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Special Issue:
Production Networks Sustainability

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Structural concepts for horizontal cooperation to increase efficiency in logistics

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ABSTRACT

Business networking strategies and especially cooperation in logistics are gaining momentum for individual companies in order to survive in competitive markets. As horizontal logistics cooperation among shippers is a new and powerful approach to optimize cost structures, this publication deals with the conceptual design and the organizational aspects of horizontal cooperation. With regard to the variety of influencing factors and parameters of cooperation a framework is presented that supports the selection of possible cooperation forms. Special attention is further dedicated to the design of cooperative logistics models as well as to the specifications of cooperation models, which are both considered as key factors to ensure a successful and sustainable cooperation. Based on the identified structural concepts the great potential of horizontal logistics cooperation is demonstrated on the example of two case studies.

1. Introduction

As a consequence of increasing competitive pressure and a changing market place driven by globalization, the speed of technological progress and the generally more dynamic nature of markets, today's business is more strongly driven by competitiveness than ever before [1,2]. Companies are forced to reorganize their business processes, to enable them to react quickly and cost effectively to fast changing market demands. As logistic costs make up a significant part of total costs, logistics has gained much attention by substantially increasing the efficiency and flexibility of organizations.

The optimization of a company's owned supply and distribution network or the utilization of freight exchanges only have limited impact on resource efficiency. Individual companies with limited shipment volumes lack access to cost efficient and highly productive transport networks. In the case of freight exchanges, an online, real time service where haulers search for freight as well as freight forwarders, which offer freight to be transported, a significant load factor increase is inhibited due to the openness of the market. Too many service providers are interested in the acquisition of fluctuating transport loads. Thus a concentration of volumes on fewer resources cannot be achieved [3]. Business networking strategies and especially cooperation in logistics is one possibility to increase efficiency and collaboration between the different partners or stages of the supply chain is gaining even more momentum nowadays.

The objectives of this paper are the illustration and determination of the various possibilities in the field of horizontal logistics for individual companies and the identification, design and operation of the optimal cooperation for the networking partners. On the basis of the existing body of knowledge and different known approaches to increase efficiency, a cooperation framework for shippers and the required concepts for network design and organizational models are presented with the result of a novel conceptual classification to guide practitioners in setting up horizontal cooperation.

2. Literature review

Both vertical cooperation in supply chains and lateral cooperation in supply networks have been the focus of various research efforts over the last decades. However, the literature on horizontal cooperation in logistics is still in its infancy, especially where operational consequences are concerned. Existing literature in the field of horizontals logistics cooperation is scarce and emphasizes the illustration or quantification of potential cost savings through cooperation by means of simulations studies and by reporting a limited number of successful implementations, as this type of cooperation is becoming more relevant in practice.

2.1. Horizontal relationships

In today's economy a common way to classify existing cooperation approaches is the differentiation with regard to the arrangement of the cooperative elements in relation to the value chain. While close cooperation between logistic service providers (LSPs) and customer is known as vertical cooperation, concerted

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practices between companies operating at the same level(s) in the market or logistic chain is defined as horizontal cooperation by the European Union [4]. These companies can be either competing or unrelated suppliers, manufacturers, retailers, receivers or LSPs, that share information, facilities or resources with the goal of reducing costs and/or improving service.

Depending on the trade-off between cooperation and competition in relationships between competitors Bengtsson and Kock identify four different types of horizontal relationships: coexistence, cooperation, competition and co-opetition [5]. While coexistence does not include any economic and merely information or social exchange in cooperating relations those exchanges are frequent and social, knowledge and legal bonds frequently arise [6].

In both academic and professional literature the various types of cooperation in horizontal logistics have been discussed. Although cooperation and collaboration are both used to refer to concerted practices on horizontal level, a high level of ambiguity exists between the definition and characteristics of these relationships. Some authors explicitly discriminate between these appellations. Studies of Mentzer et al. and Golicic et al. have shown that for supply chain executives collaboration entails much more than cooperation, especially in terms of sharing information, risks, knowledge and profit and in the required level of closeness [7,8]. The boundary between cooperation and collaboration is vague and ambiguity would lead to misconceived expectations for managers [9]. Nevertheless, there exists a large consensus on the minimum and the maximum level of cooperation. In between the two extremes of arm's length relationships as the minimum and integrated firms as the maximum level, there exists a whole range of cooperation types which Cruijssen illustrates by means of an anthology of cooperative relationships like, among others, consortia, joint ventures, alliances, action sets, supply networks, and partnerships [9]. Although some authors provide separate descriptions of some of these types, generally accepted definitions and distinctions are still lacking. To avoid confusion, from here on all these relationships will be summarized by the term cooperation.

