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   OBJECTIVES

   HYPOTHESES

   RESEARCH METHODOLOGY

   RESULTS & DISCUSSION

   FINDINGS

   RECOMMENDATIONS/SUGGESTIONS

   CONCLUSIONS

   SCOPE FOR FURTHER RESEARCH

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DEMAND ESTIMATION UNDER PUSH MARKETING STRATEGY: TOOL TO MITIGATE BULLWHIP EFFECT

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ABSTRACT

A phenomenon that is now well known as the bullwhip effect suggests that the variability in the orders increases as they move up the supply chain from retailers to wholesalers to manufacturers to suppliers. This effect is observed in a range of industries, modeled by several authors and various remedies have been suggested. Most of the authors explore the cause of bullwhip effect. Demand signal processing, non-zero lead times, order batching, supply shortages, and price fluctuations are the major reasons for bullwhip effect to occur. In this paper, the impact of push marketing strategies on bullwhip effect has been explored. Furthermore, this paper also explores the optimal order quantity for retailers under certain conditions, in case of pull marketing strategies such that the total cost per unit time at retailer's end is minimum. A mathematical model has been developed suggesting the situations under which a supplier takes the decision about whether to fill the order or not. By eliminating or controlling this effect, it is possible to increase product profitability, reducing the useless costs such as stock-out and obsolescence costs.

KEYWORDS

Bullwhip Effect, Demand Estimation, Optimal Order Quantity, Push Marketing Strategies, Supply Chain Management.

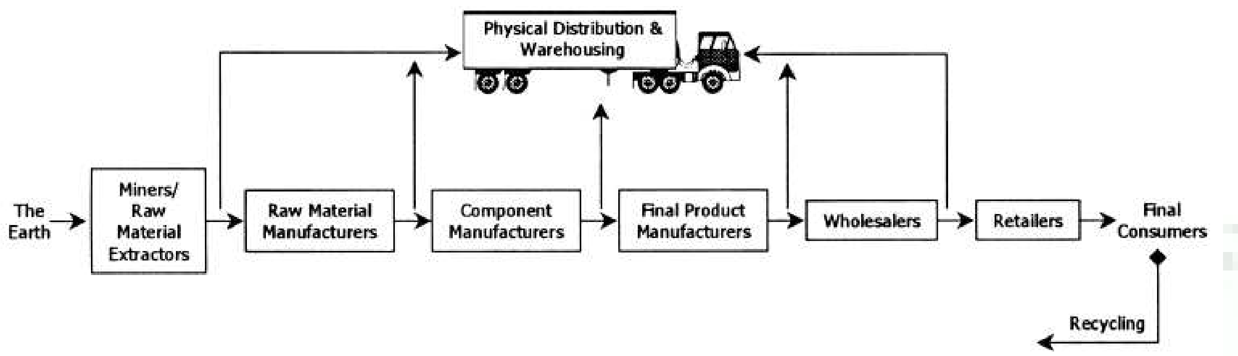
INTRODUCTION

Over the past decade, the traditional purchasing and logistics functions have evolved into a broader strategic approach to materials and distribution management known as Supply Chain Management (SCM). Supply Chain Management consists of network of organizations related to each other in different activities (like flow of material, information or finance) that produce value in form of product or service to satisfy customer. Supply Chain Management can be applied to large companies with several sites, covering large geographical area with the aim to satisfy large number of people with different types of products or services. In broad sense, supply chain management is inter-organizational supply chain which does different types of functions like marketing, production, procurement, logistic, finance, etc. The utmost need of governing supply chain management is to get competitive advantage; the organizations which apply supply chain management are able to optimize resources and hence improve its functions and survive in the market.

Supply Chain Management deals with competitiveness which can be improved by reducing cost, optimizing use of resources, increasing flexibility to deal with customer demand and frequent changes in customer demand, providing superior quality of products and services, utilizing information and communication technology. There are various facets of supply chain management. Besides competitiveness and customer service, strong integration between sub-functional departments within the organization and outside the organizations, i.e. network and inter-organization collaboration, is very much required to implement a successful and effective supply chain. Supply chain management should be process orientated and equipped with advance planning. It should also look into customer behavior, change in demand and technology, forecasting of finance, material, etc. Foundation of supply chain management includes purchasing, resource allocation and requirement, manufacturing of goods or services, logistics, marketing, finance, statistics and operational research, accounting, information technology, organizational theory, and so on.

