



The Forrester Effect: Theory, Consequences and Solutions to the Pharmaceutical industry

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Abstract

The Supply Chain includes all the parties involved that are required in fulfilling a customer's demand or requests, whether direct or indirect parties.

The supply chain consists of the manufacturers, suppliers and transporters, warehouses, retailers and consumers themselves. The impact of BWE is to increase manufacturing cost, inventory cost, replenishment lead time, transportation cost, labour cost for shipping and receiving, cost for building surplus capacity and holding surplus inventories, and to decrease level of product availability and relationship across the supply chain.

The objective of the study is to point out the major reasons of the Bullwhip effect in supply chain and propose solutions which would reduce the effect across the network.

In the end the study concludes that learning the underlying causes and relations between the different levels in the supply chain is important to nullify the impact of the BWE on the supply chain.

Keywords: Supply chain, Bullwhip effect, demand fluctuations, replenishment, lead time

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1 Introduction

1.1SCM:

Supply chain management (SCM) is a mixture of developments that help realize maximum efficiency by attaining the benchmark level of service requirement while simultaneously cutting back on costs. This is done by effective amalgamation of supplier functions, production functions, operations and storage so that the right product can be sent to the correct place at the ideal time in the essential quantities. In simple words, harmonization of manufacturing, inventory, warehousing and transportation in a way that the demands of the market are met through excellent responsiveness is what lies at the core of SCM.

Traditionally, when the subject was first explored as far back as the 1980s, SCM was known as “Logistics”. However, with time and popularity scholars of SCM came to find some fundamental differences in Supply Chain Management.

While Logistics is intrinsic to the organization, SCM is more extrinsic in nature. Logistics covers in-house activities like distribution, inventory etc. SCM, on the other hand, deals with Logistics and other activities like product development, marketing and finance. SCM usually involved multiple companies that form a channel for effective manufacturing and delivery of products/services to the final consumer.

A fruitful SCM function can only be a result of synergies between outbound and inbound function. Any improvement made has to be simultaneous because there exists a domino effect. An integral function performed by SCM is Customer Service which can help cut down on costs by lowering product-return rates; increases profitability by increasing the number of order placements and builds repute through on-time delivery.

A traditional Supply Chain will consist of:

- Customer(s)
- Retailer(s)
- Wholesaler/distributor(s)
- Manufacturer(s)
- Raw material supplier(s)

