i \notin U} \frac{\big[(|T|-|U|)+(|U|+1)\big]|U|!(|T|-1-|U|)!}{(|T|+1)!}\big(v(U \cup \{i\}) - v(U)\big) \\
&= \sum_{U \subset T, i \notin U} \left[\frac{(|T|-|U|)|U|!(|T|-1-|U|)!}{(|T|+1)!} + \frac{(|U|+1)|U|!(|T|-1-|U|)!}{(|T|+1)!}\right]\big(v(U \cup \{i\}) - v(U)\big)
\end{aligned}
$$

$$
\begin{aligned}
&= \sum_{U\subset T, i\notin U} \left[ \frac{|U|!(|T|-|U|)!}{(|T|+1)!} + \frac{(|U|+1)!(|T|-1-|U|)!}{(|T|+1)!} \right] \left( v(U\cup\{i\}) - v(U) \right) \\
&= \sum_{U\subset T, i\notin U} \left[ \frac{|U|!(|S|-1-|U|)!}{|S|!} + \frac{(|U|+1)!(|S|-2-|U|)!}{|S|!} \right] \left( v(U\cup\{i\}) - v(U) \right) \\
&= \sum_{U\subset T, i\notin U} \left[ \frac{|U|!(|S|-1-|U|)!}{|S|!} \right] \left( v(U\cup\{i\}) - v(U) \right) \\
&\quad + \sum_{U\subset T, i\notin U} \left[ \frac{(|U|+1)!(|S|-1-(|U|+1))!}{|S|!} \right] \left( v(U\cup\{i\}) - v(U) \right) \\
&< \sum_{U\subset T, i\notin U} \left[ \frac{|U|!(|S|-1-|U|)!}{|S|!} \right] \left( v(U\cup\{i\}) - v(U) \right) \\
&\quad + \sum_{U\subset T, i\notin U} \left[ \frac{(|U|+1)!(|S|-1-(|U|+1))!}{|S|!} \right] \left( v(U\cup\{i,j\}) - v(U\cup\{j\}) \right) \\
&= \sum_{U\subset S: i\notin U} \frac{|U|!(|S|-1-|U|)!}{|S|!} \left[ v(U\cup\{i\}) - v(U) \right] \\
&= \Phi_i(S,v),
\end{aligned}
$$

where the strict inequality follows from strict convexity. This shows that every path $\pi \in \Pi$ will be an SMP. It will be obvious that, by the same argument, the converse also holds.

□

In our setting, strict convexity means that the more players have already accepted the insinking offer, the more efficient the LSP can combine the order set of a not yet committed player with the current order base. This is in line with the findings of Chapter 4 that state that synergy increases when the number of combined orders grows. This is a direct result of the enlarged search space of the planning problem. However, these results are based on situations where the pickup location is identical for all flows. When this is not true (like in the example in Section 9.3), strict convexity of the insinking game is not obvious. Therefore, the LSP should always check beforehand if the insinking game based on a target group $N$ indeed possesses an SMP. Because in practical cases $|N|$ will be small, this can easily be done by complete enumeration of the paths. Finally, note that the value of $p$ does not affect the existence of SMPs.

If there are more SMPs, the next question becomes how to choose between them. For the hypothetical 3-player example the four SMPs, together with the offered percentage cost reductions , $g(i,\pi,s)$ are displayed in Table 9-3.

| $\pi_1 = 123$ | | | |
|---|---|---|---|
| player $i$ | 1 | 2 | 3 |
| $C_0(i)$ | 350 | 300 | 100 |
| $g(i,\pi_1,1)$ | 14.3% | . | . |
| $g(i,\pi_1,2)$ | 22.9% | 23.3% | . |
| $g(i,\pi_1,3)$ | 27.1% | 25.0% | 10.0% |

| $\pi_2 = 132$ | | | |
|---|---|---|---|
| player $i$ | 1 | 3 | 2 |
| $C_0(i)$ | 350 | 100 | 300 |
| $g(i,\pi_2,1)$ | 14.3% | . | . |
| $g(i,\pi_2,2)$ | 15.7% | 5.0% | . |
| $g(i,\pi_2,3)$ | 27.1% | 10.0% | 25.0% |

| $\pi_3 = 213$ | | | |
|---|---|---|---|
| player $i$ | 2 | 1 | 3 |
| $C_0(i)$ | 300 | 350 | 100 |
| $g(i,\pi_3,1)$ | 13.3% | . | . |
| $g(i,\pi_3,2)$ | 23.3% | 22.9% | . |
| $g(i,\pi_3,3)$ | 25.0% | 27.1% | 10.0% |

| $\pi_4 = 312$ | | | |
|---|---|---|---|
| player $i$ | 3 | 1 | 2 |
| $C_0(i)$ | 100 | 350 | 300 |
| $g(i,\pi_4,1)$ | 0.0% | . | . |
| $g(i,\pi_4,2)$ | 5.0% | 15.7% | . |
| $g(i,\pi_4,3)$ | 10.0% | 27.1% | 25.0% |

Table 9-3: Example of possible sequential offers according to SMPs

Although all four paths described in Table 9-3 are SMPs, path 312 does not seem to be a reasonable choice for the LSP. This is because in the first step, player 3 is not offered a cost reduction, $g(3,312,1)=0$, because he can perform his own orders more efficiently individually than the LSP can. This is captured in the concept of *first offer rationality*: the first offer of the LSP to an entering player indeed represents a cost reduction compared to player's status quo situation of performing the orders individually. SMPs that satisfy this criterion are referred to as *Rational Shapley Monotonic Paths* (*RSMPs)*:

DEFINITION 2:
$\pi$ is an RSMP if and only if $\pi$ is an SMP and $g(i,\pi,1)>0\ \forall i\in N$

In the remainder, we will restrict attention to RSMPs and the set of all RSMPs will be referred to as $\hat{\Pi}\subseteq\Pi$. It should be noted that for a path to retain its property of Rational Shapley Monotonicity, the order sets $O_i$ of the customers should be more or less stable. This is e.g. true in the grocery retail example discussed in the next section. The demand locations are supermarkets that are visited according to a fixed delivery schedule (e.g. daily delivery). If in the long run considerable changes occur in the order set of one or more customers, tariffs need to be recalculated. This of course holds true for any general contract between LSP and customer: if the terms of a contract change, the contract itself will change.

There might be various ways to judge which RSMP is best from the LSP's perspective of achieving the grand coalition. In other words: there exist various sensible functions $f:\hat{\Pi}\rightarrow\mathbb{R}$ that denote the quality of an RSMP. It seems reasonable however that the reductions on the diagonal and bottom rows in Table 9-3 are relevant considerations for players. The first correspond to the cost reductions that player $i$ is guaranteed to achieve when accepting the offer (*certain gain*, $g\left(i,\pi^*,\pi(i)\right)$), and the second are the maximum possible cost reductions that are attained when the grand coalition is indeed achieved (*top gain*, $g\left(i,\pi^*,|N|\right)$).

Here, for the purpose of illustration, we assume that the best RSMP is selected on the basis of the certain gains. Table 9-4 shows the certain gains for the three RSMPs. Consequently, we select the 'best' RSMP in the following way: first select those RSMPs that have the maximal lowest cost reduction. In our example, these are 123 and 213 with a lowest certain gain of 10%. Then, from those RSMPs, select the one that has the maximal second-lowest certain gain, etc. In our hypothetical example $\pi^*=123$ will be selected with a second-lowest certain gain of 14.3%.

| | **Certain gain** | | | ***Sorted certain gain*** | | |
|---|---|---|---|---|---|---|
| RSMP | Player 1 | Player 2 | Player 3 | *Lowest* | *2nd lowest* | *3rd lowest* |
| 123 | 14,3% | 23,3% | 10,0% | *10,0%* | *14,3%* | *23,3%* |
| 213 | 22,9% | 13,3% | 10,0% | *10,0%* | *13,3%* | *22,9%* |
| 132 | 14,3% | 25,0% | 5,0% | *5,0%* | *14,3%* | *25,0%* |

Table 9-4: RSMP selection based on certain gains

As stated above, many other quality criteria for RSMPs can be thought of. In any case, the choice of $f:\hat{\Pi}\rightarrow\mathbb{R}$ is open for the LSP, and may depend on characteristics of the targeted market and the LSP's own preference.

To summarize this section, we now recapitulate the introduced notation. Using this notation, the three steps are formalized in Table 9-2 to represent a comprehensive description of the insinking procedure.

| | | |
|---|---|---|
| $M$ | = | Set of all potential customers |
| $N$ | = | Set of targeted customers |
| $2^N$ | = | Collection of all subsets of $N$ (collection of all possible coalitions) |
| $O_i$ | = | Set of transportation orders belonging to customer $i\in N$ |
| $C_0(i)$ | = | Costs of executing $O_i$ by customer $i$ in the status quo situation |
| $C(S)$ | = | Cost of executing $\bigcup_{i\in S} O_i$ by the LSP |
| $p$ | = | The LSP's synergy claim |
| $v(S)$ | = | Value of coalition $S\in 2^N$ as determined by (9.3) |

| | | |
|---|---|---|
| $\Pi$ | = | Set of permutations of $N$ . These give the possible paths along the customers. |
| $\pi(i)$ | = | Rank of customer $i$ in $\pi$ |
| $\Phi_i(S,v)$ | = | Shapley value allocated to player i in the subgame defined on $S \in 2^N$ |
| $g(i,\pi,s)$ | = | (sequential) gains offered to player $i$ on step $s$ along path $\pi$ as determined by (9.4) |
| $\hat{\Pi}$ | = | The set of RSMPs |
| $f:\hat{\Pi} \to \mathbb{R}$ | = | Additional selection criterion function to choose the best RSMP |
| $\pi^*$ | = | The RSMP chosen to approach the targeted shippers |

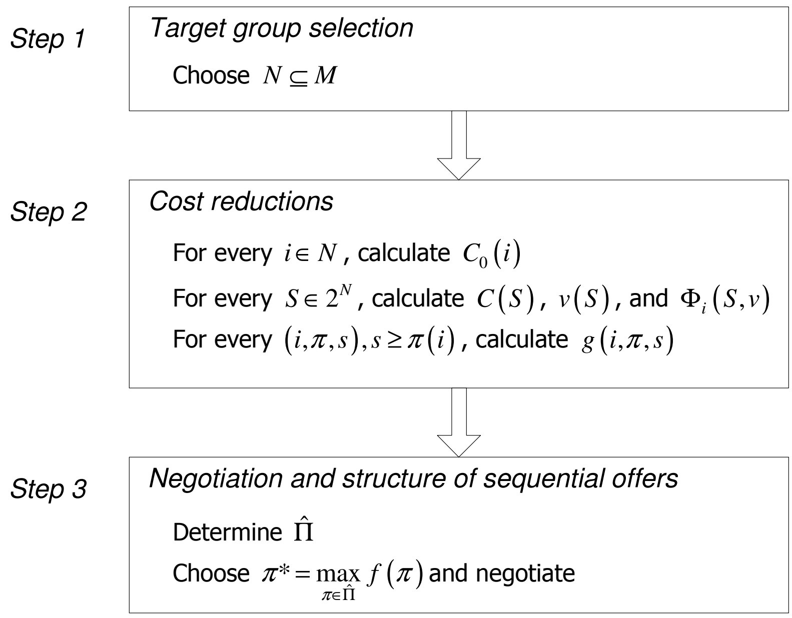


Figure 9-2: Three steps of the insinking procedure

This finishes our discussion of the insinking procedure. In the next section we illustrate the insinking procedure by means of a practical example based on real-life data from the Dutch grocery retail sector.

## 9.3 AN EXAMPLE BASED ON REAL-LIFE DATA

Many grocery retailers are not performing well and have been facing a loss of profitability in recent years. Together with the complexity and dynamism inherent to the grocery industry, this has made it difficult for retailers to survive in isolation of their competitors (cf. Chapter 1; Ballou et al., 2000). There is growing empirical evidence that retailers as a result turn to co-opetive behaviour to construct win-win situations together with their competitors. For example, Kotzab and Teller (2003), present a case study in which the largest Austrian retailers cooperate in their logistics processes by introducing uniform load units and performing joint replenishment. This cooperation runs parallel to fierce price competition and heavy promotional spending. This section presents a co-opetive insinking case study that results in considerable efficiency gains for retailers in the Dutch grocery transport sector. For reasons of confidentiality, the company names in this case study are not disclosed.

### 9.3.1 Background

The case focuses around an LSP that has a large temperature controlled distribution centre for frozen goods (FDC) in the geographical centre of the Netherlands. Taking advantage of its established position in ambient food retail, the LSP’s goal is to fill this FDC with the frozen food products of grocery retailers, and perform the transport from the FDC to their stores. Among other things, this means that in the new situation suppliers of frozen products must only visit the central FDC instead of the multiple FDCs of individual retailers, thereby reducing the number of drops that suppliers make on their delivery routes. As a side effect to the synergy attained in the retailers’ distribution process, this will increase the efficiency of the suppliers’ transport process.

The LSP applies the insinking procedure outlined in Section 9.2 to attract a number of large and medium sized grocery retailers as his customers. Below we discuss how the three steps of the procedure can be applied here.