2.2. Horizontal cooperation in transport and logistics

Whereas horizontal cooperation is well documented for maritime shipping [10] and aviation industry [11,12], the literature on horizontal cooperation in landside transport and logistics is fairly limited, although cooperation between logistic businesses is not new. Haulers already started with freight alliances in the early 1930s [13] and later focused on regional traffic. These cooperation forms are used mainly in city logistic concepts. Within the city logistic concept cities strive for central optimization of transports, where already in 1999 analysis concerning the point of implementation showed that over 30 cities had at least started planning activities for such concepts [14].

The scarce relevant literature on horizontal cooperation in landside logistics mainly deals with cooperation on the level of LSPs and only few exceptions focus on the cooperation among shippers. The most relevant are discussed in chronological order. Caputo and Mininno examine various policies such as standardized computerized document content, standardized pallets and cartons, multi-supplier warehouses and coordinated route planning in the Italian grocery industry and further discusses the aggregation of suppliers to the same courier [15]. Erdmann constructs a model to quantify the synergy potential of different forms of cooperation in the German consumer industry and elaborates guidelines and recommendations for cost allocation and design of horizontal cooperation [16]. Bahrami develops an IT-supported model to define forms of cooperation leading to the desired results, toidentify qualified cooperation partners and to evaluate the individual and overall benefit of a cooperation comparing the scenarios of individual transportation, joint distribution with current structures and joint distribution with optimized structures offering a real-life case study of two German consumer goods manufacturers [17]. Hageback and Segerstedt study co-distribution in rural areas providing the example of the approximately twenty companies located in the small and remote municipality of Pajala in Northern Sweden [18]. Further possible savings are estimated and the most important problems of launching co-distribution are stated. Cruijssen et al. study the potential benefits and impediments for horizontal cooperation between LSPs in Flanders [19]. Krajewska analyzes the profit margins resulting from horizontal cooperation among freight carriers and the possibilities of sharing these margins fairly among the partners [20]. Rieck develops methods and algorithms for vehicle routing problems for medium-sized forwarders considering time windows, simultaneous delivery and pick-up at customer locations and multiple use of vehicles within forwarding cooperations [21]. Kopfer identifies collaboration obstacles while establishing a coalition or during the collaboration process itself in order to develop frameworks and models which guarantee the functioning of horizontal collaboration forms [22]. Frisk et al. focus on the usage of cooperative game theory to allocate costs of joints transport in the Swedish forestry sector, proposing a new cost allocation method for how the costs can be distributed taking various properties of the planning problem into account [23]. Finally, Bloss and Kopfer describe the formation process of operational transport collaboration systems as two distinct and interlinked decision making problems – one for the hauler considering participation and one for the party offering the system [24].

3. Development of a cooperation framework for horizontal logistics cooperation

The existing research on horizontal cooperation on freight forwarder level mainly emphasizes the illustration of potential cost savings through transport bundling and the optimization of existing logistics processes and structures. However, further approaches to improve performance in horizontal logistics cooperation could not be found. Literature lacks a general conceptual classification to guide practitioners in setting up horizontal cooperation and as not all forms of horizontal cooperation are applicable to any given sector or companies, a general framework for horizontal logistics cooperation is needed. Thus, besides of the literature review the input-transformation-output model builds another basis for the development of the framework (Fig. 1).

The logistics system is made up by the four key elements: logistics structure, logistics processes, logistics information flows and logistics organizational structures. By means of the input-transformation-output model the obstacles that hinder logistics systems from being efficient were analyzed. High transportation tariffs, inefficient transport processes and structures and interface problems between logistics and other planning tasks like production planning were the main obstacles that could be identified. These were further verified by conducting a survey among various automotive suppliers in the region of Timis, Romania [25].

Especially for the specific needs of individual enterprises, the currently applied logistic processes do, from a holistic point of view, not appear optimal. As companies are assigning transports individually to their preferred LSP, several service providers are operating within a specific region. Under consideration of its entire customer structure each service provider strives for the optimization of its specific sub-system. LSP only rarely achieve high load factors by means of consolidation and optimized assignment of vehicles due to their sufficiently large customer base and contract volume in addition to flexible distribution systems and vehicle fleet [26].