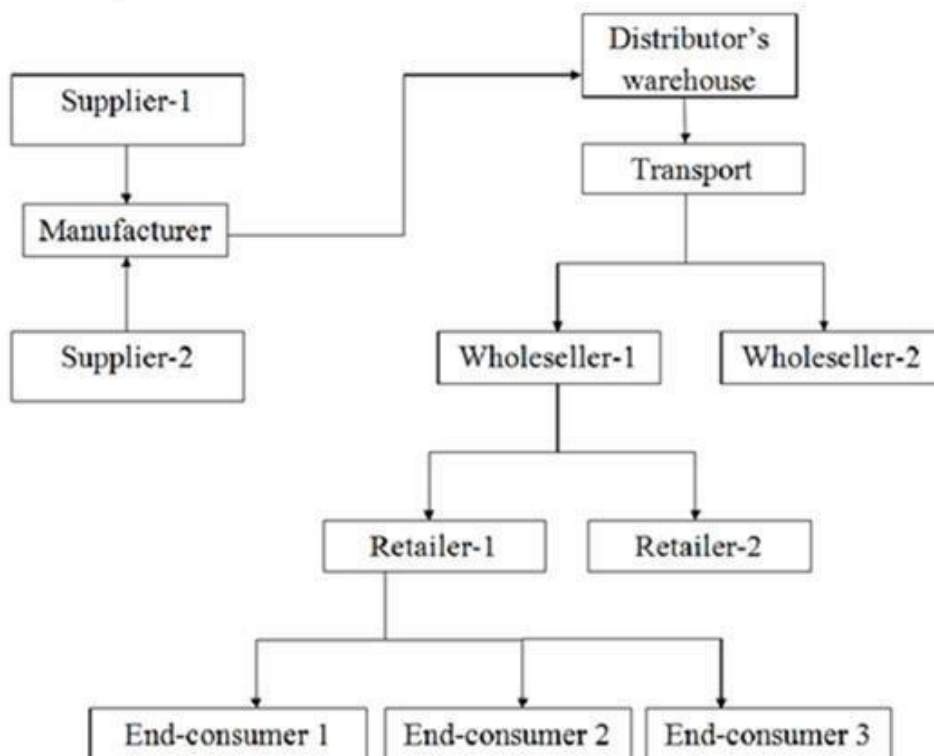


Figure 1: Basic layout of supply chain

Two core ideas from the basic idea of Supply Chain Management:

1. Firstly, the fact that any product/service that reaches the final customer is through the combined efforts of not one, but many different entities. These, combined, form the Supply Chain.

2. Secondly, even though Supply Chains have existed since the first man decided to open up a business, traditionally, all organizations have had a very narrow, self-focused approach. Very few even of them, understand even now in the 21st century the importance of combining resources and looking at the bigger picture. This myopia leads to deficiencies in the supply chain- weak links that make a dent in the final profitability.

The Supply Chain then leads to a sustainable advantage with regard to competition which cannot be imitated. This is obtained by creating and delivering superior customer value. Loyalty is created amongst the chain members when they experience high collective profits through efficient and effective running of the Supply Chain.

The connection of the organizations that constitute the Supply Chain is physical. This physicality is in the shape of material flow. Physical flow may involve important constituents like the transformation or raw material, transportation and finally, storage. However, a secret ingredient that makes Supply Chain Management fool proof is information flow. This is just as (if not more) important. This element allows for long term planning and coordination as well as short term day to day smooth sailing.

1.2 Core Objective:

The main purpose of the Supply Chain is to create added value to be added to the product/service. This in turn leads to higher sales due to customer need fulfilment which reduces inventory (decreasing storage costs). Strategically, SCM strives to:

- Reduce “working capital”
- Reduce the occurrence of “assets” being displayed on the balance sheet
- Increase cash-cycle occurrence per annum
- Increase inventory-turnover in a given year

Supply chain management is the precise formation on a smooth flow of activities between diverse phases of the Supply Chain. A gain in profitability on one stage holds no meaning unless the net profitability of all stages grows as a function of the levels combined. Many key players exist in a typical Supply Chain; however each of them would achieve more if they work together as opposed to focusing on individual gain. Therefore, a truly brilliant Supply Chain is one where the total profit of all players combined is the highest.

For example, a Honda bike purchased by a customer of from a company showroom sells for Rs. 100, 000. The cost to be subtracted from this revenue will be a sum of costs (can vary from production to delivery costs) for each player at all levels of the SC. The resulting profit will be divided amongst them according to their contribution to the value addition process. Hence, the smart thing to do is to work together and manage activities appropriately as a whole.

1.3 Importance:

Operational efficiency cannot exist independent of SCM. The scope of SCM varies from organizational success and high customer satisfaction to the society and improving life quality.

Essentially, the world in itself is a supply chain channel. It holds within itself major matters like the extension of the business world through partnerships; the success and growth of MNCs; global out sourcing; environmental issues etc. All of these matters are affected by SCM in one way or another. How well companies manage these determine the bottom line Corporate Strategy and its effect on the discipline in the business world.

1. SCM in the Society:

In societal context SCM lays the foundation for infrastructure. It solves problems like unemployment, decreases environmental concerns through efficient resource use and helps increase general standards of living.

A real life example is the Hurricane Katrina which left millions stranded without access to food and water. SCM enables these necessities to be delivered and within one week as much as 1.9 Million meals were delivered.