### 9.3.2 Target Group Selection

Table 9-5 shows some characteristics of four grocery retailers A,B,C, and D with whom the LSP maintains close contacts.

| Retailer | # Outlets | Weekly demand (roll pallets) | Yearly turnover (mln €) |
|---|---|---|---|
| A | 37 | 17,366 | 367 |
| B | 61 | 25,369 | 616 |
| C | 63 | 18,634 | 373 |
| D | 195 | 62,857 | 1,187 |

Table 9-5. Characteristics of targeted retailers (2003)

These retailers have the same (or at least a comparable) customer base and Figure 9-3 shows that their distribution networks have considerable geographical overlap. Furthermore, they have not yet outsourced their transport activities to an LSP. All four retailers use a standardised roll pallet for shop deliveries, which makes it easy to consolidate loads of different retailers in one truck. The encouraging synergy value, the existing contacts and the fact that the capacity of the FDC is sufficient to fulfil their orders, make that these four retailers form the LSP’s target group.

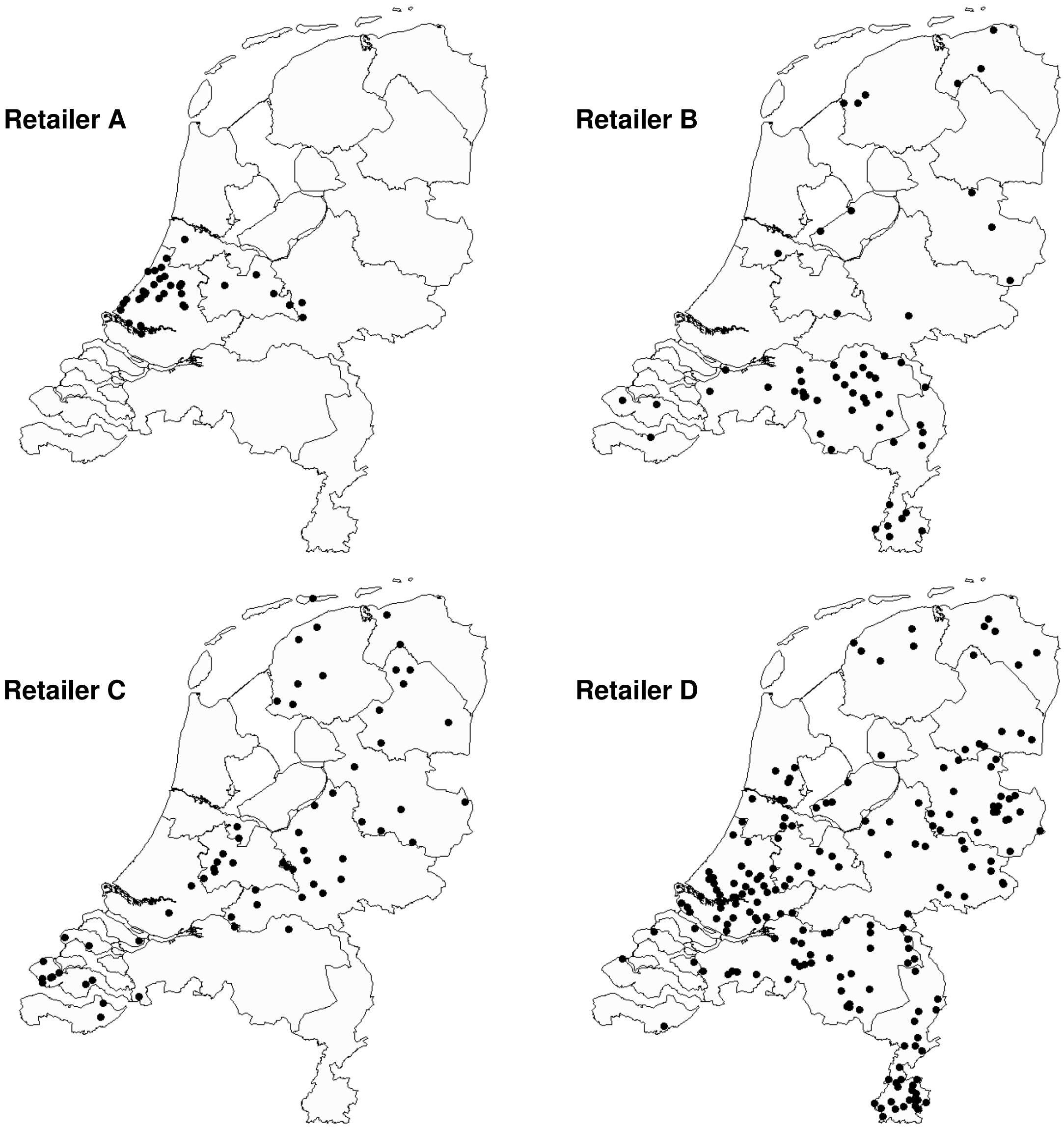


Figure 9-3. Geographical overlap of stores of retailers

### 9.3.3 Cost Reductions

In step 2 of the insinking procedure the values of all subcoalitions of {A,B,C,D} are calculated. The cost reduction that the LSP will be able to offer then depends on the synergy between the order sets of the retailers. Additionally, the offers are influenced by the LSP's synergy claim. This claim must cover the extra administrative (back office) costs, the costs of storage at the central FDC, and profit. In this case study, the synergy claim is set to 0.2 (i.e., 20%).

Below we comment on the data and the routing problems that form the basis of the calculation of the cost reduction proposals.

***Data***

Order data of the four retailers are estimated on the basis of the commercial surface of their stores and the average turnover of frozen products per square meter of commercial surface (cf. Groothedde, 2003). The daily frequency of delivery per retailer is based on de Koster and Neuteboom (2001) and information from other industry experts. Based on these data five daily order sets are constructed, representing the working days in a typical week.

By assumption, the trucks operated by the retailers and by the LSP all have a capacity of 57 roll pallets and a uniform cost structure. This cost structure is based on the published market averages for the Netherlands and consists of a fixed cost per truck per day of € 120 and a cost of € 0.33 per minute that a truck is driving or unloading at the store. The fixed costs are incorporated in the cost structure, because the retailers can dispose of the specialised temperature controlled trucks if the transport of the frozen products is taken over by the LSP.

Besides transport costs, also the costs of operating an FDC are incorporated. In the Netherlands, storage of one roll pallet of frozen goods costs on average € 2.79 per week. These costs include handling, depreciation and cooling. Whereas they are fixed for the LSP, the retailers can eliminate these costs by accepting the LSP's insinking offer. It is assumed that the FDCs of each retailer have a capacity equal to a week's throughput of pallets.

***Routing Problems***

To calculate the costs for all coalitions, 95 Vehicle Routing Problems with Time Windows (VRPTWs) need to be solved. This is because for each of the five working days in the planning period, there are $2^4$-1 VRPTWs representing the non-empty coalitions that can be served by the LSP and four extra routing problems because for the 1-player coalitions also the scenario exists that the player rejects the insinking offer and performs the transport on his own account.

Orders are to be delivered to the stores between 8:00 am and 6:00 pm. The dataset shows that the number of deliveries per store per day is either 1 or 2. If stores are delivered twice a day, there is a morning delivery between 8:00 am and 1:00 pm and an afternoon delivery between 1 pm and 6 pm. As in Chapter 4, to solve the 95 VRPTWs the heuristic of Bräysy et al. (2004) is used (for a discussion of this heuristic, see Section 4.2.3). The solutions to the routing problems can be found in Table 9-6.

| S | # Roll pallets | # Orders | Location costs | # Trucks | Total time | Transport costs |
|---|---|---|---|---|---|---|
| {A}-self | 580 | 370 | 509 | 20 | 5,251 | 4,133 |
| {B}-self | 716 | 244 | 743 | 28 | 11,161 | 7,043 |
| {C}-self | 513 | 189 | 546 | 23 | 8,852 | 5,681 |
| {D}-self | 1,758 | 585 | 1,841 | 45 | 16,345 | 10,794 |
| {A} | 580 | 370 | . | 20 | 5,254 | 5,558 |
| {B} | 716 | 244 | . | 28 | 11,519 | 7,161 |
| {C} | 513 | 189 | . | 20 | 8,954 | 5,354 |
| {D} | 1,758 | 585 | . | 44 | 16,114 | 10,597 |
| {A,B} | 1,296 | 614 | . | 48 | 17,997 | 11,699 |
| {A,C} | 1,093 | 559 | . | 45 | 16,314 | 10,783 |
| {A,D} | 2,338 | 955 | . | 62 | 23,025 | 15,038 |
| {B,C} | 1,229 | 433 | . | 44 | 17,630 | 11,097 |
| {B,D} | 2,474 | 829 | . | 63 | 23,686 | 15,376 |
| {C,D} | 2,271 | 774 | . | 51 | 20,590 | 12,914 |
| {A,B,C} | 1,809 | 803 | . | 60 | 23,801 | 15,054 |
| {A,B,D} | 3,054 | 1,199 | . | 78 | 29,383 | 19,056 |
| {A,C,D} | 2,851 | 1,144 | . | 72 | 26,826 | 17,492 |
| {B,C,D} | 2,987 | 1,018 | . | 74 | 28,566 | 18,306 |
| {A,B,C,D} | 3,567 | 1,388 | . | 89 | 34,390 | 22,028 |

Table 9-6. Routing results aggregated over five working days

The first four rows of Table 9-6 represent the cases where the retailers perform the transport individually from their private FDCs, while for the other rows the service of the LSP is used. The location costs and the transport costs form the necessary input to calculate the coalitional values from equation (9.3). Table 9-7 displays the structure of all coalitional values and the allocation over the retailers according to the Shapley value. Figure 9-4 depicts all paths from the 1-retailer coalitions to the grand coalition. Note that the percentage cost reductions in this figure are the quotient of the allocations given in Table 9-7 and the individual location and transport costs of the retailers provided in the first four rows of Table 9-6. As mentioned earlier, a synergy claim of 0.2 is incorporated in the coalitional values.

| $S$ | $\sum_{i \in S} C_0(i)$ | $C(S)$ | $v(S)$ | $\Phi(S,v)$ |
|---|---|---|---|---|
| {A} | 4,642 | 5,558 | 0 | (0; . ; . ; . ) |
| {B} | 7,786 | 7,161 | 500 | ( . ;500; . ; . ) |
| {C} | 6,227 | 5,354 | 698 | ( . ; . ;698; . ) |
| {D} | 12,635 | 10,597 | 1,630 | ( . ; . ; . ;1,630) |
| {A,B} | 12,428 | 11,699 | 583 | (42; 542; . ; . ) |
| {A,C} | 10,869 | 10,783 | 69 | (-315; . ; 384; . ) |
| {A,D} | 17,277 | 15,038 | 1,791 | (80; . ; . ; 1,711) |
| {B,C} | 14,013 | 11,097 | 2,333 | ( . ; 1,067; 1,266; . ) |
| {B,D} | 20,421 | 15,376 | 4,036 | ( . ; 1,453; . ; 2,583) |
| {C,D} | 18,862 | 12,914 | 4,758 | ( . ; . ; 1,913; 2,845) |
| {A,B,C} | 18,655 | 15,054 | 2,881 | (92; 1,474; 1,316; , ) |
| {A,B,D} | 25,063 | 19,056 | 4,806 | (297; 1,670; . ; 2,839) |
| {A,C,D} | 23,504 | 17,492 | 4,810 | (-61; . ; 1,772; 3,099) |
| {B,C,D} | 26,648 | 18,306 | 6,674 | ( . ; 1,478; 1,939; 3,256) |
| {A,B,C,D} | 31,290 | 22,028 | 7,410 | (266; 1,805; 1,908; 3,431) |

Table 9-7: Cost reduction offers

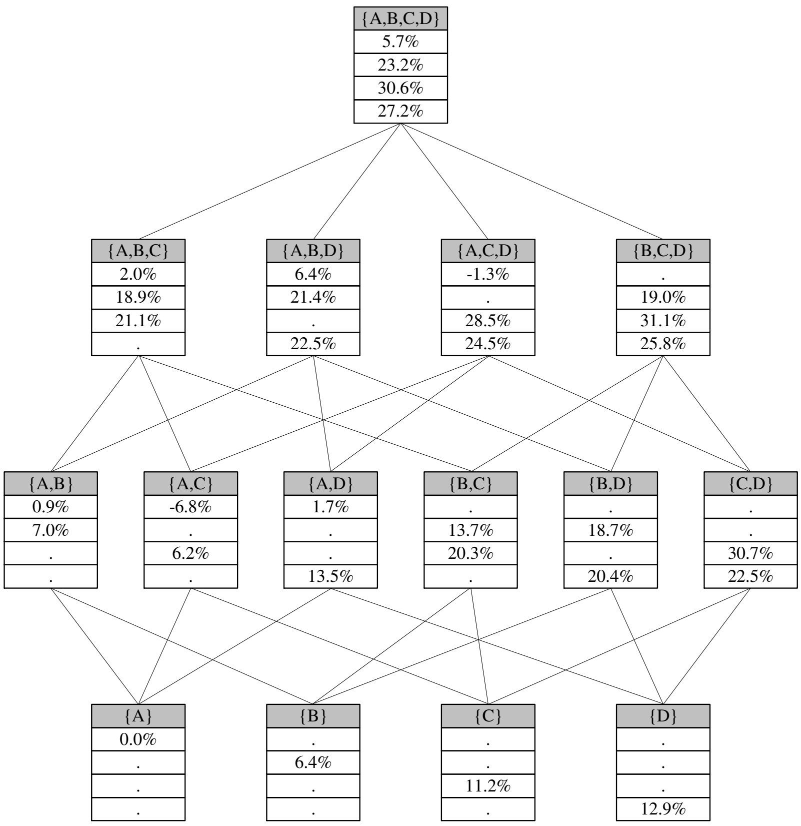


Figure 9-4. Percentage cost reduction paths

In practice the LSP will transfer the cost reductions to player $i$ by means of a lower tariff $t_i^S$ per roll pallet, depending on the coalition $S$ that he serves. This tariff can easily be calculated from the cost reductions attributed to player $i \in S$ and his demand $D(i)$ in roll pallets:

$$t_i^S = \frac{C_0(i) - \Phi_i(S,v)}{D(i)} \tag{9.5}$$

The development of these tariffs along the paths is shown in Figure 9-5. This shows that player D has by far the lowest tariff, representing the cost effectiveness of operating his dense nation-wide network of stores (see Figure 9-3).