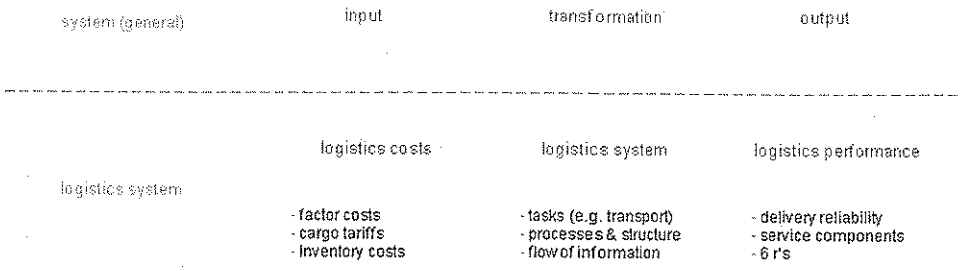

Fig. 1. input-transformation-output model for logistics.

Service providers generally struggle with the optimization of those sub-systems and cooperation on the level of service providers. As previously mentioned in the case of freight exchanges, such strategies are still not successfully employed and freight forwarders suffer from inefficient transports [3]. Deficits might emerge in the form of direct transport running far under capacity, use of small transportation carriers, less-than-truckload (LTL) with long running times or multiple handling steps as well as increased transportation tariffs due to small quantities. High stocks and capital tied up are results of these inefficiencies. Also flexibility is reduced since small changes of usual order cycles lead to additional trips. It is assumed that many companies within the same region have a similar source-sink-behaviour. Especially in the automotive industry these source-sink relations are common [25].

Hence, potential savings by means of horizontal cooperation among shippers and on freight forwarder level are high. Under consideration of the main obstacles mentioned above a framework could be developed, that offers companies different forms of horizontal cooperation to optimize transport efficiency (Fig. 2).

In contrast to the joint tendering of transport services, where given transport orders of multiple freight forwarders are the basis of a route planning and load factor optimization for a single LSP, the approach of cross-company transport bundling considers all the relevant transport information in order to generate possibilities to furthermore bundle transports within the cooperating network. The coordination between logistics and production promises the highest potential but also requires a huge effort of coordination and dynamic planning within the network.

The eligible form of cooperation mainly depends on the company with the lowest possible or desired cooperation level within the cooperation. Whereas the desired level results from issues like trust, since private information is exchanged, or strength within the network, the possible cooperation level arises from the peculiarities of the production and logistics system with regard to changeability and flexibility. On the one hand, the possibility to influence international commercial terms in effect for business orders might enable a company to be part of a purchasing cooperation and, on the other hand, the lateral supply chain cooperation requires the possibility to dynamically adjust production schedules as production has a huge timely influence on inbound as well as outbound logistics. As the overall optimization within the network might lead to the waiving of economies of scales in production for single companies, a method for the distribution of costs and benefits within the cooperation is essential.

4. Development of horizontal logistics cooperations

The aim of increasing efficiency within a horizontal cooperation can only be achieved by means of reducing waste within the transportation network. Therefore the definition and the design of new structures and processes form the basis of a successful cooperation. As similar cooperation approaches failed due to insufficient target and benefit structure of the participating partners and missing organizational incorporation, the definition of organizational aspects as well as forms and specifications of cooperation models present the other main task to guarantee sustainable success of horizontal cooperations.

4.1. Design of cross-company logistic concepts

In particular for those forms of horizontal cooperation, that allow the modification of the transportation network, the definition of an optimal logistic concept is the main requirement to create synergies. The increase of transport efficiency and the

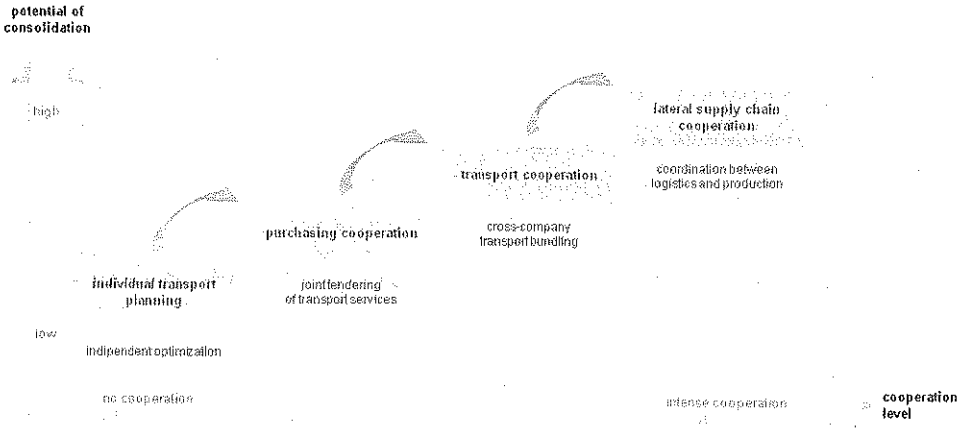

Fig. 2. Cooperation framework for horizontal logistics cooperation.

