INVENTORY AND TRANSPORTATION SHARING IN RETAIL SUPPLY CHAINS

Roel Post, Michiel Mijnhardt, Paul Buijs

Department of Operations
University of Groningen
Nettelbosje 2
9747 AE Groningen, The Netherlands

ABSTRACT

In grocery retail supply chains, a single retailer with a large market share is delivered by many suppliers. For replenishment decisions the retailer (or the supplier in case of Vendor Managed Inventory) has to make a tradeoff between keeping more inventory or using a higher replenishment frequency. In models studying this tradeoff inventory and transportation capacities are often fixed and costs are modeled linear. However, when looking from the retailer's large network, opportunities for both transport and inventory sharing capacity arise, indicating that fixed capacity constraints or fixed costs are not fully realistic. In this study we simulate the impact of sharing transport and inventory capacity in a dynamic situation and show how they can be used to reduce costs and improve supply chain performance.

1 INTRODUCTION

In grocery retail supply chains, a single retailer with a large market share is replenished by many suppliers. These suppliers deliver their products to a central Distribution Center (DC) of the retailer from which the retailer supplies the stores through his own network. To make sure the stores can maintain a high service level, the retailer monitors the inventory levels for each product at the DC and places the replenishment orders based on demand forecast and actual store orders. The suppliers then organize the transportation of these products themselves, either by using their own transportation capacity or by outsourcing it to a Logistic Service Provider (LSP), mostly using direct shipments. In the replenishment decision the retailer has to make a tradeoff between keeping more inventory or a higher replenishment frequency. Increasing inventory will lead to higher storage costs and the time products spent in the supply chain increases (which can be unfavorable for perishable goods). Increasing the replenishment frequency rises transportation costs since it requires more transportation capacity and reduces efficiencies of scale in transportation. Because both retailer and supplier agree that the transportation and holding costs are shared by all parties in the supply chain, we now see a shift towards Vendor Managed Inventory (VMI), where the suppliers become responsible for the inventory and replenishment decisions. In this situation the suppliers receive more freedom to efficiently organize the transportation.

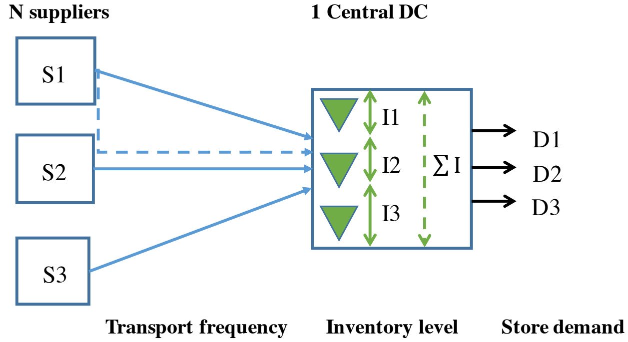

Figure 1: Schematic overview

978-1-4673-9743-8/15/$31.00 ©2015 IEEE

2 RESEARCH

The described tradeoff between inventory and transportation is studied in joint economic lot size literature, where the aim is to determine the optimal Economic Order Quantities (EOQ). In EOQ studies, storage costs at both supplier and buyer are often assumed to be linear per unit of time, storage capacity and transportation capacity are assumed unconstrained and transportation costs are assumed fixed per truck or batch capacity. Inventory routing literature does consider variable transportation costs by combining vehicle-routing and inventory management problems. This is most often done for a given transportation fleet capacity and maximum holding space. Thus far, both of these literature streams have concentrated on the sales side of the supply chain and studied primarily 1 supplier – 1 buyer relation ships (1:1) or 1 supplier delivering many customers (1:n) in a deterministic context (Glock, 2012).

When looking from the retailer's large network (n:1, Figure 1), opportunities for capacity sharing arise, indicating that fixed capacity constraints or fixed costs are not fully realistic. First of all, in the situation with many suppliers and a single DC, suppliers are on average located closer to each other than to the DC. By sharing transport capacity among suppliers, the average frequency of deliveries can be increased without increasing total transportation capacity. A prerequisite for transport collaboration among suppliers is, however, that all goods are available at the right time and place and can be jointly delivered before a certain time. In other words, transport must be executed within a narrow time window between the moment goods become available and the due time all goods in the combined in the shipment have to be delivered at the DC. To increase the possibilities to combine routes, flexible inventory capacities for each supplier at the DC can play a role relaxing these time windows, utilizing the total inventory capacity available at the DC. This way not only transportation capacity but also inventory space can be shared among suppliers. Disney et al. (2003) showed VMI enables batching without negatively impacting the overall dynamic performance of the supply chain, dynamic effects of collaboration have thus far not been researched to the authors' best knowledge.

In this research we simulate a retail supply chain with multiple suppliers and a single retailer, given the locations of supplier's and the DC, the (stochastic) demand for each of the goods the suppliers require and an order-up-to policy. Using an event based simulation model we investigate the impact of VMI storage space restrictions on the transport and warehousing performance for vendors. Next, operational-level impact of sharing transport capacity at the inbound side of the DC and sharing inventory capacity is tested in a dynamic context. In a number of scenario's, we show the interaction of these different opportunities for collaboration and find how they can support each other. This also allows us to pinpoint the supply chain coordination that would be necessary to actually realize such collaborations.

3 RESULTS

Simulation results indicate that shared inventory and transportation considerably improves inventory capacity utilization, especially when delivery frequencies are aligned with each other. This can be used either to reduce inventory costs and reduce the time goods spent in the supply chain or to increase batch size and improve transportation efficiency without without increasing inventory costs. Furthermore, the variability in warehouse utilization decreases, which can lead to advantages in warehouse operations. Letting suppliers share inventory space in pairs shows to be an effective way to realize capacity sharing with limited coordination complexity.

REFERENCES

Disney, S. M., Potter, A. T., & Gardner, B. M. (2003). The impact of vendor managed inventory on transport operations. Transportation Research Part E: Logistics and Transportation Review, 39(5), 363–380. http://doi.org/10.1016/S1366-5545(03)00014-0

Glock, C. H. (2012). The joint economic lot size problem: A review. International Journal of Production Economics, 135(2), 671–686. http://doi.org/10.1016/j.ijpe.2011.10.026