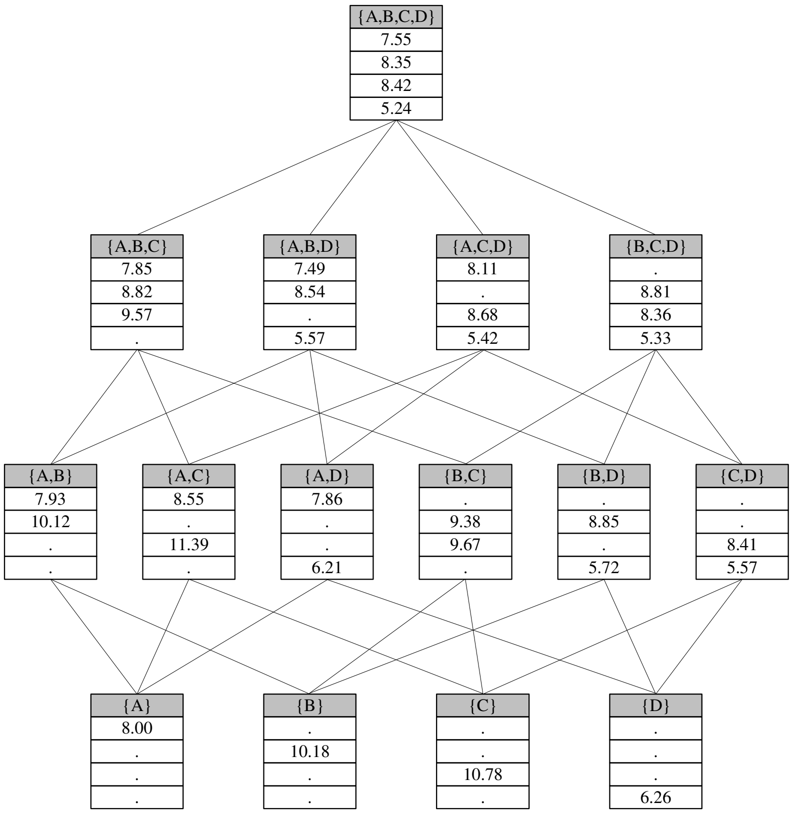

Figure 9-5. Tariff paths

### 9.3.4 Negotiation and Structure of Sequential Offers

Negotiation takes place on a bilateral basis between the LSP and the individual retailers. Only the LSP has perfect information because he has calculated all coalitional values and knows the tariffs he is going to offer to each individual retailer. The retailers on the other side only know their own current and future tariff offers and have to make their accept/reject decision based on these private data.

Figure 9-4 clearly shows that there are many paths along which retailers get a positive cost reduction at every step. It is however readily verified that the only three RSMPs are CBAD, BCAD, and BACD. Table 9-8 shows that, according to the criterion proposed in section 9.2.3, CBAD is the best RSMP.

| | **Certain gain** | | | | ***Sorted certain gain*** | | | |
|---|---|---|---|---|---|---|---|---|
| Path | A | B | C | D | *Lowest* | *2nd* | *3rd* | *4th* |
| CBAD | 2 | 13.7 | 11.2 | 27.2 | *2* | *11.2* | *13.7* | *27.2* |
| BCAD | 2 | 6.4 | 20.3 | 27.2 | *2* | *6.4* | *20.3* | *27.2* |
| BACD | 0.9 | 6.4 | 21.1 | 27.2 | *0.9* | *6.4* | *21.1* | *27.2* |

Table 9-8. RSMPs sorted lexicographically according to the certain gains

### 9.3.5 Discussion

Table 9-7 shows that all coalitions, except {A}, have a positive value. This means that for almost every coalition the LSP can perform the orders more efficiently than the corresponding players can if they reject the offer and perform the orders individually. In particular, all retailers benefit if the grand coalition is reached, i.e., if all retailers accept the LSP's insinking offer. In that case, the monetary savings attained from the synergy between the four retailers are distributed as presented in Table 9-9.

| **Retailer** | **Monetary gain** | **Percentage gain** |
|---|---|---|
| A | € 265.9 | 5.7 % |
| B | € 1,805.4 | 23.2 % |
| C | € 1,907.5 | 30.6 % |
| D | € 3,430.7 | 27.2 % |
| LSP | € 1,852.4 | . |

Table 9-9. Distribution of monetary savings

The LSP takes 20% of the total savings, which provides him with a gain of € 1,852 per week. This gain is used to cover the extra administrative (back office) costs and the costs of storage at the central FDC. The remainder is profit for the LSP. Retailer D brings in the most orders and is rewarded for this by getting the largest part of the savings from cooperation in absolute terms. Retailer C however gets the largest percentage cost reduction because his orders relatively exhibit most synergy with the other retailers. Figure 9-3 indeed shows that the stores of retailer C in a way glue together the geographical locations of the stores of the other retailers.

An important decision is to choose in which of the 24 possible sequences the LSP approaches the retailers. It turns out that in the case at hand there are only three RSMPs, implying that Shapley monotonicity is a quite discriminatory property for a path. Of the three RSMPs available, path CBAD performs best according to the chosen quality criterion. This means that the

LSP can best contact C first, then B, then A, and finally D. The virtue of an RSMP is that in every step along the path all committed players benefit if another player accepts the offer. This type of monotonicity makes that no committed player is harmed by the event that one of his competitors joins the cooperation. This is a very important condition for companies entering a co-operative relation.

The small number of RSMPs encourages the insinking LSP to perform extra effort in the target group selection. If the possibility exists to pick shippers from a larger set than the LSP can effectively handle, he can proactively perform step 2 of the procedure on test groups of shippers and evaluate the number and quality of the RSMPs present.

By applying insinking, the LSP offers shippers the opportunity to considerably cut down transport and location costs. In order to reap the maximum benefits, all involved parties depend on each other, which creates a beneficial lock-in that contributes to the probability of lasting success of the project. However, it should be noted that the numbers in Figure 9-4 represent the 'ideal' situation in which every player accepts the LSP's offer. Although the clear initiative of the LSP makes his competitors less visible to the shippers, and insinking brings the retailers considerable cost reductions, still the retailers might have the strongest negotiation power. As a result, there is a chance that retailers will (initially) reject the offer. In this case, the LSP still has some room for bargaining by decreasing his synergy claim for this specific retailer. When the LSP cannot persuade the retailer to accept the offer by lowering his synergy claim, the rejection is definitive. This retailer then has to be removed from the grand coalition. If for example on the best RSMP CBAD retailer C would reject the offer, the new grand coalition $N'$ becomes {A,B,D} and the insinking game is restricted to the subgame $\left(N', v|_{N'}\right)$. An identical analysis reveals that the best RSMP in this case would in fact be DBA, instead of the sequence BAD proposed by the original RSMP. If players further up the path reject the offer, no new negotiations with the already committed players will take place, although the negotiation plan with future players will need to be reconsidered.

## 9.4 CONCLUDING REMARKS

This chapter introduced the so-called insinking procedure that LSPs can use to attract new customers and improve their competitive position. The given format for approaching the potential customers ensures that the LSP does not run financial risks and that his business proposals to all shippers are as good as possible. In this way, sustainable horizontal cooperation between shippers can be created. Customised prices based on each shipper's actual contribution to the total synergy accomplish a fair allocation of the monetary savings from the cooperation. The procedure uses an operations research algorithm to calculate the value of every possible coalition of shippers, and a game theoretical solution concept to construct the customised tariffs.

Insinking seems to be a viable alternative for the traditional outsourcing paradigm. With outsourcing the initiative for transferring the execution of transport activities to an LSP lies with the shipper, and the occurrence of strong synergies with other shippers served by the LSP is more or less a matter of chance. With insinking however, the initiative lies with the LSP. He can use his market knowledge and experience, enriched by operations research techniques, to target exactly those shippers that exhibit strong synergies. Therefore, having the LSP in the driving seat seems natural here because the LSP is the actor in the supply chain with the best competencies to exploit synergies in transport systems. Moreover, the LSP has a clear economic incentive to attract as many shippers as possible since this increases his turnover and profit. Because of the property of Shapley Monotonicity, all parties involved benefit if the LSP attracts additional customers.

From an organizational perspective insinking also has advantages compared to outsourcing, because it facilitates horizontal cooperation without the difficulties arising from the sharing of sensitive information between the cooperating companies. Open communication about the methodology and the consistent usage of an objective and fair game theoretical solution concept to allocate savings to shippers, make the LSP a trustworthy partner. In general, transport is a hands-on and low-tech sector and practical cases have shown that practitioners often regard the problem of constructing a fair gain sharing mechanism as too difficult or academic. The insinking procedure has the advantage that this complex task now lies with only one actor who performs all necessary calculations and communication to the shippers. This avoids long and difficult rounds of discussion among the cooperating companies. Implicitly, insinking therefore also resolves impediment I2 of Chapter 5 that deals with the difficulty of finding a trusted party to lead a cooperation to this satisfaction of all participants.

Although the calculation of customised tariffs for new customers based on their actual synergy with existing customers of an LSP seems quite logical from an economical point of view, still tariff proposals by LSPs are often based on static rules of thumb, past prices and (conjectured) competitor prices. Modelling the problem as a cooperative game makes LSPs more aware of the actual value that a new customer creates for their business. The advantageous customer – service provider combinations that will result from applying a more sensible tariff quotation methodology will benefit both individual companies and society as a whole.

# CHAPTER 10 JOINT HUB NETWORK DEVELOPMENT

## 10.1 INTRODUCTION

This final chapter of PART III examines a third enabling concept for horizontal cooperation: *Joint Hub Network Development* by multiple shippers.

Since the construction and maintenance of physical distribution networks require substantial investments, a sufficiently high capacity utilization of these networks is crucial. Often it is not possible for individual shippers to attain the critical mass to justify such as investment. Therefore, horizontal cooperation between shippers that transport compatible products can be an interesting option. Developing a well-performing distribution network is however already a difficult (operations research) problem in its own right. The fact that in such networks shippers with inherently different interests depend on each other makes it even more complex. This is because actions and decisions taken by one shipper have a direct influence on other participants' payoffs.

This chapter proposes a framework to approach the problem of cooperative distribution hub network development. This framework uses existing operations research heuristics and methods from cooperative game theory. The objective is to improve the value proposition to cooperating shippers, and to attain cooperation among the best possible combination of companies. The remainder of this chapter is organized as follows. In the next section, a brief overview of related literature is provided. Section 10.3 then discusses how this literature is extended in the current chapter. Section 10.4 explains the solution method employed, which is illustrated in Section 10.5 by means of an illustrative example. Finally, in Section 10.6 concluding remarks are formulated.

## 10.2 RELATED LITERATURE

This section briefly examines literature relevant to cooperative distribution networks. Both its practical relevance and its theoretical richness have inspired academics to create a large body of literature on the topic. In its most basic form, the challenge is to design a physical network for directing flows of goods from production or assembly sites (i.e., the flows' origins) to warehouses of customers (i.e., the flows' destinations). A number of subproblems can be identified in which e.g. questions on the number, location, and size of the facilities, and the allocation of flows are answered (cf. Eskigun et al., 2005).

The current chapter illustrates the potential of existing network design techniques in a novel framework. For a general review on network redesign the reader is referred to Dullaert et al. (2006). This chapter focuses on *hub distribution network development*. This is a specific kind of distribution network in which transhipment takes place at intermediate facilities (the hubs) between the origin and destination nodes. Such a system requires less transport links and the higher concentration of traffic on these links facilitates regular service with a smaller number of trucks (Campbell, 1996). Hub networks have become the standard in air transport, and are also becoming more prevalent in landside transport, e.g. in express parcel networks.

The design problem for hub distribution networks is well studied. Over time, a number of literature reviews have appeared (Campbell, 1994; Klincewicz, 1998; Bryan and O'Kelly, 1999). Taking into account the vast body of literature on hub networks, it is remarkable that there are only few publications on hub networks where cooperation is explicitly taken into account. Skorin-Kapov (2001) recognized that in order to reap the benefits of the economies of scale made possible by using hub distribution networks, modelling cooperation between users with possibly conflicting interests is essential. Cooperative game theory is used to tackle the problem of fairly allocating the total gain to the users, and core elements are found for games with various characteristic functions. Furthermore, Matsubayashi et al. (2005) analysed the cost allocation problem in a large-scale hub-spoke network established by multiple agents. A practical allocation scheme is proposed that is proven to be in the core under certain conditions on the distribution of demand and the fixed costs of establishing a hub. In their implementation, the network is treated as a public good, in the sense that users cannot prevent others to use the system. This is for example the case in telecommunication systems, but less likely in physical transport networks. In the next section, it is explained how the current chapter is an extension to this literature on joint hub network design.