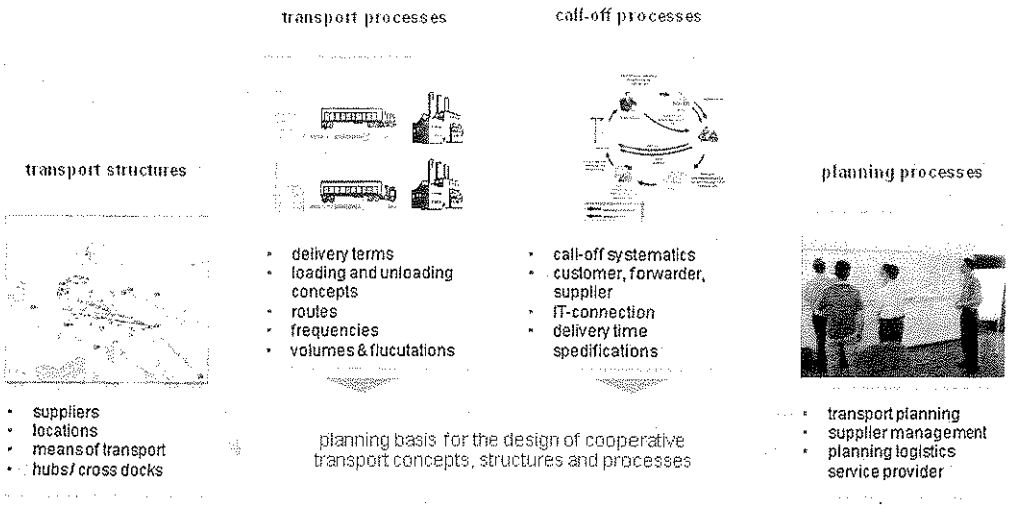

Fig. 3. Influencing factors and planning basis of cooperative transport concepts.

related possible cost reduction due to cross-company transport bundling is influenced by many different factors. Depending on the amount of influencing factors considered and the companies' ability to adjust the own structures and processes in benefit of the whole network, cross-company transport bundling might have very different characteristics and the potential of consolidation may vary extremely. Besides of transport structures and transport processes, the flow of information and the planning processes are also relevant for the design of cooperative logistic concepts (Fig. 3).

Cooperative approaches and the logistics models are mainly based on the following premises: [25]

- Homogeneity of sinks, sources or handling points within the network
- Identification of route sections where transport volumes can be handled with efficient transport carriers
- Availability of adequate partners for transport bundling on route sections (legs)
- Possibility of individual businesses to efficient usage of carriers
- Distance from source to target of possible nodes considering impacts of variance from ideal path
- Prioritization from transport volumes given limited capacities of one carrier in the main run as a result of different impacts on target categories
- Possibility to change transport frequency

Determined by the number of possible cooperating partners and the influencing factors considered, the definition and identification of cross-company logistics concepts require simulation or even optimization for more complex problems. As simulation has satisfactorily demonstrated its ability to illustrate and evaluate systems with dynamic behaviour it is suggested for both the design and operations of the network. To execute a conventional simulation study, a substantial amount of time and money has to be invested, which still prevents small and medium-sized businesses to apply those. A simulation model formed by individual logistical building modules (factory, transshipment centre, etc.), that can be combined with one another to represent any desired logistics concept, has shown huge potentials to enable planners to define planning tasks, generate models, analyze results, and optimize those results by comparing different scenarios while preventing him from dealing with the simulation expertise itself [27].

4.2. Development of organizational models for horizontal cooperation in logistics

Both the design and operations of the network require a coordinator that ensures the overall satisfaction and improvement of the logistics network as some decision might even lead to disadvantages for single cooperating partners. The identified cooperation approaches show the diversity of possible specifications and cooperation goals and tasks. Therefore no generally accepted design for organization models for cross-company logistic networks can be given; rather a framework for the development of logistic models which includes the most important requirements will be visualized.