1. SCM in Business:

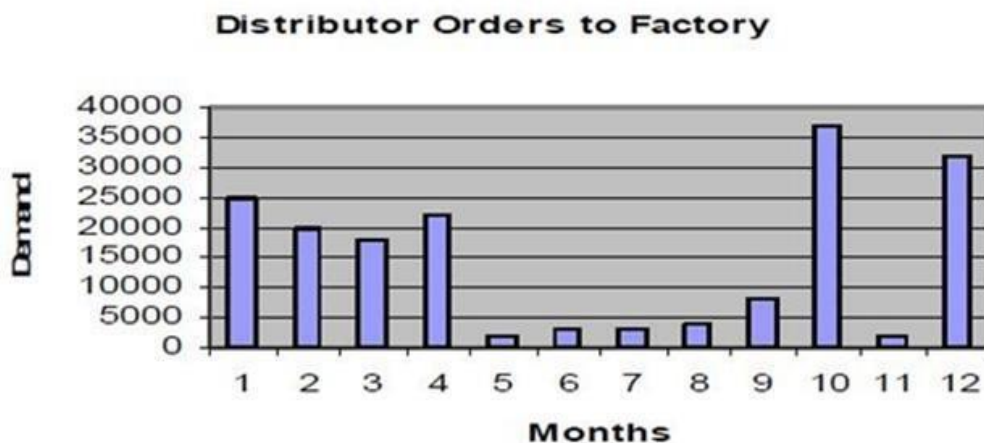
The most important function SCM plays in the business is increasing customer value. It enabled timely reach to the right people at the time they expect to be served. This increases inventory turnover.

Also, SCM enhances the bottom line by reducing the cost of fixed assets like manufacturing plant

1.6 Bullwhip Effect:

Coordination is the key issue in SCM since so many functions exist. Each maybe completely different and yet they are all linked. The Bullwhip Effect is a phenomenon that results when this much needed coordination wavers. The Bullwhip Effect is essentially an enlargement of the demand functions and not the demand. It makes itself evident when supply increases and decreases. The core essence of the bullwhip effect deals with the parity that the orders placed to the suppliers are more prone to variance that the sales made to the end consumer. The complexity of the Supply Chain increases with each additional stage and so does the probability that the Bullwhip Effect will arise.

The Bullwhip Effect can be explained through example by looking at the disposable diapers market. This market is has relatively stable demand functions. If we look at P&G as an individual manufacturer of disposable diapers, the orders placed by the retailers to them do not coincide with the demand of the customers. Simultaneously, orders placed by P&G itself to raw material providers increases this disparity even more. It can be observed in the figure below that the demand function that exists from retailer to factory fluctuates a lot more than that of customer to retailer.



1.7 Lack of Coordination:

Lack of coordination is a result of each player in the Supply Chain working to maximize self-interest (in the political world such players would be Realists) as opposed to looking at the greater good and the profiting of everyone alike (SC world Communists). This pursuance of self interest can have disastrous effects on the SC as a whole, particularly, the following functions:

- Manufacturing Costs
- Inventory Costs
- Replenishment Lead Time
- Transportation Costs
- Labour Costs
- Level of Productivity
- Relationship across the Supply Chain

A lack of flow of information also results from the absence of synergies. As a results, profit margins for all players fall due to the incurrence of higher costs at a given level of market demand.

1.8 Problems:

Any hindrance that cuts off information flow or distorts it from one level to another is fatal for the Supply Chain function and affects all players alike. All possible hindrances can be broadly divided into five major categories:

The “Goals” of each stage itself can be a major issue. For example, the purpose of Sales at the level of Distributors is to increase sales levels. If these sales are greater than the ones at Retailer levels, inventory will rise because the Retailer has bought more than it can. Next month, inventory will rise for the Distributor because it placed orders based on forecasting using historical data of sales made to the Retailer. However, since the Retailer has inventory remaining from previous months, they will buy less. This vicious cycle will continue and the demand fluctuations will create a gap in superior value delivery from one stage to another.

Secondly, “Information Processing” is another complication that can arise due to the demand concerns created in the first step. It is a result of inaccurate demand forecast and ends in the Bullwhip effect on the whole Supply Chain. Incorrect forecasting can also be a result of lack of information sharing.

“Operations” is another element that directly affects the success or failure of the Supply Chain function. Firms looking at cost cuts order in larger quantities than the customer demands because bulk purchases leads to discounts. When customer demand changes then demand will fluctuate upwards. The lead time in between different stages of the Supply Chain also affects demand. For example, if the demand fulfillment lead time from the retailer to distributor is a month, players at higher levels of the SC will have more difficulty forecasting demand correctly.

