

Bullwhip Effect and SC Partnerships

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Bullwhip Effect

Distortion of demand information of a product while it passes from one firm to the next across SC.

- ◆ P&G found out that the diaper orders issued by the distributors have a degree of variability that cannot be explained by consumer demand fluctuations.
 - Diaper consumption should be stable with a low standard deviation.
 - P&G observed orders with high standard deviation at the distributors.
- ◆ At HP, orders placed by retailers to printer division have much bigger variations than consumer demands

Bullwhip Effect

- ◆ The information transferred in the form of “orders” tend to be distorted and can misguide upstream members in their inventory and production decisions.
- ◆ In particular, “variance of orders” $>$ “variance of sales”

- ◆ Information sharing in SCs is important
- ◆ Sales Information available in the form of orders received from the downstream member should be used with great caution.

Three causes of Bullwhip Effect

- ◆ Suppose that we have three conditions
 - Finite supply shared by many retailers
 - » Rationing game: retailer orders more than demand
 - Fixed order cost
 - Wholesale price varies over time
 - » Inflationary / deflationary environment
 - » Prices with no trend but variability

Each condition one at a time leads to bullwhip effect.

The Rationing Game

- ◆ Consider a product whose demand exceeds supply due to limitation in production capacity or uncertainty of production yield.
 - New successful high-tech products
- ◆ Manufacturer allocates output to retailers proportionally to their orders. In order to secure more units, each retailer will issue an order which exceeds in quantity what the retailer would order if the production is unlimited.
 - IBM's semiconductor manufacturing plants allocate capacity to products
 - » Memory, CPU, Telecommunication chips
 - Units managing these products overestimate their orders.
- ◆ Optimal order quantity for retailer in the rationing game exceeds the order quantity in the traditional newsvendor problem.

Order Batching

- ◆ Fixed ordering costs lumps demand together
 - Order in some periods in big quantities
- ◆ Sales commissions, salespeople tend to close deals generally at the end of period.
 - Ex. Given the demand rate of 1 per day. Suppose that ordering becomes infrequent with fixed ordering costs. What happens to the standard deviation of order sizes over a month of 30 days while the standard deviation of demand is constant at zero?

	Order once in 1 day	Order once in 2 days	Order once in 3 days	Order once in 4 days	Order once in 5 days
St deviation	0	1.017	1.438	1.799	2.034

Price Variations

- ◆ Frequent markdowns or promotions by the supplier will distress SC.
- ◆ Smart retailers will wait for the lower price.
 - Supplier's demand will not be uniform because retailer shifts its orders to low price periods.
- ◆ Overstocking will result
- ◆ Even when there is no price trends but variability, a risk sensitive retailer will order in larger quantities to reduce the exposure to demand variability.
- ◆ The reverse can be argued for a risk-seeking retailer. But many SC partners are not risk-seeking.

Beergame results

Average demand=50, stdev=20, daily averages and stdev of orders:

Factory	DC	W/H	Retailer	
112	93	71	46	Year 2002
46	45	48	47	Year 2002
50	51	51	51	Year 2002

Factory	DC	W/H	Retailer	
227	141	96	50	Year 2002
38	32	30	26	Year 2002
35	31	31	17	Year 2002
49	39	41	46	Year 2004

Information Sharing applications between SC members

- ◆ Bullwhip effect will propagate in an amplified form upwards the supply chain if each member processes order signals coming from below.

- ◆ Information sharing enhances SC in two fundamental ways
 - It enables supplier to respond consumer demand quicker by appropriately scheduling production and replenishing retailer`s inventory
 - » Continuous Replenishment Program(CRP)
 - » Vendor Managed Inventory(VMI)
 - It improves accuracy of demand forecast
 - » Collaborative Forecasting and Replenishment(CFAR) facilitates sharing of both short term and long term demand forecasts between manufacturer and retailer

Examples

- ◆ Upstream partnerships: Cisco`s e-hub project, Cisco is able to see not only first tier suppliers but also second tier suppliers
- ◆ 3M, P&G, Wal-Mart
- ◆ Advance Information: Singapore Airport, flight schedule information is given to taxi drivers to reduce inside airport traffic

Further Reading on Bullwhip Effect

- ◆ The Bullwhip Effect by Lee, Padmanabhan, Whang, Management Science Vol.43, No.4, April 1997
- ◆ Forrester, 1961 pointed out that basic form and policies used by an organization can give rise to characteristic and undesirable behaviors in the supply chain.
- ◆ Sterman, 1989 – “Beer Distribution Game”
- ◆ Economical point of view, Holt, 1960; Blinder, 1982 and Blachard, 1983
- ◆ Kahn, 1987, positive serial correlation and backlogging also results bullwhip effect.