Different authors have given the different definitions of supply chain management. Tan et al. defined it as a capability which is to enhance competitive advantage. Berry et al. (1994) defined supply chain in terms of information and trust. Jones and Riley (1987) defined it as "An integrative approach to dealing with the planning and control of the materials flow from suppliers to end-users." Christopher (1992) defined it in terms of upstream and downstream operation. Another definition of supply chain management emerges from the transportation and logistics literature of the wholesaling and retailing industry, emphasizing the importance of physical distribution and integrated logistics. There is no doubt that logistics is an important function of business and is evolving into strategic supply chain management (New and Payne, 1995).

FIG. 1: ACTIVITIES AND FIRMS IN A SUPPLY CHAIN. SOURCE: NEW AND PAYNE (1995)

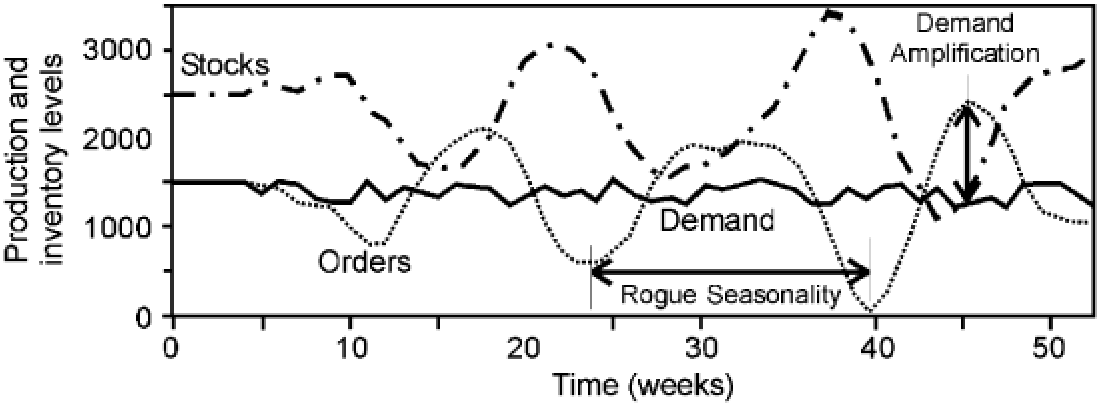


As it can be noted from Figure 1, process integration in terms of information exchange plays very important role to make supply chain management effective. Information is to flow from customer to retailer, retailer to wholesaler and then wholesaler to manufacturer, this flow of information is termed as upstream information.

On the basis of the information various activities like planning, manufacturing, distribution and marketing are performed to attain some functional objectives under system constraints.

Information exchange within supply chain is main pillar to make it successful and effective. If either desired information or in-flow of information is having any error then it causes a big problem. The problem in deformation of the information while it goes upstream in supply chain is termed as **Bullwhip effect**. Any fluctuation in demand at customer end results in big deviation at manufacturer end. Even it has been seen that if demand is constant it gives a distorted picture to the manufacturer about the quantity to produce.

FIG. 2: DEMAND AMPLIFICATION OF TIME SERIES TO BE VIEWED THROUGH THE "FILTER" LENS. SOURCE: BERRY AND TOWILL, 1995



Suppose for a particular period, demand of a certain product is not known to retailer, then retailer would have high stock in order to overcome the uncertainty and the same information is passed to the wholesaler and then to the manufacturer. In that case manufacturer would produce the product in more quantity than it must have produced. So the inventory level becomes high only due to lack of information of demand at retailer's end. Higher inventory results in blocking of working capital for the firm. The blocking of working capital reduces the operational efficiency of the firm. When the number of supply chain increases, the complexity becomes larger and the aggregate inventory becomes much higher. This aggregate inventory results in loss of opportunity cost, reduces the required efforts, integrity and flow of information between partners.

According to the study of R. Metters (1997), the retailer's end cost of carrying inventory of product for a year equals at least 25 percent of what they pay for the product. Two-week inventory reduction represents a cost savings nearly equal to 1 percent of sales or the average retailer profit equals about 2 percent of sales so saving is enough to increase profit by 50 percent. Campbell soup found that after it introduced the program, profit of its product grew twice as compared to earlier profit.

Procter and Gamble (P&G) is the company which named this phenomenon as bullwhip effect after seeing the great variation between the order they are producing and actual sales of the product "pampers diapers." They observed that diaper with uniform demand created a wave of changes up the supply chain due to very minor changes in demand. HP also found great variability in the sale of printers; HP found it difficult to fulfill the orders on time and in order to meet the time it resulted in the increase in cost. Studies of apparel and grocery industry have shown a similar phenomenon in order as they move upstream in supply chain from retail to manufacturing. Nearly in all types of companies bullwhip effect has been observed like Campbell soup in consumer product IBM and Motorola in electronics, General Motors in automobiles and Eli Lilly in pharmaceuticals, etc.

