

A COMPARISON STUDY: IDENTIFYING THE BEST PARTNERSHIP FOR YOUR SUPPLY CHAIN

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Abstract: Consider a manufacturer that sells goods to a retailer. When each party makes independent decisions, one party's replenishment quantity may not be preferred by the other. Coordinated decision making, however, can help achieve system-wide optimality. It may reduce the need for inventories and lower the shipping costs, or enable improved utilization of resources at the manufacturer. Here, we present the characteristics of various partnerships used for coordinated decision making. Through comparison, we show that system-wide cost savings can be realized with the right partnership.

Keywords: *Supply Chain, Partnership, Inventory, Coordination*

1. Introduction

Vendor Managed Inventory (VMI) emerged in the late 1980's as a partnership to coordinate replenishment decisions in a supply chain while maintaining the independence of chain members. An important part of continuous replenishment program (CRP), VMI is also referred to as a program of supplier-managed inventory, or direct replenishment. In this partnership between a vendor and customer, it is the *vendor* that decides when and in what quantity the customer's stock is replenished. With such an agreement, the vendor may be able to share the customer's point-of-sale and inventory-level data.

The VMI agreement may also specify a consignment inventory (CI), whereby the customer will not be invoiced right at shipment, but only after selling the goods to its end consumer. Whether part of VMI or not, CI thus leaves ownership of the products shipped with the vendor, until the customer sells those items. Hence, the consignment inventory is not shown as an asset on the customer's books, and the inventory turnover ratio will be higher.

In this study, we numerically analyze and compare various VMI and/or CI agreements in supply chains.

2. Problem Definition and Research Scope

In our models, we consider one vendor (manufacturer or supplier) who produces a single product at a sole manufacturing plant and supplies it to a particular customer (buyer or retailer). The customer faces a constant, deterministic demand which is known. When the parties act independently, the customer decides its replenishment orders. Suppose there is no lead time and all customer orders are known instantaneously by the vendor. At any moment of time, the vendor's plant is either idle (actually, producing other SKUs not part of this analysis), or producing the given item at a constant production rate which is larger than the customer's demand rate. The vendor thus produces in batches at a finite rate, with output sent to vendor's stock from where the customer is replenished. We assume that the vendor's fixed costs of setup and of shipment dispatch, and the customer's fix cost per order are independent of the quantities involved. Both parties' inventory costs are directly proportional to the average stock levels.

The performance criterion we use in our models is the same as in EOQ models, namely the total cost of inventory holding plus ordering (including shipment dispatch). We begin with the simplest situation where the vendor and customer make independent decisions. This forms the base case. We then develop and analyze a variety of VMI agreements and compare them to the preceding, so as to obtain insights into the potential benefits of vendor managed inventory and those agreements.

Determination of the optimal order quantity and number of orders, where each party minimizes his own cost, is the well known EOQ approach for the customer and modified EPQ for the manufacturer. Taking this as the base case, and carefully identifying the cost parameters of each party, our aim is to develop and analyze quantitative cost models through which the economic value of VMI and/or CI agreements can be estimated. In light of those analyzes, we will provide insights of desirable agreements from the point of view of the vendor, the customer and the whole system. Inventory control policies of the following cases will be investigated in Section 3:

1. No agreement between the parties: Vendor and customer act separately as in traditional systems. Hence, each party is responsible for its own inventory control. The customer decides the quantity and timing of replenishments. Vendor produces any quantity demanded in an optimal way.

2. Joint economic lot sizing: System-wide cost, which is merely the sum of all costs associated with each party, is minimized. As a result, customer's optimal order quantity is found, and the vendor's optimal batch production quantity is an integer multiple of it.
3. The vendor pays the customer's ordering cost (pure VMI): The vendor and customer act based on a VMI agreement where each party is responsible for its own inventory holding costs, but the vendor establishes and manages the inventory control policy of the customer.
4. The vendor pays the customer's inventory holding cost (CI): Vendor and customer act based on a consignment agreement where the quantity and timing of customer's replenishment are decided by the customer itself. (The customer thus pays its own ordering cost.) Any inventory supplied by the vendor is kept in stock at the customer's site until it is sold, and the holding cost on it is charged to the vendor.
5. VMI and CI together: Vendor and customer act based on a consignment agreement (the vendor still pays the inventory holding costs of the customer) where now the vendor decides the timing and quantity of replenishments for the customer.

3. Conclusions

This section is provided to highlight relevant conclusions derived from our case analyses. Case 1 is the well-known approach in which a vendor and customer do business together. All ways to decrease costs are compared to this basic one.

Case 2 provides many insights, yet has various drawbacks. Many researchers have observed that a system-wide cost minimization yields better results than minimizing each party's cost separately. From those observations, the idea of general coordination has emerged. Any deviation from the customer's optimum increases its costs, but the overall cost decreases. Since the manufacturer and the retailer are owned by different firms, a *convincing* mechanism is required to achieve the general coordination. The types of incentives used include transfer payments, quantity discounts, and as in our Case 3 and Case 5, supply contracts.

General coordination determines an order quantity different than that of Case 1, which is the customer's optimum. Hence, we can state that, when compared to Case 1, the customer's total cost always increases in Case 2. Although there might be some benefits (through transfer payments or quantity discounts) to the customer after various negotiations, he will be reluctant to change his current policy. This might be the biggest obstacle to application of general coordination.

Supply agreements, on the other hand, propose immediate and direct cost savings to the customer. Under pure VMI the customer does not pay any ordering cost, and he is not charged with inventory holding cost in CI. The customer realizes the largest cost savings with VMI-and-CI-together contracts where he pays only a small percentage of his original inventory holding cost. If it is a pure VMI, the customer does not pay any ordering cost.

As opposed to general coordination, where both parties are assumed to share cost-related information (as if they are parts of a single firm), VMI and/or CI contracts form coordination based on cost *reallocation*, and hence, each party is still independent. Although the total cost might decrease considerably with VMI or VMI & CI contracts, the vendor's cost increases greatly. Then, the following questions arise for the vendor:

1. What's the motivation to make such agreements with the customer?
2. How could we decrease the vendor's cost to a more reasonable level?
3. How, if possible, could the savings in total cost be shared?

Future research may address these issues for various cases. For example, if the vendor is the supplier of more than one customer, or more than one product for the same customer, economies of scale for the vendor might be the answer.