## 10.3 STEP-WISE HUB NETWORK DEVELOPMENT

With hub network development, in addition to obtaining an efficient final solution, it is also important to take the development path towards this solution into account. To facilitate cooperation between shippers, a *step-wise* hub network development procedure is needed. Groothedde (2005) indicates that although most previous research has focussed on constructing networks that are as close to the optimal solution as possible from a cost or service perspective, having such a step-wise development path towards the final solution is vital for the benefits to effectively materialize.

Unlike hub networks in e.g. telecommunication, physical hub networks require such large investments that in a cooperative setting having a sustainable development path towards the final network is nothing less than a necessary condition for success. A step-wise approach is possible because participating in a cooperative hub network is not an all-or-nothing decision for shippers.

Instead, they will initially only bring in those transport flows for which the highest savings can be attained. Because installing only a small number of hubs already requires a considerable capital investment, participants are likely to desire an evaluation period during which they can incorporate the changed network in their daily processes and 'get used to' the other partners. For the hub network to develop further, a trustworthy relationship between the partners has to be established. This will take some time, also because partners have to incorporate the new logistics structure in their operations. Therefore, in practical cases of joint hub network development, a step-wise approach can be more appropriate than a 'big-bang' approach where the complete final network is constructed at once. In the remainder of this chapter, the intermediate solutions in which the hub network operates will be referred to as the *levels* of the hub network development process. These levels are illustrated in Figure 10-1.

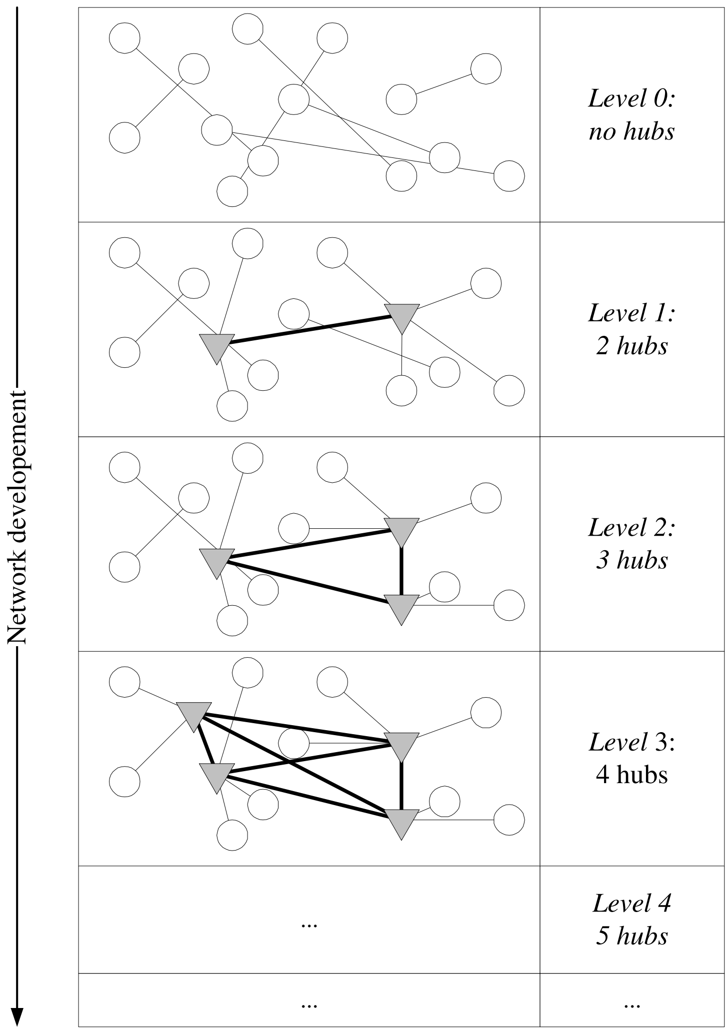


Figure 10-1. Levels in hub network development

In the setting of this chapter, shippers engage in horizontal cooperation by jointly investing in a hub distribution network. Although aimed at horizontal cooperation between Logistics Service Providers, the empirical research in Chapter 5 indicated that the outlook of cost reductions is the most important opportunity underlying horizontal cooperation. Furthermore, according to the respondents the most severe impediments are the problems with 1) finding a reliable party that can coordinate the cooperation in such a way that all participants are satisfied and 2) the construction of fair allocation mechanisms for the attained savings. These observations form important drivers for the research described in the current chapter.

Because the final network is not constructed at once, it is not straightforward to construct a fair gain sharing mechanism. When applying a step-wise approach, it is essential that the network is stable at all intermediate steps. Like in Chapter 9, to ensure stability fair gain sharing is an important ingredient of the procedure. The difference with the approach of Chapter 9 is that in the current chapter cooperative games are played iteratively at each level of the hub network development process, to share the benefits of cooperation. In this way, shippers can choose at every level whether or not they send additional flows through the newly extended network. The reasoning behind this is that in a practical setting, participating shippers are mostly multinational companies that potentially send many shipments through the hub network. At every level, shippers can choose whether or not to increase the number of shipments they send through the network. Hence, on any level of the hub network development process, some of a shipper's flows will be travelling via the hub network, while the others will remain with their individual direct routes. Such a step-wise approach to hub network development with gain sharing at each intermediate level does not yet exist in literature.

## 10.4 SOLUTION FRAMEWORK

This section explains the step-wise approach in three steps. First, two basic necessary network design routines that serve as building blocks for the procedure are discussed in general terms. Then, Section 10.4.2 summarises the cooperative game underlying the hub network development procedure. Finally, the integrated solution approach is explained.

### 10.4.1 Network Design Routines

The procedure requires two basic components: the ‘add-hub’ and ‘add-flows’ routines. For the purpose of this chapter it suffices to provide a high-level description of their main functionality. A detailed discussion of possible implementations of these building block heuristics can be found in Groothedde (2005).

Add-hub chooses the best location for a hub that is to be newly introduced in an existing hub network configuration. It is assumed here that hubs are fully interconnected. Every time a hub is added, it is checked if there are nodes that were connected to a more distant hub than the newly added hub. In those cases, these nodes are re-linked to the new hub.

The other routine, add-flows, adds flows to a given hub network configuration. A ‘flow’ is defined as a shipment of a fixed size, belonging to one of the cooperators, that travels from a known origin to a known destination. If a flow is added, this means that instead of travelling directly from origin to destination, this flow now goes from its origin to the closest hub, then via an inter-hub link to the hub that is located closest to its destination, and finally from this hub to the destination.

### 10.4.2 The Underlying Cooperative Game

A fair allocation of the generated synergy savings is critical to any horizontal cooperation. Mistrust about the fairness of the applied allocation rule for the savings has already caused many horizontal cooperation initiatives among shippers to marginalize or disintegrate. This particularly holds true for capital-intensive projects such as the construction of hub networks for physical distribution.

To ensure a fair gain sharing mechanism, the marginal contributions of each shipper to the total gain have to be accurately quantified. Therefore, along the lines of Chapter 9, solution procedures from cooperative game theory are used. The basic notions of cooperative game theory that are needed for the current problem have already been discussed in Chapter 9 and will only briefly be repeated here.

Let $N$ be a finite set of players (here: shippers) and denote by $2^N$ the collection of all subsets of $N$. Elements of $2^N$ are called *coalitions,* $N$ itself is called the *grand coalition*. The cost savings that a coalition $S$ can generate is called the *value* of coalition $S$. The characteristic function $v:2^N \to \mathbb{R}$ maps the values of all coalitions $S$.

In the case of step-wise hub network development, coalitional values are calculated based on the current level of the network development process (level $j$). Every time a new hub is introduced to reach the next level of the development process, a new game is calculated. The game for level $j$ is denoted by $\left(N, v_j\right)$. Coalitional values $v_j\left(S\right)$ resemble the cost savings that can be attained by a coalition $S$ on level $j$ of the development process. They are calculated as follows:

$$v_j(S) = \sum_{i \in S} C_0(i) - C_j(S) \tag{10.1}$$

Here, $v_j(S)$ is the value of coalition $S$ on level $j$ of the network development, $C_0(i)$ are the costs that shipper $i$ incurs in the original situation where there is no hub network and all flows travel directly from origin to destination, and finally $C_j(S)$ are the costs that coalition $S$ incurs for the execution of all their flows at level $j$. These costs also include the fixed costs for establishing hubs.

The Shapley value (Shapley, 1953), represented by $\Phi(N, v_j) \in \mathbb{R}^N$, is used to allocate the value of the grand coalition to the shippers on level $j$:

$$\Phi_i(N, v_j) = \sum_{S \subset N : i \notin S} \frac{|S|!\left(|N| - 1 - |S|\right)!}{|N|!} \left[ v_j\left(S \cup \{i\}\right) - v_j(S) \right], \text{ for all } i \in N. \tag{10.2}$$

### 10.4.3 Solution Approach

All necessary ingredients to describe the solution approach for developing a cooperative hub network are now available. Figure 10-2 gives a high-level description of the procedure, which consists of a number of iterative steps.

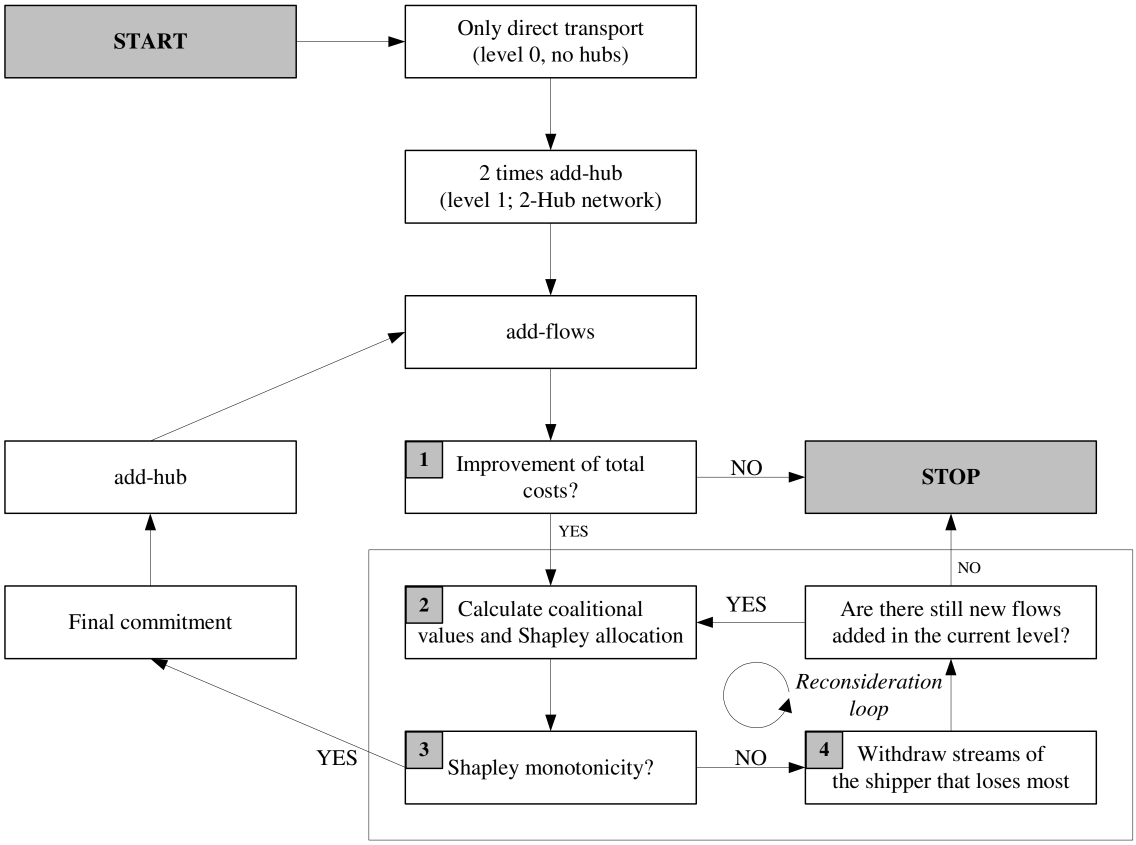


Figure 10-2. High-level solution procedure

The procedure initialises by constructing a network configuration consisting of two hubs. This is because in the current setting it is assumed that horizontal cooperation by joint transport only takes place on inter-hub links. It is also possible to perform joint route planning on the links between hubs and origin or destination nodes (cf. Chapter 4). This would however require a much higher intensity of cooperation, which introduces additional risks and coordination costs. Here the choice is made to restrict cooperation to the inter-hub links. Because of this choice, no benefits can be gained by introducing only a single hub. Therefore, the first configuration that is tested incorporates two hubs. The locations of these hubs are chosen by the add-hub heuristic. Below, only those steps of the procedure that need further explanation are commented on. These are indicated by the numbers in Figure 10-2.

***Step 1***

The total costs $C_j(N)$ of the network configuration at each level consists of three components:

1. The transport costs of the flows that do not use the hub network (the direct shipments form origins to destinations)
2. The transport costs of the flows that travel via the hub network (origin-hub, hub-hub, hub-destination)
3. The fixed costs of the established hubs (including handling, interest, overhead etc.)

***Step 2***

In Step 2 the cooperative game is calculated. For this game it is important to note that the individual shippers might have multiple flows passing through the hub network. This constitutes an important difference with existing literature on joint network development, where players are usually single flows or nodes. Based on all coalitional values following from formula (10.1), the Shapley values are calculated using formula (10.2).