LITERATURE REVIEW

Supply chain management has received attention since the early 1980s, yet conceptually the management of supply chains is not particularly well understood, and many authors have highlighted the necessity of clear definitional constructs and conceptual frameworks on supply chain management (Saunders, 1995, 1998; New, 1995; Cooper et al., 1997; Babbar and Prasad, 1998). Saunders (1995) warns that pursuit of a universal definition may lead to unnecessary frustration and conflict, and also highlights the fragmented nature of the field of supply chain management, drawing as it does on various antecedents including industrial economics, systems dynamics, marketing, purchasing and inter-organizational behavior. The scientific development of a coherent supply chain management discipline requires that advancements be made in the development of theoretical models to inform our understanding of supply chain phenomena. As an illustration, the application of Forrester's (1961) industrial dynamics model applied to supply chains (the Forrester Effect, also known as bullwhip effect or whipsaw effect) exemplifies such a model. Its value lies in the ability to aid understanding of the actions of materials flow across a chain, and has provided a basis for further advancement of understanding supply chain dynamics (for example, see Sterman, 1989; Towill, 1992; Van Ackere et al., 1993; Lee et al., 1997). Cooper et al. (1997) support this view, pointing to the fact that whilst supply chain management as a concept is a recent development, much of the literature is predicated on the adoption and extension of older, established theoretical concepts.

Forrester (1961) initiated analysis of this variance amplification phenomenon i.e. the bullwhip effect. His work has inspired many authors to develop business games to demonstrate the bullwhip effect. The well-known Beer Game originated from MIT at the end of the fifties and Sterman (1989) reports on the major findings from a study of the performance of some 2000 participants. Kaminsky and Simchi-Levi (1998), Kaminsky et al. (2000) developed a computerized version of the beer game. There is certainly no lack of empirical evidence from real-world supply chains. Lee et al. (1997a, b) identify five major causes of the bullwhip effect: demand signal processing, non-zero lead times, order batching, supply shortages and price fluctuations. Of these Disney and Towill (2003b) consider lead time and demand signal processing to be of particular importance. Remedies include synchronizing capacities and lead times (Lee et al., 1997; Towill, 1997), increased coordination among companies (Metters, 1997), vendor-managed inventory (Disney and Towill, 2003b) and including demand variability in pricing decisions (Naish, 1994). In terms of management science techniques, Yao and Dong-Qing (2001) indicates that demand forecasting and ordering policies are two key methods of controlling the bullwhip effect and Paik and Seung-Kuk (2003), in a statistical study, identified demand forecasting as one of the significant variables for bullwhip control. Miyaoka and Hausman (2004) also found that improved forecasting could reduce fluctuations in manufacturing production levels.

Out of the various above mentioned factors that results in bullwhip effect, there are many other factors also that are causes bullwhip. The marketing strategies like push and pull marketing strategies leads to fluctuation in demand.

The push marketing strategies are the production and distribution strategies based upon the forecast rather than on specific customer demand. It is applied to the supply chain where the uncertainty of demand is small and production and distribution are based on long term forecast.

Most marketing activity in push strategy is directed at distributors and retailers in order to get them to carry the product and promote it to the consumers. The sales force, price incentives, retailers advertising and other forms of trade promotions are used to push the product through the distribution channel (agents, wholesalers, retailers, and others) to consumers.

The present study focuses on the impact of push marketing strategies on retailers order quantity. The retailers have two choices either the order is filled under the impact of push marketing strategy where the benefits are provided to it or fill the usual order.

A mathematical model is formed that shows the optimal order quantity for the retailer such that total cost per cycle per unit time is minimum. The research paper is further divided into several sections. The next section discusses the assumption and notations used through the research paper. In section 4, the mathematical formulation for retailer's optimal decision with algorithm is discussed. Later on demand estimation is discussed in section 5 and section 6 is having concluding remark.

ASSUMPTIONS AND NOTATIONS

1. Demand is deterministic and occurring with constant rate.
2. Lead time is negligible, supply is instantaneous.

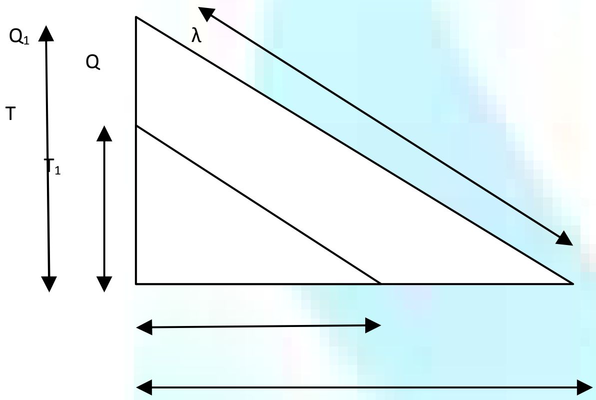
3. Shortages are not allowed.
4. The value of money is constant over a period of time, cycle length.