“Pricing” can be yet another factor creating obstacles in the Supply Chain. Changes in pricing policies cause demands to fluctuate. Assuming a retailer/wholesaler choose to buy forward- that is, they purchase in bulk when prices are low to meet future demands- this forward buying behaviour leads to larger demands in discount periods and lower demands after it. This variability will ultimately result in the Bullwhip effect set into motion in later stages.

There also exists a “Behavioural” obstacle which refers to the problem in organization learning. This results in information distortion. The four dimensions of this phenomenon are:

- Localized outlook of each stage in the Supply Chain, with complete disregard to effects of individual activities on the Supply Chain as a whole.
- Solving the problem and not uprooting it completely.
- Ongoing blame-game between stages, leading to rifts.
- Lack of empathy and trust between players in the Supply Chain, leading to creation of opportunist visions.

2 Literature Review:

2.1 BWE:

(Forrester, 1958) Was the first person to conduct research on the Bullwhip effect. He stumbled upon it while working on a four stratum Supply Chain and found variability in demand on different stages. Forrester forecasted that this delay in time of meeting demand at each stage will result in amplification in the whole Supply Chain demand.

This prediction was supported by (Burbridge, The New Approach to Production, 1961) whose suggestions about the Bullwhip effect were along the same lines. However, his findings were more focused on inventory management and production. He coined the term “stock control ordering” and put forth the opinion that this would lead to fluctuation in demand.

The incident which grounded the Bullwhip Effect even more firmly was the creation of the “Beer Distribution” game at MIT by Sterman. This game established the existence of the Bullwhip Effect through simulation of a supply chain with different stage members (Sterman & Senge, 1989) these members (Factory, Distributor, Wholesaler, and Retailer) were arranged linearly to purge team costs. The root cause of the Bullwhip Effect is incorrect information deciphering and quick, irrational decision making by one or more of the key players (Nienhaus J. , 2003) . It was also suggested by these researchers that the only way to eliminate this issue was through training and development to educate each player individually. They are, however, challenged by (Lee et al. 1997) who seem to think that no amount of rational decision making can eliminate the Bullwhip Effect.

(Buchmiester, 2008) was inclined to believe that suppliers tend to react to not only demand but safety stocks and the issue can be dealt with better policies regarding stock management.

According to (Cachon, 2005) an industry will exhibit symptoms of the Bullwhip Effect if a variance between inflow and outflow of goods exists. That is, the materials procured for production exceeds the material needed to satisfy market demand during a particular period. They are also of the opinion that the wholesale industry is cursed by this phenomenon more frequently than the manufacturing or retailing industries due to high variance.

A view that greatly contradicts the fore-mentioned one is of (Sucky, 2009). His studies suggest that the Bullwhip Effect is made out to be more of a nuisance than it is due to the obvious neglect of what he terms the “risk pooling effect” of the supply chain structure. Statistical correlation of the orders received by the retailer is what causes this RPE. Hence, correct analysis of the Bullwhip Effect is impossible without studying it.

In the opinion of (Forrester, 1958) and (Burbridge, Back to Production Management, 1995) the Bullwhip effect can be explained by four underlying causes:

1. Too much dependence on intuition when forecasting. This leads to human error which makes the supply chain prone to unforeseeable fluctuations in demand and hence loss of income.
2. “Muda” or non-value adding steps are the second cause. Even if their effect is not immediately apparent, it becomes so later on when the ripple effect takes place, amplifying delays. Some common “Muda” practices include: Wait time; delay in transportation; inventory mismanagement; excess movement; overproduction etc. Taichi Ono, Toyota’s Chief Engineer, first identifies these wastes and came up with a remedy in the form of “Lean Manufacturing”.
3. Yet another factor that contributes to the Bullwhip Effect is information synergy amongst players. Each player has its own bias which it exhibits. This leads to no one knowing how much to produce/order and when. More often than not, the addition of tiers to the SC network increases the likelihood of the Bullwhip Effect. This is because each new player brings a certain amount of inflexibility and slows change adaptation.

