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Integration of the cost allocation in the optimization of collaborative bundling

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ABSTRACT

A model is proposed that integrates a cost allocation method – the Shapley value – into the optimization of the *synchronized* consolidation of transportation orders. By balancing each partner's delivery date changes (when synchronizing) against its *allocated* profit, it ensures that the operational plan is acceptable by all partners. In comparison to a model that first plans and then divides the costs, this model limits expensive delivery date changes and does not systematically favor a company with a slightly higher cost of change.

1. Introduction

The myopic optimization of a single functional entity in the supply chain can often have negative effects on the companies downstream or upstream (Ireland and Bruce, 2000). The bullwhip-effect for example Lee et al. (1997), demonstrates how self-optimization and non-communication can lead to an increased demand amplification along the chain. It is increasingly recognized that, in order to create more efficient supply chains, companies need to collaborate and become *partners* in a horizontal logistics *coalition*. As can be seen in Fig. 1, such collaboration can take on various forms. *Internal* collaboration entails cooperation between different functions in the same company (e.g., sales representatives communicate with the production site). *External* collaboration refers to cooperation between different companies and can take on two forms: vertical and horizontal. *Vertical* collaboration happens between a company and its suppliers or customers (e.g., Vendor Managed Inventory). The term *horizontal* collaboration is used to refer to cooperation between organizations on the same level of the supply chain, and even between competitors.

In an increasingly common form of horizontal collaboration, companies that have similar or complementary logistic needs combine their orders and transport them to their respective customers in a single logistic operation, rather than individually. The chosen means of transportation (truck, train, ...) can thus contain orders of several companies simultaneously. This is referred to as "order bundling" or simply "bundling".

A good business case for bundling occurs when companies are located in close proximity and share a significant number of clients. An example is the collaboration between two fast-moving consumer goods producers, Kimberly-Clark and Unilever-HPC. Kimberly-Clark was pressured by its retailers in the Netherlands to allow a very short-term replenishment

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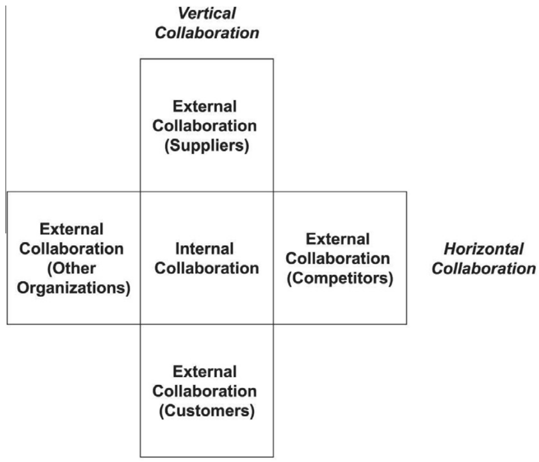

Fig. 1. The scope of collaboration (Barratt, 2004).

policy, which increased its delivery frequency and reduced its average shipment size. Rather than comply and face an increased transportation cost, Kimberly-Clark looked for another company that was shipping to those same retail stores and found one in Unilever-HPC, that shared 60 to 70% of its delivery addresses in the Netherlands. After a successful trial, both partners formed a coalition and started shipping their products from a shared warehouse to their mutual retail clients. To operate the shared distribution center and perform transportation on their behalf, a third-party logistic provider was added to the agreement. Order bundling in this coalition resulted in an increased service level (three delivery days per week instead of two), a 50% reduction in the number of trips, and a decrease in handling costs of 20% (Verweij, 2009; Cooke, 2011).

Another approach to profitable collaborative distribution can be found in the creation of so-called "shipping lanes", that arise when companies in the same region ship long-haul to another region. In a recent horizontal collaboration effort, plastics manufacturer JSP and metal forger Hammerwerk send out their trucks from the Czech Republic to Germany collaboratively, in collaboration with a third-party logistics provider they mutually agreed upon, and under the guidance of a neutral third party. Without increasing operational costs, they realize an increase in the number of days on which deliveries are made, while achieving a double-digit reduction in CO_2-emissions and reducing the inventory-in-transit cost (Guinouet et al., 2012).

In Europe, a framework supported by the European Union is currently being developed, entitled COllaboration COncepts for CO-modality (CO^3). The aim of this framework is to support horizontal collaboration efforts. It suggests the use of a *trustee*, an independent actor that helps to create and manage the collaboration and supports the partners in the coalition to maximize the synergy gains. Additionally, the use of a trustee limits the amount of information shared among competitors and remain compliant with European anti-trust law. CO^3 also provides a legal framework that describes the entry and exit clauses for a collaboration, and promotes a game-theoretical method (the Shapley value, see further) to divide the costs (Biermasz, 2012).

One of the criteria for exemption of European anti-trust law is that the agreement is indispensable to achieve the stated efficiency gains (Slaughter and May, 2012). This implies that the collaboration gains should exceed the economies of scale that can be achieved by traditional consolidation and groupage provided by many third-party logistics providers. In Vanovermeire et al. (2013a) and Biermasz (2012), it is argued that collaborative bundling differs from traditional consolidation or groupage in that it allows for the active *synchronization* of shipments. This implies that the coalition can decide to delay or expedite some orders of its partners if this results in a lower total transportation cost or is otherwise beneficial. In traditional consolidation and groupage, the third-party logistics provider has no impact on the timing of its customers' shipments, and is forced to ship them on the exact days specified by the customers.

The viability of collaborative bundling has been proven by TriVizor, a spin-off company of the University of Antwerp, Belgium.[1] This company currently manages several horizontal logistic coalitions as a neutral third party. It operates through a multi-party contract between itself, the shippers in the coalition, and a third-party logistics provider. TriVizor itself is payed for its services by a fixed percentage of the coalition gain (thereby increasing its own incentives to increase the efficiency of the coalition) and/or through a fixed amount per planned order. On a day-to-day basis, the partners in a coalition managed by TriVizor send their order data, i.e., the list of shipments they wish to send out, to a central database. Access to this database is restricted so that the partners do not have access to each other's order data. Using this data, the planners at TriVizor schedule the transports, which are then communicated to the third-party logistics provider for execution. TriVizor actively searches for bundling opportunities, but this is a manual and cumbersome process. For example, when the planners at TriVizor notice that a

[1] http://www.trivizor.be