λ: Demand rate
A: ordering cost per order
c: cost of unit item
p: selling price of unit item
I: Inventory carrying Charge
Q: Ordering quantity without the impact of push marketing strategy
T: cycle length of Quantity Q
Q_1: ordering quantity under the impact of push marketing strategy. ($Q_1 > Q$)
T_1: cycle length of Quantity Q_1.
B: benefits given to the retailers under the push strategies.
I_p: Interest paid to incurred more inventories to take the benefits of Push Strategy.
TC: Total Cost per cycle per unit time

MODEL FORMULATION

This section consists of three parts. In first part, the retailer decision without the impact of push marketing strategy is discussed where as in second part the total cost is if takes the order according to push marketing strategy where he has to fill the order more than usual quantity. In third section the algorithm about the decision making problem regarding whether to take the extra inventory with benefits or not.

FIG. 3: SHOWS THE COMPARISON BETWEEN THE USUAL ORDER QUANTITY AND THE ORDER QUANTITY UNDER THE PUSH STRATEGY.



Source: Author

From figure 3, it can be predict that,

$$Q = \lambda T \text{ and } Q_1 = \lambda_1 T_1 \quad (1)$$

4.1 Order Quantity without effect of push marketing strategy

In this section, retailer places the usual order on the basis of demand such that total cost per cycle per unit time is minimum.
Total cost per cycle is taken as sum of ordering cost, purchasing cost and inventory carrying cost.

$$Total\ Cost\ per\ cycle = A + cQ + \frac{1}{2}IcQT \quad (2)$$

Total cost per unit per unit time, $TC(Q) = \frac{A\lambda}{Q} + c\lambda + \frac{1}{2}IcQ$ (3)

To minimize this TC, applying the principal of maxima and minima, put $\frac{dTC}{dQ} = 0$ and $\frac{d^2TC}{dQ^2} > 0$

We get $Q = \sqrt{\frac{2A\lambda}{Ic}}$ which is known as EOQ (Economic Order Quantity)

Corresponding total optimal cost can be obtained $TC = \sqrt{2A\lambda Ic} + c\lambda$ (4)

$$Total\ revenue\ generated\ during\ this\ cycle = pQ$$

$$Revenue\ per\ unit\ time = \frac{pQ}{T} = p\lambda$$

Profit per cycle per unit time is given by

$$p\lambda - \left[\frac{A\lambda}{Q} + c\lambda + \frac{1}{2}IcQ\right] \quad (5)$$

1.2 Order Quantity with effect of push marketing strategy

Now if retailer takes the benefit which is of Rs. B, then order quantity will increased to Q_1. To purchase more quantity then Q, retailer has to take a loan which is having a interest rate I_p.
the total interest paid during the cycle is given by,

$$I_p c(Q_1 - Q)$$

The interest paid per unit time is given by, $\frac{I_p c(Q_1 - Q)}{T_1}$

This can be rewrite as, $\frac{I_p c\lambda(Q_1 - Q)}{Q_1}$ (6)

Now, the total cost per cycle per unit time is given by,

$$TC(Q_1) = \frac{A\lambda}{Q_1} + c\lambda + \frac{1}{2}IcQ_1 + \frac{I_p c\lambda(Q_1 - Q)}{Q_1} \quad (7)$$

So the total profit per cycle is given by,

$$p\lambda - \left[\frac{A\lambda}{Q_1} + c\lambda + \frac{1}{2}IcQ_1 + \frac{I_p c\lambda(Q_1 - Q)}{Q_1}\right] \quad (8)$$

Now, the increase in profit per unit time is given by applying $(8) - (5)$

$$p\lambda - \left[\frac{A\lambda}{Q_1} + c\lambda + \frac{1}{2}IcQ_1 + \frac{I_p c\lambda(Q_1 - Q)}{Q_1}\right] - p\lambda + \left[\frac{A\lambda}{Q} + c\lambda + \frac{1}{2}IcQ\right]$$

This can be rewrite as,

$$TC(Q_1) - TC(Q) = A\lambda\left(\frac{1}{Q} - \frac{1}{Q_1}\right) + \frac{1}{2}Ic(Q - Q_1) - \frac{I_p c\lambda(Q_1 - Q)}{Q_1} \quad (9)$$

