

## Research on the Reducing Measures of Bullwhip Effect

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**Abstract.** Demand variability increases when it moves downstream to upstream in a supply chain, this is called the 'Bullwhip effect'. This effect causes unnecessary inventory build up along the nodes of the supply chain and hence reductions of this play a vital role. In this paper the causes of bullwhip effect are analyzed and the reducing measure is discussed, such as: Establishing the information sharing mechanism, Coordinating the information sharing's benefit allocation model, establishing the strategic alliance, strengthening the trust cooperation, Strengthens the stock management and reduces the supply chain lead time.

**Key words:** bullwhip effect, inventory, supply chain, lead time.

### 1. Introduction

With the accelerating trend of global economic integration, in order to survive in the fierce market competition the links between enterprises become increasingly close, especially between upstream and downstream enterprises. In order to respond market demand quickly, Around the core business, the supplier, the supplier's suppliers, the core business, clients and customers form the chain structure - Supply Chain. This chain includes supply, production and sales. At the same time supply chain management has come into being. The effect of demand fluctuations is amplified widespread in the supply chain, this demand information distortion phenomenon is called the "bullwhip effect" (Chen et al., (2000) [1]). The bullwhip effect is a dynamical phenomenon in supply chains. It refers to the tendency of the variability of orders rates to increase as they pass through the echelons of a supply chain towards producers and raw material suppliers. Bullwhip creates unstable production schedules. These unstable production schedules are the cause of a range of unnecessary costs in supply chains. Companies have to invest in extra capacity to meet the high variable demand. This capacity is then under-utilised when demand drops. Unit labour costs rise in periods of low demand, over-time, agency and sub-contract costs rise in periods of high demand. The highly variable demand increases the requirements for safety stock in the supply chain. Additionally, companies may decide to produce to stock in periods of low demand to increase productivity. If this is not managed properly this will lead to excessive obsolescence. Highly variable demand also increases lead-times. These inflated lead-times lead to increased stocks and bullwhip effects. Thus the bullwhip effect can be quite exasperating for companies; they invest in extra capacity, extra inventory, work over-time one week and stand idle the next, whilst at the retail store the shelves of popular products are empty, and the shelves with products that aren't selling are full. The figure 1 shows the Bullwhip effect. (Dejonckheere et al., 2003, 2004 [3, 9]).

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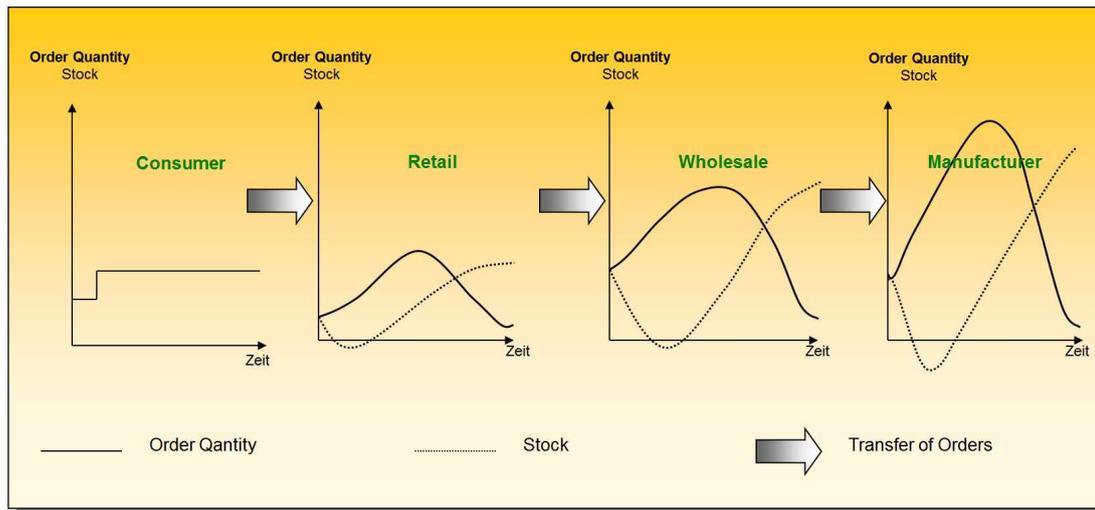


Figure 1 the Bullwhip effect

## 2. Harms of Bullwhip Effect

Bullwhip effect in supply chains has led to the distortion of demand information, the harm is done both at the micro and macro (Deng and Ma, 2009 [4]):

At the micro level, the existence of the bullwhip effect in supply chain will bring a double loss for companies include efficiency and profitability. Firstly, the product stock is to adapt the demand change to set up, the excessive demand fluctuation caused to supply in chain's excessive stock directly, has taken enterprise's fund massively, formed the high quota the inventory cost, brought the pressure for enterprise's production and operating activities. Secondly, because the demand uncertainty increased, the difficulty of the enterprise' perfect forecast to the demand is also enlarged. And in the supply the possibility which the back ordering and out of stock is increasing, all of these lead to reduce the level of customer service. Third, the demand distortion also affects enterprise's production. Because of the distortion demand information misleading, the productive plans have to revise frequently, produces cannot advance continually. Therefore the production cost and the physical distribution cost is increasing also.