***Step 3 and Step 4***

Consequently, the current level of the hub network development process is checked for what we call *Shapley monotonicity*. The basic idea behind the step-wise approach is to consistently check whether each shipper is willing to 'take the next step'. If this is not the case, the development of the network will stop. Therefore, in Step 3 a 'reconsideration loop' is initiated for each new level of network development (see Figure 10-2). In this loop, it is checked whether each shipper has a higher payoff than he had on the previous level. If the Shapley value that is allocated to shipper $i$ indeed corresponds to higher savings than were attained at any previous level (i.e., shipper $i$ benefits from the newly added hub), then this shipper's flows that were added on the current level are retained. In fact, to compensate for risks and switching costs, it can even be expected that shippers will require a certain minimum level of savings before engaging in an extended hub network. These thresholds can easily be incorporated in the proposed procedure.

If on the other hand shipper $i$ is worse off at a level $j$ than in an earlier level, he withdraws the added flows in Step 4. This means that these particular flows will travel directly from origin to destination again. Note however that the flows of shipper $i$ that were added at previous levels are retained in the hub network. Shipper $i$ is then treated as a *dummy player* (see Section 9.2.2) for the rest of level $j$ of the network development process. Specifically, this means that:

$$v_j(S \cup \{i\}) - v_j(S) = 0 \qquad (10.3)$$

Then, the Shapley allocation of Step 2 is repeated based on the coalitional values that are updated according to the withdrawal of the flows of shipper $i$. This updating is necessary because the resignation of shipper $i$ reduces the total volume transported through the network, which may influence the costs of the remaining shippers. In a sense, the process is therefore a 'correction' of the add-flows heuristic. Note that the procedure stops in case none of the shippers add any flows on the current level anymore. Furthermore, in cases where more than one shipper loses, the flows of the shipper that loses most are withdrawn. The flows of the other losing shippers are (temporarily) retained.

Only when after these iterative steps the add-hub routine is called again, the flows that have entered the hub network in the last iteration and constituted cost reductions are really committed. Before this point, flows were only tentatively included and possibly excluded again in the reconsideration loop when benefits turned out to be absent or insufficient.

## 10.5 AN ILLUSTRATIVE EXAMPLE

This section provides a hypothetical example for joint hub network development (see Figure 10-3). It should be noted that the only goal of this example is to illustrate this procedure, not to evaluate the concept's cost savings potential in practice. For example, practical considerations such as volume-dependent transport tariffs are not incorporated.

Consider three shippers (white, grey and black) that each have two flows travelling from disjunctive origins to disjunctive destinations. For each shipper, these two flows are depicted as either a square or a circle. Note that in the tables in this section, the white shipper is referred to as 'w', the grey shipper as 'g', and the black shipper as 'b'. For the purpose of illustration, but without loss of generality, it is assumed that all flows travel from left to right (see Figure 10-3). Furthermore, the demand size of each shipment is displayed underlined next to the origin and destination nodes. The flows are transported in trucks with a capacity of 25 units and there are no further restrictions in terms of product compatibility, time windows etc. The transport costs that the shippers incur are proportional to the Euclidean distances. However, it is assumed that inter-hub links have a 10% costs discount per unit of distance as compared to the other links as a result of the larger economies of scale. The transport costs are displayed on the links. In the current setting, shippers are only charged for one-way transport: the trucks are free at the destination node. It is however straightforward to adjust the procedure to support routes in which trucks must return to their origin. Furthermore, establishing a hub facility costs 1. This is the share of the costs incurred during the hub's complete lifetime that is allocated to the period under consideration. By doing so, it becomes possible to make a fair trade-off between the non-recurrent costs for establishing a hub and the recurrent benefits of sending flows through the hub network. Finally, it is assumed that hubs are always located at origin or destination nodes of flows.

Because there is no hub structure in Step 0, there is no cooperation and no savings can be shared among the shippers. This starting situation is displayed in Figure 10-3 and Table 10-1.

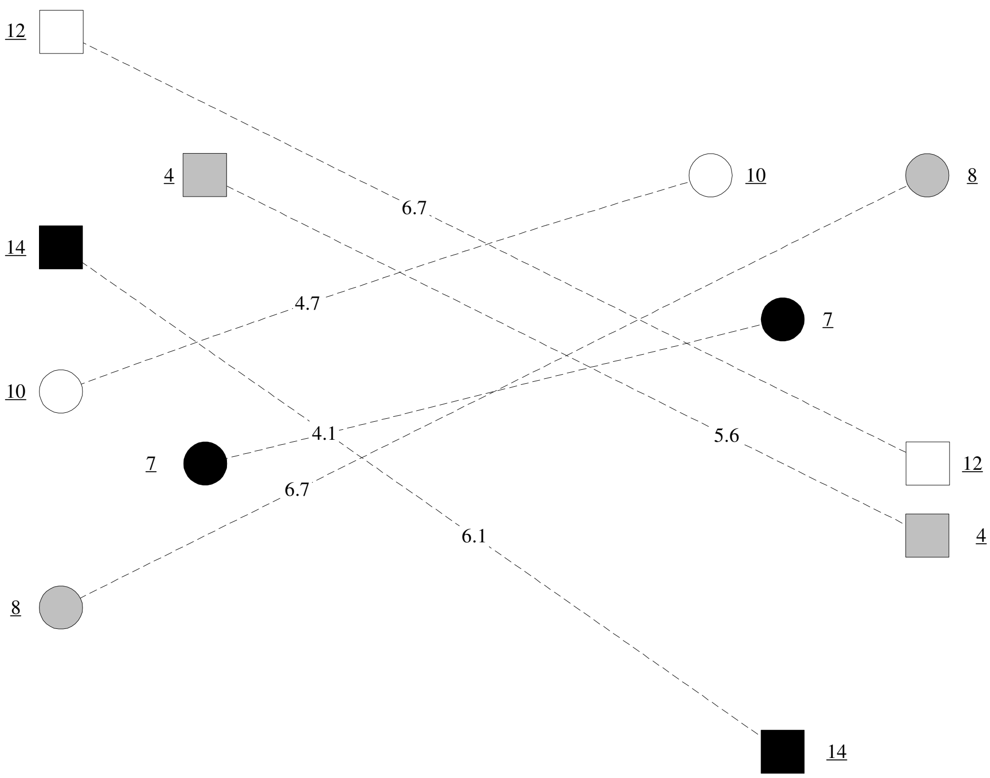


Figure 10-3. Illustrative example: Level 0

| $S$ | {w} | {g} | {b} | {w,g} | {w,b} | {g,b} | {w,g,b} |
|---|---|---|---|---|---|---|---|
| Hub costs | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Transport costs | 11.4 | 12.3 | 10.2 | 23.7 | 21.6 | 22.5 | 33.9 |
| $C_0(S)$ | 11.4 | 12.3 | 10.2 | 23.7 | 21.6 | 22.5 | 33.9 |
| $v_0(S)$ | . | . | . | . | . | . | . |
| $\Phi_0(S)$ | . | . | . | | | | |

Table 10-1. Coalitional values and allocations on level 0

The first iteration of the procedure (to reach level 1) is then entered and a hub structure is actually installed. The add-hub routine chooses both 'circle locations' of the black shipper as the most appropriate hub locations. This is illustrated in Figure 10-4 by the circles around these nodes, which have furthermore changed into triangles to represent hubs. The link connecting both hubs is in bold. The add-flows routine determines that also the circle locations of the white and grey shippers will now enter the hub network. Note that in the new configuration the circle locations' demands of 10, 8 and 7 exactly fit into one truck, so that the hub link needs to be crossed only once to serve all three added flows. This results in a significant cost reduction for these flows.

Based on the costs incurred in the new configuration, coalitional values are calculated. These values are given in Table 10-2, together with the Shapley values. It turns out that the black shipper receives the highest savings (21.6%), because his two locations are beneficial for the other two shippers and coincide with the hub locations. Note that the fixed costs for establishing the hubs are evenly spread over its users. This is a direct consequence of the additivity property of the Shapley value. When the game is split up in two subgames, one for the hub costs and one for the transport costs, it is readily verified (see the first row of Table 10-2) that in the hub costs subgame all coalitional values are equal and the costs will be evenly shared.

Table 10-2 shows that all cooperators receive a cost reduction for their participating flows. This means that none of the flows will be withdrawn from the hub network via the reconsideration loop. Now, a new iteration of the procedure can be started to reach the next level of network development.

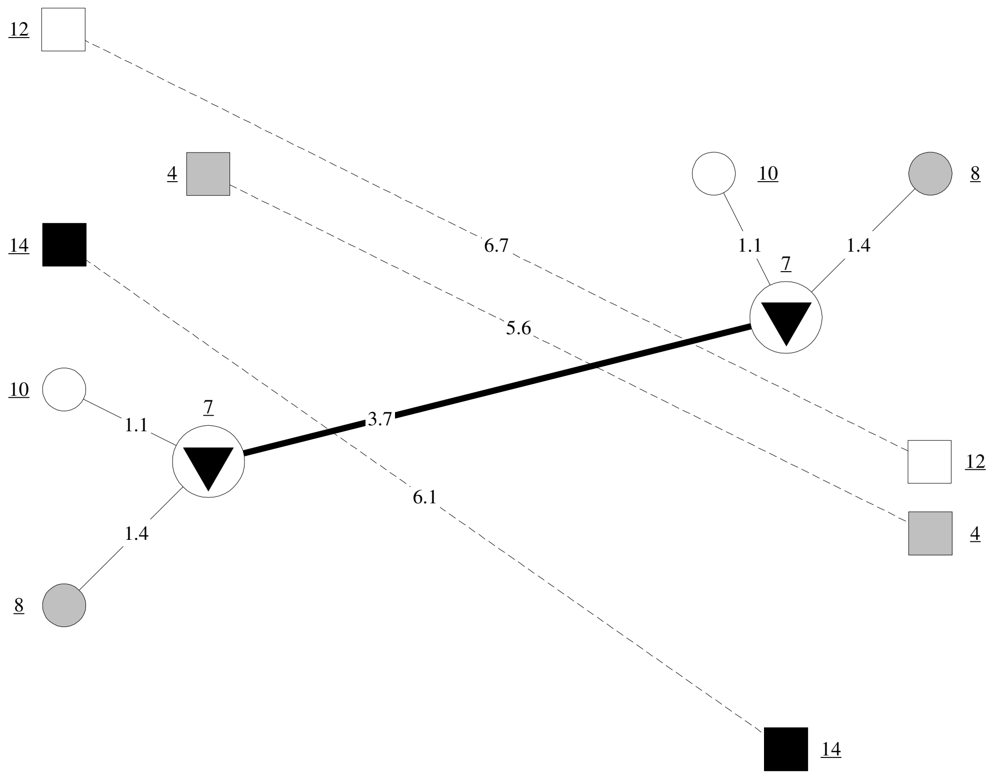


Figure 10-4. Illustrative example: Level 1

| $S$ | {w} | {g} | {b} | {w,g} | {w,b} | {g,b} | {w,g,b} |
|---|---|---|---|---|---|---|---|
| Hub costs | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Transport costs | 12.6 | 12.1 | 9.8 | 21.0 | 18.7 | 18.2 | 27.1 |
| $C(S)$ | 14.6 | 14.1 | 11.8 | 23.0 | 20.7 | 20.2 | 29.1 |
| $C_0(S)$ | 11.4 | 12.3 | 10.2 | 23.7 | 21.6 | 22.5 | 33.9 |
| $v_1(S)$ | -3.2 | -1.8 | -1.6 | 0.7 | 0.9 | 2.3 | 4.8 |
| $\Phi_1(S)$ | 0.6 | 2.0 | 2.2 | | | | |
| Allocation hub costs | 0.67 | 0.67 | 0.67 | | | | |
| Allocation transport costs | 10.13 | 9.63 | 7.33 | | | | |
| Costs after allocation | 10.8 | 10.3 | 8.0 | | | | |
| Costs previous level | 11.4 | 12.3 | 10.2 | | | | |
| Savings w.r.t. previous level | 5.3% | 16.3% | 21.6% | | | | |

Table 10-2. Coalitional values and allocations on level 1

In the second iteration, add-hub chooses the grey square origin node as the new hub location (see Figure 10-5). The add-flows routine now adds all remaining flows to the cooperative hub network.

Note that since there are now multiple inter-hub links in the network, some elementary routing problems need to be solved to calculate the coalitional values. For example, for the coalition consisting of only the white shipper ($S = \{w\}$), the best choice is to combine the two flows at one of the left-hand side hubs and then crossing the link to the hub at the right-hand side together. This route is feasible, because the corresponding shipments sum up to 22 (10+12). This amount still fits into one truck so that the inter-hub link has to be crossed only once to transport both shipments. This is however not possible for any of the 2-shipper coalitions, nor for the grand coalition. For these coalitions, it is best to respectively combine the square and circle shipments into separate groups that travel from left to right via the two inter-hub links. For coalition $S = \{w, b\}$ and the grand coalition, a long hub-link even needs to be crossed three times.