1.3 Algorithm to find the Retailer's optimal Decision

The following steps can be taken to estimate the optimal cost for the retailer

Step 1. Find the minimum Q, corresponding to the total cost obtain in (3) and corresponding total cost give by (4)

Step 2. Knowing the value of Q_1 on which wholesaler agrees to pay benefits B, and value of Q obtain in step 1, compute (9) i.e. $TC(Q_1) - TC(Q)$

Step 3. Compare the value obtain in equation (9) with B,

If, $TC(Q_1) - TC(Q) < B$, then purchase quantity Q_1 otherwise purchase Q.

2. Demand estimation for manufacturer

In the last section, retailer's optimal order quantity decision under the impact of push marketing strategy has been explored. An algorithm has been suggested on the basis of which retailers are able to decide whether the large order should be placed or not. In this section estimation has been done by which manufacturer is able to predict the quantity that needs to be manufactured.

Let $r_1, r_2, r_3, r_4 \dots\dots\dots\dots r_n$ be the n retailers present in the supply chain.

Out of which some retailers work under the impact of push marketing strategy and place big orders. Since such retailers can be exactly identified by the algorithms provided in section 4, let out of n retailers k order the big order quantity denoted by Q_1.

There may exist some retailers who order usual quantity and stick to the same. Since k number of retailers fill the order of quantity Q_1, hence rest of the retailers $n - k$ fill the usual quantity. For such retailers who fill the usual order quantity, the expected quantity is yet to be determined as the optimal order quantity varies from retailer to retailer.

The quantities $Q_{11}, Q_{12}, Q_{13}, Q_{14} \dots, Q_{1m}$ are considered as possible quantity that a retailer can order. Let $p_{11}, p_{12}, p_{13}, p_{14} \dots\dots\dots, p_{1m}$ be the probability with which any retailer fill the order of quantity $Q_{11}, Q_{12}, Q_{13}, Q_{14} \dots, Q_{1m}$.

Hence the expected units ordered by any retailer is given by

$$\sum_{i=1}^{m} p_{1i}Q_{1i} \quad (10)$$

Since there are $n - k$ such retailers so the expected quantity ordered by these retailers is given by

$$\sum_{j=1}^{n-k}\sum_{i=1}^{m} p_{ji}Q_{ji} \quad (11)$$

The remaining k retailers will fill order with quantity Q_1 each, hence the total number of units filled by these retailers are kQ_1.

So the expected quantity $E(Q)$ that needs to be manufactured by manufacturer on the basis of retailers order quantity is given by

$$E(Q) = kQ_1 + \sum_{j=1}^{n-k}\sum_{i=1}^{m} p_{ji}Q_{ji} \quad (12)$$

To compute the variance in this expected demand we have

$$var(Q) = var(kQ_1 + \sum_{j=1}^{n-k}\sum_{i=1}^{m} p_{ji}Q_{ji}) \quad (3.2.1.4)$$

$$var(Q) = var(kQ_1) + var\left[\sum_{j=1}^{n-k}\sum_{i=1}^{m} p_{ji}Q_{ji}\right] \quad (13)$$

Now since k and Q_1 both are constant quantities, hence $var(kQ_1) = 0$

$$var(Q) = var\left[\sum_{j=1}^{n-k}\sum_{i=1}^{m} p_{ji}Q_{ji}\right] \quad (14)$$

As it is known high variance results in higher uncertainty and it will be difficult to predict the demand. In this case when the algorithm about order quantity is known the variance is less than the variance which is computed applying the algorithm. Mathematically

$$var\left(\sum_{j=1}^{n}\sum_{i=1}^{m} p_{ji}Q_{ji}\right) \geq var\left[\sum_{j=1}^{n-k}\sum_{i=1}^{m} p_{ji}Q_{ji}\right]$$

Hence the expression obtained in (12) is better than the estimation when the algorithm of retailers optimal order quantity is not determined.

To deal with the uncertainty of this variance the desired level (*z*) of output that can be produced is given by

$$E(Q) + z\,var(Q)$$

where $E(Q)$ and $var(Q)$ can be determined by (12) and (14), and z is a normal distribution parameter.

CONCLUSION

Forecasting is always considered as one of the reason by which bullwhip effect occurs. In such a cut throat competition when the push marketing strategies are applied the estimation of demand by forecasting methods become obsolete. The mathematical procedure is provided by which demand estimation can be done and hence results in reduction of bullwhip effect. Beside the demand estimation the variance of demand is also computed.

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