This requires the consideration of the determining cooperative characteristics, which were defined by Wojda et al. [28] as content of service provision, cooperation volume, type/number/location of partners, privity of contract, organization/information structure and culture and financing. Parameter values of these characteristics are dependent on the form of cooperation and in addition, there exist interdependencies between the factors. Content of cooperation and volume of service provision are derivates of the arranged cooperation goals. These parameters set the complexity for organizational structures and contracts. By means of an enquiry of automotive suppliers requirements the following planning premises could have been identified for the development of an organizational structure [25]:

- Neutrality in handling or priority of jobs
- Confidentiality regarding the given data
- Joint definition of rules and regulations and processes
- Definition and implementation of interfaces (IT requirements)
- Availability of contact person or local contact point
- Fair cost-benefit distribution

With regard to the distribution of expenses and revenues various pricing models are available like e.g. price recommendations in accordance to volume and distance, performance based price, pallet-based pricing plus a flat rate for disposition or a price composed of fix and variable component [20,29]. As fairness is claimed by all parties involved in a sharing problem a solution which is, or perceived as, unfair will obviously be rejected by some of the cooperating partners [20]. The best distribution depends on the specific cooperation and strongly on the number of cooperation partners and their relationship. Considering these requirements

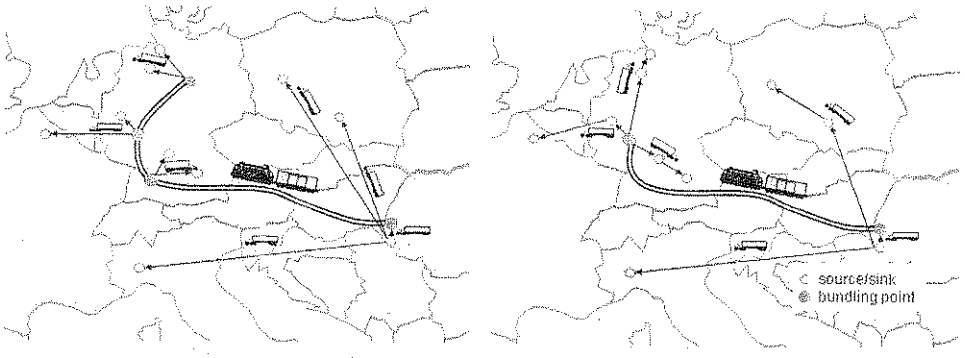

Fig. 4. Schematic illustration of the developed scenarios for Romanian suppliers.

and the general tasks of planning, executing and controlling the logistic performance for all partners permits the derivation of attributes and possible characteristics of a coordinating entity. Although there are several possibilities of how to fulfil the coordination function, a neutral coordination seems to accomplish the requirements best, as the enquiry of potential partners identified neutrality and confidentiality as the key factors for a successful cooperation. Therefore the organizational model is the decisive factor to tap the full potentials of cross-company logistic models.

Depending on the number of shipments und the complexity caused by various recipients with different delivery restrictions, the effort for scheduling within the network is increasing. The higher the burden of scheduling, the more inevitable is the need to invest in infrastructure and personnel. That means, in turn, that contractual cooperation agreements are needed at a certain cooperation level, although contractual agreements impede the occurrence of horizontal cooperation. An institutionalized regional management that supports businesses in using the synergies of cooperation would be an asset with respect to the success of the concept. To ensure neutrality of the coordinating entity the shippers require the very planning instead of the provision of logistic services. On the other hand the negotiation of prices and framework contracts should ideally be part of the duties of a coordinator.

5. Practical application to automotive suppliers in Romania and Spain

In a research project funded by the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Austrian Research Promotion Agency (FFG) logistics models as well as organizational models were demonstrated using the example of the region Timis in Romania. Focusing on 7 automotive companies, outgoing shipment volumes were analyzed. Starting from the current state of individual transports, different scenarios were defined based on the developed framework. As the current contractual agreements of some suppliers with their customers impede influencing production scheduling, both purchasing and transport cooperation were suitable for the considered suppliers. The scenarios target cost reduction and an increase of sustainability by means of using efficient transport modes like rail transport.