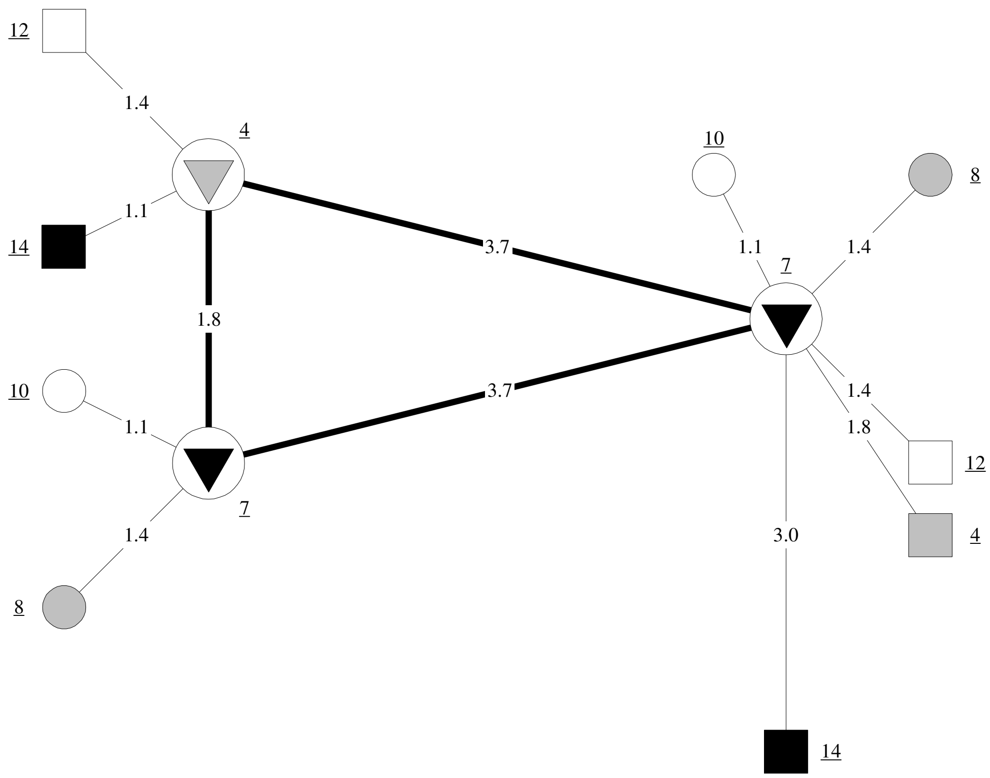


Figure 10-5. Illustrative example: Level 2

| S | {w} | {g} | {b} | {w,g} | {w,b} | {g,b} | {w,g,b} |
|---|---|---|---|---|---|---|---|
| Hub costs | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Transport costs | 10.5 | 10.1 | 9.6 | 17.0 | 20.2 | 16.1 | 24.8 |
| $C(S)$ | 13.5 | 13.1 | 12.6 | 20.0 | 23.2 | 19.1 | 27.8 |
| $C_0(S)$ | 11.4 | 12.3 | 10.2 | 23.7 | 21.6 | 22.5 | 33.9 |
| $v_2(S)$ | -2.1 | -0.8 | -2.4 | 3.7 | -1.6 | 3.4 | 6.1 |
| $\Phi_2(S)$ | 1.08 | 4.23 | 0.78 | | | | |
| Allocation hub costs | 1 | 1 | 1 | | | | |
| Allocation transport costs | 9.32 | 7.07 | 8.42 | | | | |
| Costs after allocation | 10.32 | 8.07 | 9.42 | | | | |
| Costs previous level | 10.8 | 10.3 | 8.0 | | | | |
| Savings w.r.t. previous level | *4.4%* | *21.7%* | *-17.8%* | | | | |

Table 10-3. Coalitional values and allocations in level 2

The bottom row of Table 10-3 shows that on level 2, the black shipper loses compared to level 1. This means that in the reconsideration loop of the procedure, this shipper will withdraw the flow that he added to reach level 2. This situation is illustrated in Figure 10-6: The black 'square-flow' does not use the grey hub anymore, but chooses for direct transport again. This illustrates how the reconsideration loop corrects the add-flows routine based on fair gain sharing between the participating shippers: although adding the black square flow might be beneficial from a total costs perspective, the black shipper does not gain and is not willing to loose money to the benefit of the other shippers.

As explained in Section 10.4.3, the black shipper is treated as a dummy player in the remainder of the reconsideration loop on level 2. He again incurs the costs he incurred at level 1 (8.0) and does not bring additional value to any of the coalitions (see Table 10-4). Note that since the black player has committed his circle flow in level 1, he still incurs his share of the fixed costs for the two hubs established on level 1 (see Table 10-2).

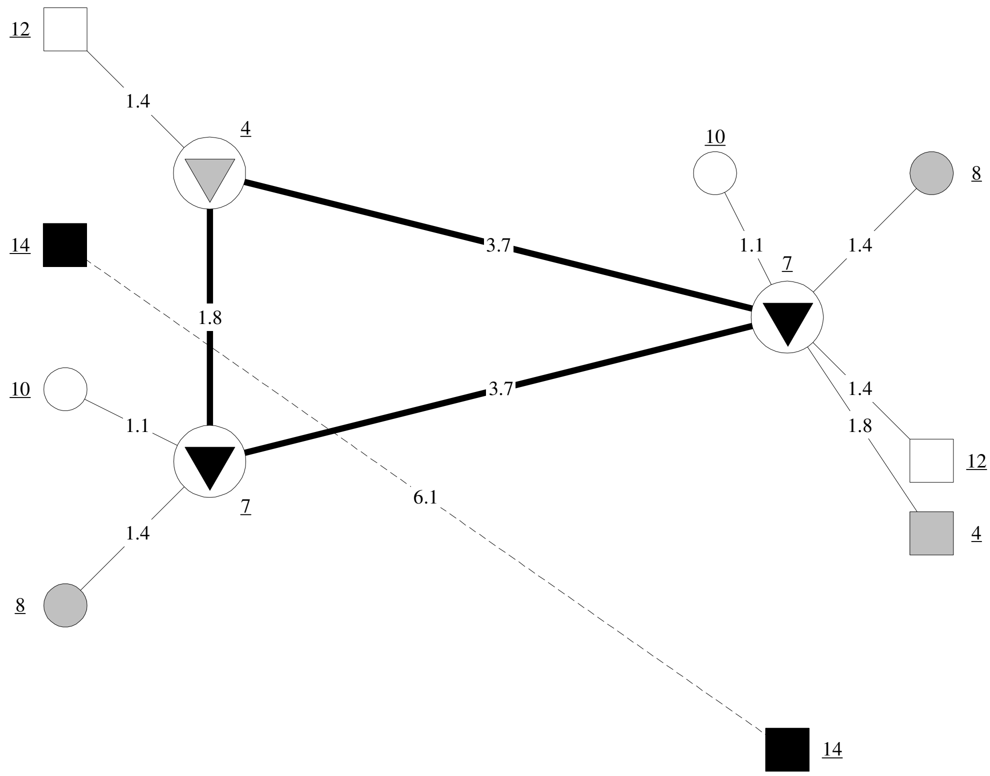


Figure 10-6. Illustrative example: Level 2 (reconsidered)

| S | {w} | {g} | {b} | {w,g} | {w,b} | {g,b} | {w,g,b} |
|---|---|---|---|---|---|---|---|
| Hub costs | 2.33 | 2.33 | 0.67 | 2.33 | 3 | 3 | 3 |
| Transport costs | 10.5 | 10.1 | 7.33 | 17.0 | 17.83 | 17.43 | 24.33 |
| $C(S)$ | 12.83 | 12.43 | 8.0 | 19.33 | 20.83 | 20.43 | 27.33 |
| $C_0(S)$ | 11.4 | 12.3 | 10.2 | 23.7 | 21.6 | 22.5 | 33.9 |
| $v_2(S)$ | -1.43 | -0.13 | 2.2 | 4.37 | 0.77 | 2.07 | 6.57 |
| $\Phi_2(S)$ | 1.54 | 2.84 | 2.2 | | | | |
| Allocation hub costs | 1.17 | 1.17 | 0.67 | | | | |
| Allocation transport costs | 8.69 | 8.29 | 7.33 | | | | |
| Costs after allocation | 9.86 | 9.46 | 8.0 | | | | |
| Costs previous level | 10.8 | 10.3 | 8.0 | | | | |
| Savings w.r.t. previous level | 8.7% | 8.2% | 0.0% | | | | |

Table 10-4. Coalitional values and allocations in level 2 (reconsidered)

After the withdrawal of the black shipper, it turns out that the white and grey shipper still benefit from the extra hub (8.7%, and 8.2% with respect to level 1). Therefore, the reconsideration loop of level 2 is terminated here without any further flow withdrawals. It is a straightforward exercise to check that adding another hub will not be sustainable, because in the reconsideration loop of level 3, all flows will be withdrawn and the procedure will stop. The final network therefore is the one depicted in Figure 10-6.

This finishes the discussion of the framework for developing cooperative hub distribution networks.

## 10.6 CONCLUDING REMARKS

This chapter focussed on shippers that cooperate by setting up a joint hub network for the transport of goods. The construction of such networks is a well-studied optimisation problem in the operations research literature. However, besides the final solution, also the development path towards this solution is of importance. Building a physical hub for the transhipment of goods is expensive and therefore involves considerable risks for the cooperating companies. In a practical setting, it is unlikely that the entire network corresponding to the final solution of the optimisation problem will be built at once. Rather, the partners will have a more cautious attitude and build the hub facilities one-by-one. Every time a new hub is introduced, partners will have the opportunity to decide whether or not they participate (and thus invest) in this network extension.

Compared to the ‘big bang’ approach that prevails in literature, the step-wise procedure developed in this chapter will generally result in an inferior final solution in the sense that possibly fewer flows will travel via the hub network, overall costs will be higher and less hubs will be constructed. However, this should not be considered a valid drawback. The investments in physical transport hub networks are that large that they cannot be made without a sustainable development path towards the final network. Nevertheless, comparing the performance of the step-wise and big-bang approaches is an interesting direction for further research.

It is important to note that the framework introduced in this chapter is applicable in other situations than hub networks as well. In many cases where multiple (infrastructural) investments have to be made by a consortium of logistics companies, the participants are likely to take advantage of a step-wise approach with gain sharing at intermediate levels. When looking at the horizontal cooperation types discussed in Section 3.1, the procedure can e.g. benefit maintenance groups, warehouse sharing initiatives, and intermodal groups.

# PART IV CONCLUSIONS AND RECOMMENDATIONS

# CHAPTER 11 CONCLUSIONS AND RECOMMENDATIONS

This thesis provides an analysis of horizontal cooperation in transport and logistics. This concept is defined as: *active cooperation between two or more firms that operate on the same level of the supply chain and perform a comparable logistics function on the landside*, and it provides an interesting direction of thought for logistics companies struggling with difficult market situations.

The large economic significance of the logistics sector and the problems it is currently facing, contribute to the importance of horizontal cooperation. Increased economies of scale are clearly necessary to prevent the rising transport costs, congestion and emissions from becoming an even larger burden to welfare than they are at present. Horizontal cooperation seems to be a viable alternative to mergers and acquisitions, to attain this increased scale. To illustrate its practical relevance, note that in the heavily congested European logistics centre of gravity (Belgium and the Netherlands) many horizontal cooperation initiatives of various types have already been initiated. Yet, existing literature lacks a general framework to guide practitioners in setting up these horizontal cooperations. For sure, not all forms of horizontal cooperation are applicable to any given sector or company. As such, the horizontal cooperation that currently exists may very well not be as effective as it could be.

## 11.1 RESEARCH QUESTIONS REVISITED

In Section 1.5.2, five central research questions were formulated. They were addressed in the chapters of this thesis as displayed in Figure 1-5. Below, these research questions are revisited.

***Q1: What are the expected cost savings of horizontal cooperation through joint route planning?***

This first research question deals with the expected savings of horizontal cooperation. To answer this question, the most basic type of horizontal cooperation in transport and logistics (i.e., joint route planning) was analysed in detail. A benchmark scenario was developed in Chapter 4, for which the benefits of joint route planning turned out to be considerable: savings up to 30.7% of total distribution costs were obtained. In this chapter, the concept of the *synergy value* is formally introduced. This is defined as the (percent) difference between distribution costs in the original situation where all entities perform their orders individually, and the costs of a system where all orders are collected and route schemes for different *flow controlling entities* (FCEs) are set up simultaneously. Sensitivity analyses were then conducted to gain insight into the main drivers for synergy. The results indicate that joint route planning is most beneficial in situations where there are a large number of FCEs of a uniform and not too large size. Furthermore, the synergy value increases if order sizes are small compared to a standard truck's capacity, time windows are narrow, and inter-customer distances are large. Together, the synergy value for the benchmark scenario and the sensitivity analyses provide an answer to research question Q1. The results have clear interpretations and can therefore be used by practitioners to develop insight on synergy value, should there be no time or budget to go through all the calculations. This insight thus allows for a rapid determination as to whether a group of cooperating logistics companies have a high synergy value. The mode of operation employed in this chapter can also be used to estimate savings for other horizontal cooperation types described in Chapter 3.

***Q2: To what extent do logistics practitioners consider horizontal cooperation a viable business approach?***

To answer research question Q2, Logistics Service Providers (LSPs) were contacted in Flanders by means of a questionnaire. This survey is discussed in Chapter 5. The results provide some important insights into the opportunities and impediments for horizontal cooperation. These opportunities and impediments arose from the literature review of Chapter 2 and were further developed into specific propositions based on input from interviews with industry experts. The results show that the opportunities are widely supported across the Flemish logistics sector. The proposition that horizontal cooperation increases a company's productivity for core activities, receives the strongest support. In particular, it receives more approval than the statement that horizontal cooperation reduces the costs of non-core activities. It can therefore be concluded that cooperation on core activities, although this involves the exchange of (sensitive) customer information, is considered to be more desirable than cooperation on non-core activities because of the higher potential of cost savings. Exploratory factor analysis subdivided the proposed impediments for horizontal cooperations into two sets: Partner Selection Impediments and Other Impediments. As was apparent from the literature review in Chapter 2, partner choice is vital for the success or failure of cooperation. The problems with finding suitable partners seem to be less severe for the more profitable respondents. Concerning the other impediments, respondents expect most difficulties from issues related to bargaining power. Especially the enabling concepts for horizontal cooperation discussed in Chapter 9 and Chapter 10 provide useful directions concerning bargaining and fair gain sharing.

