Optimal Deliveries in a Vendor Managed Inventory Service

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ABSTRACT

In a VMI service, a central production center (i.e. the vendor) can control the inventory of each retailer according to the optimization of the costs due both to the overfilling/stock-out of the inventories and to the travels required for the deliveries. In this work, an original mathematical programming approach has been formulated and implemented in order to show that under specific but common conditions (the most important of which are: capacity of the retailer warehouse higher than the demand and than the vehicle capacity, a maximum of two drops for travel, unsatisfied demand lost and not backlogged), a true direct delivery VMI service may not be the best solution. Results are shown on a fictional network as well as on a real logistics system represented by a central depot and by a network of petrol service stations, giving evidence to some peculiar aspects of the VMI service which can be useful on their own to enhance the decision making strategies of a logistic company.

Keywords: Decision Support Systems, Direct Delivery, Full Truckload, Inventory Control, Inventory Routing Problem, Logistics, Retail Inventory Management, Vendor Managed Inventory Service

INTRODUCTION

The Vendor Managed Inventory (VMI) service (Kleywegt et al., 2002; Jianxiang et al., 2009) is an efficient approach to align economic objectives and streamline supply chain operations for both suppliers and their customers managing concurrently inventory management and distribution processes. VMI needs to involve both vendors and their retailers (RTs) in order to assess the inventory and distribution organization taking into account RT’s requirements, customer satisfaction, and holding and transportation costs. In a more traditional approach, retails send their purchase orders imposing the amount of the product requests and the time to be refilled and, with shared shipping, the supplier holds inventory and fills demand directly according to the order produced by the RT, i.e. according to retail inventory management (Bertazzi et al., 2005).

In a VMI service, the vendor can “push” orders at each RT on the basis of the customer demand and on its forecast for each RT (Tersine, 1994). Both the material flow and the order generation are decided by the vendor, who is the
only decision maker for the delivery schedules and the related product amounts to the retails. The delivery strategies are so driven by the actual requirements and are close to just-in-time strategies (Kaynak, 2002). In few words, a VMI service is a “push” distribution system based on the forecasted demand and where the vendor effectively build orders on his/her own (Pyke & Cohen, 1990). Nowadays, modern information and communication technologies (ICT) allow to develop and to implement a variety of flexible supply-chain design options that can save significant cost and create value advantages (Sounderpandian et al., 2007; Krishnamurthy et al., 2008). In this context, the VMI approach can be supported using an inventory control approach, monitoring remotely inventory levels by ICT technologies, in order to forecast daily demand and to monitor each inventory. The vendor can generate replenishment orders for each RT on the basis of the inventory level and on the current trend of the daily sold product. In a VMI service, the decision making process has to trade-off the objectives of the inventory holding costs, and of transportation costs. Growing literature has been focusing on models to analyze the optimization processes related to inventory management, production, stocking and logistics costs, and customer relationship management.

**LITERATURE SURVEY**

In literature, there are two main services of road freight delivery. The first service is referred to dedicated shipping loads to each customer and it has been defined either as “direct delivery service” (DDS) or “direct shipping” (Jianxiang et al., 2008; Gallego et al., 1990). The second service is referred to dispatch vehicles that deliver items to more than one customer per load (Gong et al., 2012) and it has been referred to as “peddling shipping” service (PSS) (Burns et al., 1985).

In a DDS, and in a PSS as well, a “Full Truckload” (FTL) strategy (Kleywegt et al., 2002; Burns et al., 1985; Gronalt et al., 2003) - where the vehicle is filled up with the product at the maximum of the vehicle loading capacity - is often chosen in order to minimize the rate between the kilometres spent for the deliveries and the overall quantity of carried product. This latter is an indicator often used in the delivery context. A “Less than Full Truckload” (LFTL) strategy (Kleywegt et al., 2002; Waller et al., 1999) may be also required by RTs, as a cheaper service, but in this case a more complex management - with several pick-up/deliveries, terminals and breakbulks, as well as other logistic processes - is usually required to make the service convenient. However, under a VMI service, FTL and LFTL delivery strategies may assume a different role, as it will be shown in the following section. Undoubtedly, retail demand rate, time and service requirements, possible bullwhip effect and inventory capacity dictate the freight moves (Moyaux et al., 1991). Similarly, the fleet size, vehicle efficiency, facility layout and handling, storage equipments, buffer storage disciplines, influence the handling and storage capacity trade-offs (Malmborg et al., 1989; Malmborg et al., 1991). The optimization of resources and asset utilization in shipment management is classified as one the main important issue in the cost effective supply chain (Chopra, 2003). In general, transportation costs are reduced with the VMI approach, which, managed properly, should allow the vendor to coordinate the distribution process instead of satisfying daily the orders as they might be received by RTs. If the RTs’ inventory capacities and demands are sufficiently large with respect to the vehicle capacity, and the inventory costs are sensibly lower than the transportation cost, then it is an optimal strategy to deliver according to FTL or nearly full vehicle loads (Kleywegt et al., 2002). Burns (2003) considers an infinite horizon problem and develop an analytical method to minimize the inventory and transportation costs. The authors compare the performances of the distribution system applying the DDS and the PSS strategies. The cost trade-off in each strategy depends on shipment size. The results indicate that, for DDS, the optimal shipment size...
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