Although the companies show a very similar source-sink-behaviour, currently 96% of the shipments were sent as direct transport to their destinations in Western Europe. A purchasing cooperation would improve load factors and tariffs but with regard to the huge transport loads coordination between shippers and forwarders allow a shift to more efficient transport modes. Fig. 4 shows 2 defined transport cooperation scenarios of transport bundling for the Timis Region. Scenario 1 comprises a block train with 3 stops and direct relations from the end of the train regardless of locations in Poland and Italy that cannot profit from consolidation in the main leg. Scenario 2 limits the block train to one stop and strives for transport bundling on the preliminary and subsequent leg. Shipments with destinations not considered in the main leg bundling are consolidated as well. By shifting the main leg to railway and optimizing the collection and distribution of goods from and to transhipment points costs could be reduced by 15% in the given case. The improved ecological impact, cutting fuel consumption in half and reducing the CO_2 emissions by 40%, shows the success in more than one target dimension. The main deficit of the models is the doubled lead time coming from the ceteris paribus transport execution. In addition to the simulation and evaluation of scenarios a sensitivity analysis was executed, that proved the full functionality of the model even with fluctuation of volumes and prices.

To prove that the increase of efficiency is not exclusively a result of the modal shift but horizontal logistics cooperation are also worthwhile in the case of smaller shipment volumes and transport bundling on trucks, a potential analysis for automotive suppliers in the region of Eastern Spain was carried out in a second project. Various suppliers, which are located mainly in the region of Valencia and Catalonia, send their shipments through direct transport to customers in Saxony, where the customers' production sites and central warehouses are located. Due to the reduced shipments volume and low desired cooperation level, an advanced purchasing cooperation turned out to be optimal for the suppliers. Their daily transport orders are collected by a single LSP, who aggregates and optimizes the shippers demand in terms of vehicles routes and transport means. An optimized logistics concept consisting of direct transport in the case of full loads and milkruns or consolidated transport in the case of LTL was developed as shown in Fig. 5.

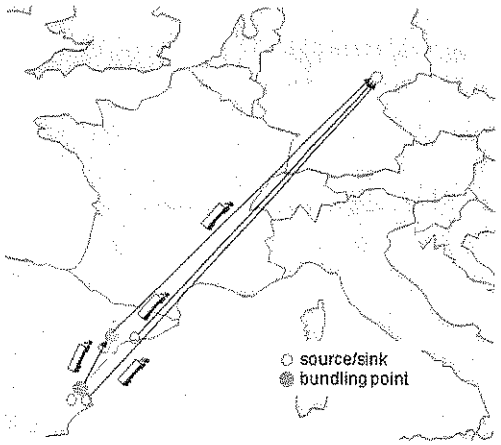

Fig. 5. Schematic illustration of the developed scenario for Spanish suppliers.

A simulation has shown, that transport bundling among the coordinating partners in Spain result in a reduction of the number of journeys by 14% and a reduction of fuel consumption and CO_2 emissions by 17%, without any negative impacts on the logistics performance. In addition to a noticeable cost reduction on the transport side, the efficiency of the customers unloading terminal could also be increased due to the increase of the average load factor per truck.

6. Conclusions

Horizontal logistics cooperation help companies, which individually do not have access to highly productive transport networks, to activate cost cutting potential in logistics. Overlapping transportation networks based on similar source and sink regions are both prerequisite and indication of possible cooperation synergies. The empirical analysis could give proof to the high potential of horizontal logistics cooperation and showed a reduction of road traffic, emissions and costs.

As there are various possibilities to cooperate and not all forms of horizontal cooperation are applicable to any given company or network, this paper presents the structural concepts for horizontal logistics cooperation. Depending on the possible or desired cooperation level various characteristic forms of cooperation are conceivable, ranging from the joint tendering of transport services to the coordination between logistics and production planning within a joint processing of transports. By identifying the possible or desired cooperation level in the course of analyzing the production and logistics system, the framework anticipates the termination of the cooperative relationship. It can be expected that the more intense the cooperation between the partners, the higher the resulting consolidation potential in terms of savings and efficiency increase. The framework prepares and guides the partners by defining and identifying the main obstacles which need to be overcome in order to reach further improvements.

As the overall goal of the cooperation is to increase transport efficiency to an optimum, the disadvantages of single network partners have to be considered by a fair distribution of costs and benefits. Further organizational models that fit the different needs of the specific cooperation have to be developed in each single case in order to guarantee a sustainable success of the cooperation. With regard to the organizational models has to be mentioned, that this approach has big implications for the future role of LSP. Most forms of horizontal cooperation require a neutral coordinator whose tasks and duties are similar to the current service offering of an LSP. In each of the proposed stages there is a different trade-off between managing the network by planning and scheduling transportation and forwarding the freight for service providers. Thus LSP might increase their important role to improve competitive abilities of manufacturing and distribution companies in the future.

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