Strategic Partnership

◆ What is SP?

- Idea is to achieve benefits of vertical organization with independent companies by systematically driving independent players towards a single and common objective
 - » Use contracts to “align the misaligned objectives”
- It is not exclusive!

◆ What is SP not?

- Ownership
- Franchising
 - » Franchising is exclusive

Strategic Partnering: Types of SP:

- ◆ **Only POS:** Retailer determines order sizes and timing but in addition passes POS (point of sales) data to the supplier. POS improves Supplier's forecasts.
 - Recall the Japan 7-eleven
- ◆ **Reverse Purchase Order:** Retailer determines order sizes and timing after discussing with supplier. Suppliers often send their recommendations for order sizes and times, these recommendations are known as reverse purchase order.
 - Panasonic (supplier) and BestBuy (retailer) decide on Bestbuy's order sizes using the Reverse Purchase Order concept.
 - Upside: Panasonic seems to be providing high service.
 - Downside: Panasonic does not see the real demand.

Strategic Partnering

◆ Vendor Managed Inventory (VMI):

- » VMI Projects at Dillard Department Stores, J.C. Penney, and Wal-Mart have shown sales increases of 20 to 25 percent, and 30 percent inventory turnover improvements.
- **Continuous Replenishment:** Vendors receive POS data and use it to prepare shipments at previously agreed upon intervals to maintain agreed levels of inventory.
 - » Wal-Mart, Kmart
- **Advanced Continuous Replenishment:** Suppliers may gradually decrease inventory levels at the retailer's store or distribution center as long as service levels are met. Inventory levels are thus continuously improved in a structured way.
 - » Kmart

Strategic Partnering

- ◆ **Quick Response:** Vendors receive POS data from retailers, and use this information to synchronize production and inventory activities at the supplier. In this strategy, the retailer still prepares individual orders, but the POS data is used by the supplier to *improve forecasting and scheduling*.
 - Milliken and Company: The lead time from order receipt at Milliken's textile plants to final clothing receipt at several of the department stores involved was reduced from eighteen weeks down to three weeks.

Main Characteristics of SP

Criteria Types	Decision Maker	Inventory Ownership	New Skills Employed by suppliers
With POS and Quick Response	Retailer	Retailer	Forecasting Skills
VMI	Supplier	?	Inventory planning
Continuous Replenishment	To Contractually Agreed Levels	Either Party	Forecasting & Inventory Control
Advanced Continuous Replenishment	To Contractually agreed & Continuously Improved Levels	Either Party	Forecasting & Inventory Control

Requirements for Effective SP

- ◆ Advanced information systems
 - Information Technology is a mean for SP not an end.
- ◆ Top management commitment
- ◆ Common standards and culture
- ◆ Mutual trust

Important SP Issues

- ◆ Inventory ownership:
 - Supplier owns the goods until they are sold or,
 - Retailer owns the goods
- ◆ Performance measures: Fill rate, inventory level, inventory turns

Important SP Issues

◆ Confidentiality

- Non-exclusiveness is a problem. P&G partners with both Kmart and Wal-Mart

◆ Communication and cooperation

- When First Brands started partnering with Kmart, Kmart often claimed that its supplier was not living up to its agreement to keep two weeks of inventory at all times. It turned out that this was due to the fact that the two companies employed different forecasting methods.

Steps in SP Implementation

- ◆ Contractual negotiations
 - Ownership
 - Credit terms
 - Ordering decisions
 - Performance measures
- ◆ Reengineer SC operations
- ◆ Develop or integrate information systems
- ◆ Develop effective forecasting techniques
- ◆ Develop a tactical decision support tool to assist in coordinating inventory management and transportation policies

Advantages and Disadvantages of SP

Advantages

- ◆ Fully utilize system knowledge
 - Consider the partnership between White-Hall Robbins (W-R), who makes over-the-counter drugs such as Advil, and Kmart. W-R initially disagreed with Kmart about forecasts, and in this case, it turned out that W-R forecasts were more accurate because they have a much more extensive knowledge of their products than Kmart does.

Advantages and Disadvantages of SP

- ◆ Decrease required inventory levels
- ◆ Improve service levels
- ◆ Decrease work duplication
 - In apparel industry manufacturers prepare garments for sale at the stores, attaching labels, packaging.
- ◆ Improve forecasts

Disadvantages of SP

- ◆ Expensive advanced technology is required
- ◆ Supplier/retailer trust must be developed.
- ◆ Supplier responsibility increases.
- ◆ Expenses at the supplier often increase.
 - Cost sharing?