From a macro level, the bullwhip effect will cause the economic resource the blind flowing and the low efficiency disposition. Bullwhip effect is a classic "market failure" phenomenon, because the upstream industry received the demand information deviated from the true demand, it may lead to over-investment or investment shortage. The capital enters excessively means the competition aggravating and the income drop, ultimately hurting the development of the industry itself. Therefore causing the financial system's hidden danger and bring the risk of the macro economic movement.

## 3. Causes of the Bullwhip Effect

Supply chain is a complex net chain system which includes the numerous suppliers, the manufacturer, the seller and the customer. The demand information is upward transmission in the chain end of network. Because of the exterior market environment disturbance and the internal divergent interest main body goal conflict, the demand information presents the uncertainty, the lagging, the misalignment, the dynamic, the succession to interlock, the transmission structure multiplicity and so on, these factors together have caused the supply chain bullwhip effect production (Wang et al., 2002 [7]; Zou and He, 2003[9]).

### 3.1 Demand information uncertainty

Based on the demand forecasting, the enterprise in supply chain node usually establish a certain inventory including raw materials, components and finished products. Because the final customer's demand information is indefinite in the exterior market environment, the retail merchant is unable to forecast the perfect market demand. And so the retail merchant will use the method that enhancing the order quantity to transfer this potential risk to his upstream enterprise. When the upstream node enterprises receive the distortion ordering information, they will use the same processing mode to deal with the order. Therefore,

The demand information's uncertainty will cause the demand information to be amplified continuously from bottom to top in various nodes supply chain. The uncertainty of demand information is the basic reason of bullwhip effect in supply chain.

### **3.2 Nonlinear delayed information**

When the actual inventory is less than expected amount, the node enterprise in supply chain which includes raw materials, intermediate products and final products will order from his upstream in order to supply the inventory. But there exist a time difference from accepting the customer order form to send out the ordering demand to its supplier for the downstream enterprise. So the demand information which the upstream enterprise achieved is not the most recent market information, it is called the delays of information. The length of delay time is variable, showing a nonlinear characteristic. As a result, the upstream node enterprise uses these methods to avoid the risk such as increasing inventory, enhancing the order of times and the volume. Therefore those facts aggravate further the bullwhip effect.

### **3.3 Staggered timing of the node because of information game**

The node enterprise in supply chain is the interdependence, the benefit connection partner relations. But as a rational participant, the various nodes enterprise will choose the optimization decision-making behavior which the own effectiveness is the most maximization. So the various nodes enterprise will contend mutually and game. As a result, the various nodes enterprise will lack the communication, even the partner will choose again. The communication's flaw and the node enterprise's restructuring cause the supply chain's structure presenting the succession staggered dynamic evolution characteristic. At the same time, because of the cooperation unstable and the cooperation time indefinite, this kind of succession interlocks will intensify the node enterprise the information transmission to be blocked and distorted in a certain extent. Therefore those aggravate the bullwhip effect again.

### **3.4 Demand information dynamic**

On the one hand, enterprise's gambling causes the node enterprise's succession interlock; On the other hand, after a product's life cycle had ended, the system corresponding structure system will decompose, and very quick the new system structure will built up according to the market demand change. The demand information's succession dynamic and restructures along with the supply and demand process cause the purchasing, the production, the sale and so on present the dynamic characteristic. The kind of dynamic which is nonlinear and uncertain increase the possibility of bullwhip effect and the demand information fluctuation degree.

### **3.5 Organizational structure's multiplicity**

The supply chain is composed of the numerous manufacturers, producer, seller and the final customer, the net chain structure is very complex and long. This kind of condition causes the demand information's degree which be twisted to enlarge unceasingly from the downstream to upward in transmission process.