***Q3: Is there a relation between a company's (financial) characteristics and its attitude towards horizontal cooperation?***

To answer research question Q3, Data Envelopment Analysis (DEA) was applied to the survey data of Chapter 5. The DEA results made it possible to draw conclusions regarding 1) the efficiency of the Flemish road transport sector and 2) the potential of horizontal cooperation to improve this efficiency. Research question Q3 is further developed into a number of conjectures formulated in Section 6.2. First and foremost, it turns out that the Flemish road transport sector is highly inefficient: less than 5% of the responding companies come within a reasonable distance of the efficient frontier. It became clear that an important reason for this inefficiency lies in the strong fragmentation of the sector. Horizontal cooperation is then put forward as a possible way to boost a company's efficiency by rationalising on inputs. The scale inefficiency found by the various DEAs is high enough to expect that market consolidation will be needed in the future for the sector to keep up with foreign (Eastern-European) competitors. Furthermore, it turned out that a minimum degree of efficiency and scale is needed before the impediments for horizontal cooperation can be overcome and rewards can be reaped.

To answer research question Q3, two conjectures about the relation of road transport companies' efficiency levels with their attitudes towards opportunities and impediments for horizontal cooperation were tested. It turned out that inefficient companies consider the impediments for horizontal cooperation significantly more severe than the more efficient companies do. However, no significant difference in the evaluations of the opportunities between efficient and less efficient companies could be found. This means that even the inefficient transport companies think that horizontal cooperation can improve their business, but their bad (financial) performance currently prohibits it: they cannot afford to spend time and money on starting up a horizontal cooperation project and run the risk of failure. This constitutes a possible role for governments to subsidise the starting period of horizontal cooperations. The time and capital restrictions are also the most probable explanation for the observation that inefficient companies consider the impediments to be more severe than their more efficient counterparts.

***Q4: Do regional differences exist between LSPs' attitudes towards horizontal cooperation?***

0 deals with research question Q4 by testing the hypothesis that Flemish LSPs consider the impediments for horizontal cooperation more severe than their Dutch colleagues do. This hypothesis is indeed supported based on the survey data of Chapter 5 and the results of an identical survey conducted in the Netherlands. It was also observed that the opportunities are valued alike by the two groups. The explanation for the different attitudes towards the impediments is probably of a cultural nature: Flemish entrepreneurs may be more inclined to first see where the cat jumps before implementing innovative or otherwise far-reaching concepts. They can therefore learn from both the successful and failed cooperation projects in the Netherlands.

In Chapter 7, also the similarities in both surveys are examined to get a feel for the validity of the results of the two surveys for other countries. It turns out that to a large extent, Flemish and Dutch respondents have similar beliefs about the relative importance of the individual opportunities and impediments. Therefore, it is conjectured that the relative importance of the opportunities and impediments in Flanders and the Netherlands gives a good estimate of the importance of the relative importance in other countries.

***Q5: Which logistics concepts can be used to enable horizontal cooperation?***

This final research question is answered by discussing three enabling concepts for horizontal cooperation in detail. These are Factory Gate Pricing, Insinking, and Joint Hub Network Development.

Firstly, in Chapter 8 Factory Gate Pricing (FGP) is examined. A model was developed that is capable of simulating different scenarios in terms of the orchestration, cooperation, and flow synchronisation of a distribution system. Results have been generated for a case study in the Dutch retail supply chain for slow moving dry grocery goods. Cost savings are attained by three factors. Firstly, the frequencies of delivery are optimised based on total supply chain costs. Secondly, by means of order synchronisation, the retailer can determine the timing of replenishment orders so that nearby suppliers can be combined in one route. Finally, the asymmetry in the network is exploited to create more efficiency: in the case study, the suppliers outnumber the retailers' distribution centres. FGP facilitates horizontal cooperation, since the number of decision makers is smaller. The experiments show that a shift to FGP alone results in a 22% decrease in supply chain costs. If there is also horizontal cooperation, savings up to 26% are possible.

As a second enabling concept, Chapter 9 introduces Insinking. Over the last decades, companies' profit margins have been decreasing, and the efficiency of logistics processes has become critical. To cut down costs, shippers often outsource transportation to an LSP. Traditionally, the initiative for this lies with the shipper: once he reckons that logistics activities should be outsourced, an invitation to submit a tender is sent out to a number of pre-selected LSPs. Based on this invitation, the LSPs then propose a price for their services. Chapter 9 deals with the reverse mode of operation, where the initiative for the contract lies with the LSP. To stress the contrast between the traditional push approach of outsourcing, and the proposed pull approach where the LSP is the initiator, we will refer to this phenomenon as insinking, the antonym of outsourcing. Insinking has the advantage that the logistics service provider can proactively select a group of shippers with a strong synergy potential. Moreover, these synergies can be allocated to the participating shippers in a fair and sustainable way by means of solution methods from cooperative game theory. Insinking facilitates horizontal cooperation without the difficulties arising from the sharing of sensitive information between the cooperating companies. The complex task of allocating the attained savings solely lies with one actor who performs all necessary calculations and communication. This avoids long and difficult rounds of discussion among the cooperating companies. Insinking is illustrated by means of a practical example based on data from the Dutch grocery transportation sector.

Finally, Chapter 10introduces a framework for joint hub network development. Building a joint physical hub for transhipment of goods is expensive and therefore involves considerable risks for the cooperating companies. In a practical setting, it is unlikely that an entire network will be built at once. Rather, the partners will have a more cautious attitude and build the hub facilities one-by-one. In the proposed framework, every time a new hub is introduced, partners will have the opportunity to decide whether or not they participate (and thus invest) in this network extension. The framework is applicable in other cooperative situations than hub network development as well. In practically all cases where multiple (infrastructural) investments have to be made by a consortium of logistics companies, the participants are likely to take advantage of a step-wise approach with gain sharing at intermediate steps. More specifically, the procedure can also benefit maintenance groups, warehouse sharing initiatives, and intermodal groups.

## 11.2 RECOMMENDATIONS FOR FURTHER RESEARCH

The literature on horizontal cooperation, especially in the transport and logistics sector, is still in its infancy. Therefore, it was inevitable to make choices on which aspects to investigate and which not. As a consequence, some important features of horizontal cooperation have received less attention. In addition, parts of the research performed in this thesis give rise to supplementary research questions. This section provides a list of important directions for further research on the topic of horizontal cooperation in transport and logistics.

***Implementation and Management of Horizontal Cooperations***

Not much attention has been paid to how horizontal cooperations should be implemented and managed in everyday business. Nevertheless, this is a very important aspect. During the lifetime of a horizontal cooperation, four generic phases can be identified. These are: Strategic positioning, Design, Implementation, and Management (Verstrepen et al., 2006). Each of these phases in turn consists of multiple tasks that are to be carried out carefully to make the cooperation a success. During the lifetime, it is possible that conflicts between partners will occur about e.g. contractual issues, growth strategies, newly entered partners, or necessary investments. A good management of these conflicts is crucial for a cooperation’s long-term success. Some useful insights concerning the role of conflicts and other soft factors in cooperative relations can be found in the psychological literature (e.g. Mulder et al., 2005). Additional research is however needed to combine insights from various disciplines such as phychology, operations research, and management science into comprehensive implementation and management plans. There do exist business reports that discuss the management of logistics cooperations (e.g. van der Ham, 2005; Verstrepen, 2006). A more formal consideration by social scientists would however strongly enrich our understanding of how horizontal cooperations should be managed, and is therefore an important direction for further research.

***Factory Gate Pricing Model Extensions***

Chapter 8 introduced the concept of Factory Gate Pricing (FGP). An optimisation model was constructed to gauge the impact of frequencies of delivery, transport mode choice, and supply chain orchestration. In its present form however, the model only covers primary transport. It is certainly possible to also incorporate secondary transport, since for certain (large) flows it may be optimal to bypass the retailer's DC and travel directly from supplier to retail outlet. Allowing for these two extensions creates a higher degree of freedom and thus increases the total cost savings of FGP. An extended model in which also secondary transport was incorporated has already been developed and applied to the supply chain of large retailers in the Netherlands and Sweden. Preliminary results show that optimising primary and secondary transport simultaneously offers an additional savings potential of around 5%. More research is however needed to validate these savings in other supply chains.

***Game Theoretical Extensions***

Chapter 9 and Chapter 10 consider one of the most difficult and delicate questions concerning cooperation: gain sharing. Both chapters show how cooperative game theory can be used to make horizontal cooperation more sustainable. The application of a combination of game theoretic methods and operations research techniques to real life problems is quite unique in literature. This gives rise to a number of interesting questions. For example: Under which conditions do Rational Shapley Monotonic Paths (RSMPs) exist in the context of Insinking? What happens if also a competing Logistics Service Provider applies Insinking to attract some of the targeted shippers? How robust is a given RSMP to system changes such as growth or decline of a shipper, mergers, geographical displacements, withdrawals of shippers, etc.? What are the relevant selection criteria when choosing between multiple RSMPs? Furthermore, for both chapters, it would be very interesting to know how the results would change when a different game theoretical solution concept (nucleolus, tau-value, etc.) is used instead of the Shapley value. And what is the complexity of the various solution procedures? Answering (some of) these questions is an interesting direction for further research.

***Calculation of Savings***

In Chapter 4, expected savings are calculated for horizontal cooperation through joint route planning. A basic distribution setting was chosen for this analysis. Further research is needed to understand the impact of joint route planning in more complex distribution systems. It would be useful to perform an investigation into how the results of the analysis are influenced by the introduction of e.g. multiple depots or pick up and delivery orders.

***Joint Hub Network Development***

Chapter 10 proposes a framework for the step-wise development of joint hub distribution networks. This framework is illustrated by means of a small hypothetical example. There are however some practical issues that are hard to simulate in such an example. For instance, it would be very interesting to compare the final solutions of the step-wise approach and the big bang approach in a real-life case. Finally, in the current setting it was assumed that cooperation only takes place on the inter-hub links. A study on hybrid forms of horizontal cooperation, for example by means of introducing joint route planning on the other links, would be a useful contribution.

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# SAMENVATTING (SUMMARY IN DUTCH)

Dit proefschrift behandelt horizontale samenwerking in transport en logistiek. Hoewel deze vorm van samenwerking 'hot' is in de praktijk, staat het wetenschappelijk onderzoek hiernaar nog in de kinderschoenen. Binnen dit proefschrift wordt de aandacht gericht op horizontale samenwerking in transport en logistiek aan de landzijde, die als volgt gedefinieerd wordt:

*Horizontale samenwerking in transport en logistiek is actieve samenwerking tussen twee of meer bedrijven die opereren op dezelfde hoogte in de aanvoerketen en een vergelijkbare logistieke functie uitvoeren aan de landzijde.*

Het grote belang van transport en logistiek voor de Westerse economieën en de problemen voor welke de sector zich momenteel gesteld ziet, vormen de belangrijkste drijfveer voor het onderzoek dat in dit proefschrift beschreven wordt. Er bestaat geen twijfel over dat logistieke ondernemingen een zekere schaalgrootte nodig hebben om te voorkomen dat transportkosten, congestie en $CO_2$-uitstoot uit de hand lopen. Dit kan uiteraard bereikt worden door fusies en overnames, maar horizontale samenwerking wordt hier naar voren gebracht als een aantrekkelijk alternatief.

***Beknopt overzicht***

Het proefschrift is onderverdeeld in drie delen, aangevuld met een inleiding (Hoofdstuk 1) en een conclusie (Hoofdstuk 11). Deel I geeft de benodigde voorkennis over het onderwerp en is zelf weer opgesplitst in drie hoofdstukken. Hoofdstuk 2 bevat de eerste uitgebreide inventarisatie van de relevante academische literatuur op het gebied van horizontale samenwerking in transport en logistiek. Hoofdstuk 3 geeft vervolgens een aanzet tot een typologie voor horizontale samenwerkingsvormen die in de praktijk voorkomen. Deze kunnen variëren van een ad hoc vrachtuitwisseling tot bijvoorbeeld het gezamenlijk investeren in een gedeeld distributiecentrum. Tenslotte geeft Hoofdstuk 4 een inschatting van de omvang van de besparingen op transportkosten die behaald kunnen worden door gezamenlijke ritplanning.

Deel II bespreekt het empirische gedeelte van het onderzoek. Door middel van twee enquêtes werden ongeveer 1.500 Vlaamse en 2.500 Nederlandse Logistiek Dienstverleners (LDVs) gevraagd om voor hun eigen bedrijf de kansen van en drempels voor horizontale samenwerking in te schatten. Hoofdstuk 5 beschrijft een uitgebreide statistische analyse van de opvattingen van de Vlaamse respondenten. Deze resultaten zijn vervolgens gekoppeld aan (financiële) bedrijfsgegevens. Dit maakt het mogelijk om in Hoofdstuk 6 een genuanceerder beeld te vormen van bepaalde opvattingen van LDVs over horizontale samenwerking. Het empirische deel wordt afgesloten in Hoofdstuk 7 door de antwoorden van de Vlaamse en Nederlandse respondenten met elkaar te vergelijken.