## **4. Reducing Measures of Bullwhip Effect**

### **4.1 Establishing the information sharing mechanism**

The information uncertainty, dynamic, the delaying as well as the transmission structure's multiplicity has caused the demand information transmission distortion together (Mu, 2005 [6]). Establishing the highly effective real-time information sharing mechanism, can avoid the negative influence effectively which the information's delaying, dynamic as well as the transmission structure's multiplicity, thus reduces the bullwhip effect effectively. Establishing the information sharing mechanism plays a vital role in the solution bullwhip effect process. Besides final customer demand information, Sharing information includes various nodes enterprise's stock information, the order form condition tracking information, the demand forecast information, the product price information, the new product research and development information and so on.. Modern advanced information technology like POS, EDI, ERO, Practices that support an effort to reduce uncertainty involve the implementation of systems such as electronic data interchange (EDI) and extensible markup language (XML). Both these technologies allow companies to share information (such as

consumer sales) with partner companies in the supply chain. EDI uses specific network services with an agreed information protocol while XML supports information sharing over the Internet. POS (point of sale) data can be transmitted to all chain operators, which will enable them to have a clear picture of consumer demand.

#### **4.2 Coordinating the information sharing's benefit allocation model, establishing the strategic alliance, strengthening the trust cooperation.**

Benefit coordinated is the guarantee for the various nodes enterprise in supply chain to realize the information sharing, is also efficacious method to reduce the node enterprise succession interlocks. The demand information is distorted unceasingly in the transmitting process, the waste cost is also being increased unceasingly. Obviously, under the information sharing pattern, to the Downstream Enterprise, the saving cost is a few and the degree of seeking the information sharing is low; to The Upstream Enterprise, the saving cost is many and the degree of seeking the information sharing is high. To realize the information sharing effectively, the Upstream Enterprise must use the incentive mechanism to the Downstream Enterprise, realizes the benefit redistribution of the information sharing. The coordinated benefit's method includes: The Upstream Enterprise gives certain compensation to the Downstream Enterprise, including raw material price preferential benefit, the cargo first supplies, the scarce material full amount supply and so on; At the same time, the node enterprise may establish the enterprise strategy alliance and strengthen the trust cooperation.

#### **4.3 Strengthens the stock management**

##### **4.3.1 VMI inventory control**

The VMI(Vendor Managed Inventory) management system is a system which the supplier manages the user stock, is one of supplementary goods ways continually (Disney and Towill, 2003[7]). VMI is one kind of supply chain integration operation policy-making proxy pattern, it gives the customer stock decision-making power to the supplier, and the supplier exercises the stock decision-making authority for an agency of the distributor or the wholesaler. Thus breaks the traditionally pattern which firstly produce the order form then make up the goods supply. The actual or the forecast consumer demand information is the basis for making up the goods. This method eliminates the demand information's the enlargement and the distortion in the transmit process from the distributor to the supplier, therefore reduced the bullwhip effect influence greatly.

##### **4.3.2 Union inventory control**

Different in the VMI integration operation policy-making proxy pattern, the union stock is the stock management pattern which risk shares. Simply, the union stock management is based on the coordination center union stock management pattern. The union stock management is different from the supplier manage the customer stock, it stressed both sides all participation, works out the stock plan together, causes each stock superintendent (supplier, manufacturer, distributor) to consider from the coordination in the supply chain process, maintains the chain neighboring two nodes keep pace with the demand anticipated information, thus eliminated the demand variation enlargement phenomenon.

##### **4.4.4 Reduce of the supply chain lead time**

The reduction of the overall supply chain lead time is treated with the utmost priority in contemporary supply chain management. This has resulted in rapid response manufacturing practices which are built on the concept of agile manufacturing. Decreasing the lead time between each level of the supply chain will aid in reducing the bullwhip effect. In fact it has been recognized that time compression is the key to supply chain excellence. Supply chain lead time is made up of the delays in information processing and materials processing (Mason-Jones and Towill 2000[8]). While in the short term the material flow lead time can be reduced by transportation techniques like cross docking, information pipeline lead time can be reduced by effective information sharing using technology. This has been made possible by integrating the physical transfer process with information system integration. This enables an agile enterprise to respond rapidly to customer demand, reducing the lead time.

## 5. Conclusion

The bullwhip effect is an inevitable question in supply chain management. Based on the demand information complexity, this paper analyzes the causes of bullwhip effect, and discusses some alleviation countermeasures, such as: Establishing the information sharing mechanism, Coordinating the information sharing's benefit allocation model, establishing the strategic alliance, strengthening the trust cooperation, Strengthens the stock management and reduces the supply chain lead time. In order to eliminate further the bullwhip effect's influence, we must carry on the management innovation unceasingly.

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