Het laatste deel van dit proefschrift behandelt een aantal innovatieve logistieke concepten die horizontale samenwerking kunnen faciliteren. Dit zijn: Factory Gate Pricing (Hoofdstuk 8), Insinking (Hoofdstuk 9) en Joint Hub Network Development (Hoofdstuk 10). Praktische relevantie was één van de belangrijkste eisen aan de analyse van elk van deze concepten. Daarom is waar mogelijk gewerkt met objectieve praktijkdata en worden bovendien adviezen uitgebracht over de vraag hoe horizontale samenwerking daadwerkelijk in de praktijk bereikt kan worden door middel van deze concepten.

***Doel en Onderzoeksvragen***

Het hoofddoel van dit proefschrift is het identificeren van interessante en vruchtbare onderzoeksrichtingen rond horizontale samenwerking in transport en logistiek om zo verder academisch onderzoek naar dit onderwerp te ondersteunen. Hopelijk inspireren de verkregen resultaten en inzichten onderzoekers om dit interessante onderzoeksgebied verder uit te werken, en logistiek managers om horizontale samenwerking daadwerkelijk in te zetten als een oplossing voor de uitdagingen in de logistieke sector. Het hoofddoel wordt onderverdeeld in vijf specifieke onderzoeksvragen:

Q1 Wat zijn de potentiële besparingen van horizontale samenwerking door gezamenlijke ritplanning?

Q2 In hoeverre beschouwen managers van logistieke ondernemingen horizontale samenwerking als een haalbare kaart?

Q3 Is er een relatie tussen (financiële) karakteristieken van een bedrijf en haar opvattingen over horizontale samenwerking?

Q4 Bestaan er regionale verschillen in de opvattingen van LDVs over horizontale samenwerking?

Q5 Welke logistieke concepten kunnen ingezet worden om het potentieel van horizontale samenwerking uit te buiten?

Hieronder wordt elk van deze onderzoeksvragen nader uitgewerkt.

Q1 - Deze eerste onderzoeksvraag behandelt de (maximale) besparingen die te behalen zijn door horizontale samenwerking. Om deze vraag te beantwoorden, analyseren we in Hoofdstuk 4 de meest basale vorm van horizontale samenwerking in transport en de logistiek, namelijk gezamenlijke ritplanning. Het uitgangspunt is een benchmarkscenario, waarin de voordelen van gezamenlijke ritplanning aanzienlijk blijken te zijn (30,7% van de totale distributiekosten). Deze besparing noemen we de *synergiewaarde*. Dit is een belangrijke term in het hele proefschrift en we definiëren dit formeel als het (procentuele) verschil tussen de kosten in de uitgangssituatie waar alle bedrijven hun eigen orders uitvoeren, en de kosten in een systeem waar alle orders worden verzameld en gelijktijdig routeschema's worden geconstrueerd voor alle samenwerkende bedrijven. Door middel van gevoeligheidsanalyse wordt onderzocht wat de invloed is van verschillende factoren op de synergiewaarde. De resultaten hiervan geven aan dat gezamenlijke ritplanning het voordeligst is in situaties waarin een groot aantal gelijkwaardige en niet te grote partijen samenwerkt. De synergiewaarde neemt nog verder toe wanneer de gemiddelde ordergrootte klein is ten opzichte van de capaciteit van de gebruikte vrachtwagens, tijdvensters krap zijn en de gemiddelde afstand tussen de losadressen groot is. Deze resultaten hebben een duidelijke betekenis in de praktijk en kunnen dus gemakkelijk gebruikt worden door logistiek managers om in te schatten of samenwerking tussen bepaalde bedrijven voldoende potentieel heeft.

Q2 - Voor de beantwoording van onderzoeksvraag Q2, zijn circa 1.500 Vlaamse LDVs geënquêteerd. De resultaten hiervan staan beschreven in Hoofdstuk 5. De hoofdmoot van de enquête bestaat uit een aantal stellingen over specifieke kansen en drempels voor horizontale samenwerking. Uit de evaluaties door de respondenten blijkt dat het potentieel van horizontale samenwerking sterk onderschreven wordt door de Vlaamse logistieke sector. De stelling dat horizontale samenwerking de productiviteit van de kernactiviteiten verhoogt, kon rekenen op de meeste bijval. In het bijzonder werd deze stelling breder ondersteund dan de stelling dat horizontale samenwerking de kosten van niet-kernactiviteiten verlaagt. We concluderen hieruit dat samenwerking op kernactiviteiten, ondanks dat dit vaak uitwisseling van gevoelige (klant)informatie vereist, kansrijker is dan samenwerking op niet-kernactiviteiten, met name vanwege het grotere besparingspotentieel. Vervolgens hebben we exploratieve factor analyse toegepast op de stellingen. Dit resulteerde in een onderverdeling van de drempels in twee groepen: drempels gerelateerd aan partnerselectie en 'overige' drempels. Zoals ook bleek uit het literatuuroverzicht in Hoofdstuk 2, is partnerselectie van essentieel belang voor de slaagkans van een samenwerking. Voor wat betreft de overige drempels, verwachten de respondenten de meeste moeilijkheden door verschillen in de onderhandelingsposities van de partners. In de hoofdstukken 9 en 10 worden door middel van innovatieve logistieke concepten praktische handvatten aangereikt om deze drempels te slechten en vervolgens ook de synergiewaarde eerlijk te verdelen.

Q3 - Om onderzoeksvraag Q3 te beantwoorden, is Data Envelopment Analysis (DEA) toegepast op de enquêteresultaten van Hoofdstuk 5. Deze techniek maakt het mogelijk om conclusies te trekken aangaande 1) de efficiëntie van de Vlaamse wegtransportsector en 2) het potentieel van horizontale samenwerking om deze efficiëntie te verhogen. De onderzoeksvraag is in Sectie 6.2 nader uitgewerkt in een aantal concrete hypothesen. De voornaamste conclusie is dat de Vlaamse wegtransportsector hoogst inefficiënt is: minder dan 5% van de responderende bedrijven komt binnen een redelijke afstand van de zogenaamde efficiënte grens. Een belangrijke verklaring voor deze inefficiëntie is de sterke fragmentatie binnen de sector. Rationaliseren op de benodigde productiemiddelen door middel van horizontale samenwerking wordt vervolgens naar voren gebracht als een mogelijke remedie. De 'schaalinefficiëntie' is omvangrijk genoeg om te veronderstellen dat in de toekomst vergaande marktconsolidatie nodig zal zijn om de toenemende Oost-Europese concurrentie het hoofd te kunnen bieden. Verder bleek uit de analyse dat een zeker minimum niveau van efficiëntie nodig is alvorens de drempels voor horizontale samenwerking kunnen worden overwonnen en de voordelen kunnen worden benut. Tenslotte bleek er geen significant verband te bestaan tussen de evaluaties van de kansen en het efficiëntie niveau van bedrijven. Dit betekent dat zelfs de inefficiënte transportbedrijven denken dat horizontale samenwerking hun bedrijfsvoering ten goede kan komen. Hun slechte (financiële) situatie maakt dit echter een hachelijke onderneming: door de kans op mislukking kunnen zij het zich moeilijk veroorloven tijd en geld te spenderen aan het opstarten van een horizontaal samenwerkingsproject. Dit is ook de meest voor de hand liggende verklaring voor het feit dat de inefficiënte bedrijven de drempels hoger inschatten dan hun meer efficiënte collega's.

Q4 - Hoofdstuk 7 behandelt onderzoeksvraag Q4 door de hypothese te testen dat Vlaamse LDVs de drempels voor horizontale samenwerking hoger inschatten dan hun Nederlandse collega's. Deze hypothese wordt getest op basis van de Vlaamse onderzoeksgegevens van Hoofdstuk 5 en de resultaten van een identieke enquête onder 2.500 Nederlandse LDVs. Het blijkt dat de voordelen door beide groepen even hoog worden ingeschat, maar dat de Vlaamse respondenten de drempels voor samenwerking significant hoger inschatten dan hun Nederlandse collega's. De verklaring zou van culturele aard kunnen zijn: de Vlaamse ondernemers zijn mogelijk geneigd om langer de kat uit de boom te kijken voordat daadwerkelijk overgegaan wordt tot invoering van innovatieve of anderszins ingrijpende logistieke veranderingen. De Vlamingen kunnen hierdoor dus leren van zowel de succesvolle als de mislukte Nederlandse initiatieven. Een tweede doel van Hoofdstuk 7 is een idee te krijgen van de generaliseerbaarheid van de resultaten van de Vlaamse enquête naar andere West-Europese landen. Het blijkt dat er slechts beperkte verschillen zijn tussen de relatieve inschattingen van stellingen door Vlaamse en Nederlandse respondenten. We spreken daarom het vermoeden uit dat de ordening van de stellingen betreffende de voordelen en drempels voor horizontale samenwerking zoals die uit de Vlaamse enquête naar voren kwam een goede indicatie is voor het relatieve belang van elk van de voordelen en drempels in andere landen.

Q5 - Deze laatste onderzoeksvraag wordt beantwoord door drie logistieke concepten te bespreken die horizontale samenwerking kunnen faciliteren. Dit zijn achtereenvolgens: Factory Gate Pricing, Insinking, en Joint Hub Network Development.

Om te beginnen onderzoekt Hoofdstuk 8 Factory Gate Pricing (FGP). Dit is een retail concept waarin retailers hun bestellingen zelf ophalen bij hun leveranciers, in plaats van dat de leveranciers de bestellingen komen afleveren bij de distributiecentra van de retailers. De analyse gebeurt door middel van een model dat in staat is verschillende scenario's in termen van ketenregie, samenwerking en ordersynchronisatie voor een distributiesysteem te simuleren. Concrete resultaten zijn gevonden voor een casestudy van langzaamlopende droge kruidenierswaren in Nederland. De kostenbesparingen worden hier met name bereikt door drie factoren. Ten eerste is er de optimalisatie van leverfrequenties op basis van de totale logistieke kosten. Ten tweede kan de retailer door ordersynchronisatie de timing van bestellingen veranderen, zodanig dat nabijgelegen leveranciers in één route worden gecombineerd. Tot slot wordt de asymmetrie in het netwerk benut teneinde een hoger efficiëntiegraad te bereiken: in de voorliggende casestudy zijn er immers (veel) meer leveranciers dan distributiecentra. Dit maakt horizontale samenwerking onder FGP gemakkelijker, aangezien het aantal beslissers kleiner is dan in de traditionele situatie. De uitkomsten tonen aan dat de genoemde drie factoren een daling van 22% van logistieke kosten mogelijk maken. Als er daarnaast ook samenwerking tussen de retailers is, zijn er besparingen tot 26% mogelijk.

Het tweede logistieke concept dat geïntroduceerd wordt is insinking (Hoofdstuk 9). Teneinde de kosten te verlagen, besteden verladers hun transportactiviteiten de laatste jaren in toenemende mate uit aan één of meerdere LDVs. Traditioneel ligt het initiatief hiervoor bij de verlader: wanneer deze onderkent dat het beter is om het transport uit te besteden, stuurt hij een offerteverzoek naar een aantal vooraf geselecteerde LDVs. Gebaseerd op de informatie in dit verzoek, offreren de LDVs dan een tarief. Onder insinking wordt dit proces omgedraaid en komt het initiatief bij de LDV te liggen. Om het verschil tussen de traditionele ‘push’ methode en de hier voorgestelde ‘pull’ benadering te benadrukken, noemen we dit fenomeen ‘insinking’ (het antoniem voor het Engelse woord ‘outsourcing’). Insinking biedt het voordeel dat de LDV proactief een aantal verladers met een grote onderlinge synergiewaarde kan selecteren. Verder kan deze synergiewaarde eenvoudig en eerlijk worden verdeeld over de verladers door middel van methoden uit de coöperatieve speltheorie. Ook insinking wordt geïllustreerd aan de hand van een voorbeeld op basis van praktijkdata uit de Nederlandse retail sector.

Tot slot introduceert Hoofdstuk 10 een methode voor de gezamenlijke ontwikkeling van een hub netwerk. Het opzetten van een gezamenlijk fysiek hub netwerk voor het transport van goederen is erg duur en brengt daardoor aanzienlijke risico's voor de samenwerkende bedrijven met zich mee. Het is dus onwaarschijnlijk dat een compleet netwerk in één klap zal worden gerealiseerd. De partners zullen zich aanvankelijk terughoudend opstellen en de hubs één voor één bouwen. In de voorgestelde methode kunnen de partners telkens wanneer er een nieuwe hub wordt geïntroduceerd beslissen om al dan niet aan deze netwerkuitbreiding deel te nemen. In elk van deze tussenstappen vindt winstverdeling plaats op basis van coöperatieve speltheorie. Op deze manier wordt het mogelijke een duurzaam ontwikkelingspad richting het ‘finale netwerk’ uit te stippelen, zodat de moeilijkheden door de terughoudendheid van de partners omzeild kunnen worden. De voorgestelde methode kan eveneens toegepast worden in andere situaties dan de gezamenlijke ontwikkeling van hub netwerken. In veel gevallen waar een consortium voor meerdere (infrastructurele) investeringen staat, zullen de deelnemers immers een trapsgewijze benadering met winstdeling in de tussenliggende stappen nastreven. Meer in het bijzonder kan de procedure van nut zijn voor horizontale samenwerking door middel van gezamenlijke onderhoudsfaciliteiten, gedeelde distributiecentra en intermodaal transport.

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