4. Lastly, the absence of a smooth flow of product/service from orders right to delivery is what Forrester identified as the fourth major loophole. His opinion is reinforced by Burbidge who also found that a very ardent Bullwhip Effect arises due to the Equal Batch Quantity Principle followed by most customers.

For the most part, if all Supply Chain experts agree on one thing, then it is this: The Bullwhip Effect is caused by the demand forecasts. In reality, the only supply chain member that takes the final consumer's demand into consideration is the Retailer. This is because all the other players estimate demand according to what the player immediately ahead of them needs. They then fine-tune to adjust the effect of any fluctuation (Carlson & Fuller, 2001)

Any individual company will place outgoing individual orders based on individual incoming demand which may be inaccurate to begin with. This means that soon, everyone is ordering more/less than they actually need. One player's inaccuracy amplifies variability for all.

The only solution to this is information sharing: As a customer, always provide accurate, complete information; as a company receiving that information, register and process it accurately.

Information sharing is a common practice as it is, but its accuracy can be questioned. It is practiced by employing VMI (Vendor-Managed Inventory), CRP (Continuous Replenishment Program), etc. (Moyaux Thierry, Brahim Chaib-draa, & Sophie D'Amours. 2006).

When companies order in bulk then don't order before that stock is about to be consumed, this is known as Order Batching. This is done to reduced costs through discounts and cutting over heads. The producers essentially control the price market. This is because they do not know the

consumer's exact consumption pattern. They purchase in bulk so it cannot be determined when and at what rate they consume the product. To get a better demand forecast, producers offer incentives like price discounts and rebates so that the demand is more stable and foreseeable. If this is not done, the manufacturers face the consequences in the face of the BWE- peak season premium transportation rates are incurred, overtime production occurs and inventory overflows. (Carlson & Fuller, 2001)

This move by the manufacturers may seem to shield them from the Bullwhip Effect but the counter move of the consumer as corrective action can still be a threat. Sensing that a shortage will occur in the market (due to manufacturer rationing) customers amplify demand needs. This will cause a further increase in the Bullwhip Effect occurring if the customers are permitted to cancel orders when real demand is fulfilled. This ongoing "survival of the fittest" philosophy leaves little room for authentic information being available to anyone (Carlson & Fuller, 2001) Rationing, too, exaggerates the Bullwhip Effect (Chopra and Meindl 2004). Short gaming will eventually lead to bigger problems due to a fall in demand and subsequent order cancellation.

Numerous examples of P&G and HP and other industries reveal how the BWE came to be recognized as a major phenomenon that caused inefficiencies in the supply chain. As these companies moved up and down the supply chain they highlighted the variability's that were caused in order demand.

Take for example P&G reviewing the order pattern of pampers. One step above the supply chain the variability's were not that huge. But downstream and difference with those was huge. And this was something that was not before seen as companies could not see the sales of their products at the consumer stage.

The effect in a prolonged state may be harmful to the effective functioning of the organization as a whole.

The factors that cause and affect the BWE may be hard to identify and even harder to mitigate. These factors seem to be interrelated in some way. Forming a conclusion based on market mechanisms might be folly as it would not show a whole picture.

(Lee et al) give us one explanation of the BWE. They use the simple multiple period inventory for a single product that has a constant demand.

Then they assume a system in which the retailer or distributor orders by using previous demand. If there is higher demand in one period it will translate into the order S plus a safety margin. The formula for this is given by

$$D_t = d + \rho D_{t-1} + u_t$$

The gist of the above formula is that an optimal order quantity is an optimal order policy. This shows that changing orders is not going to help in the reduction of the BWE.

Another way the BWE was identified was through the beer distribution game.

In short the objective is to use as less capital as we can while still having enough inventories to satisfy increased demand. There would be a 0, 50 \$ cost on per product on stock per round. And if there is a failure to deliver that product it would be a 1, 00 \$ cost.

The results when tabulated are surprising for each member in the supply chain.



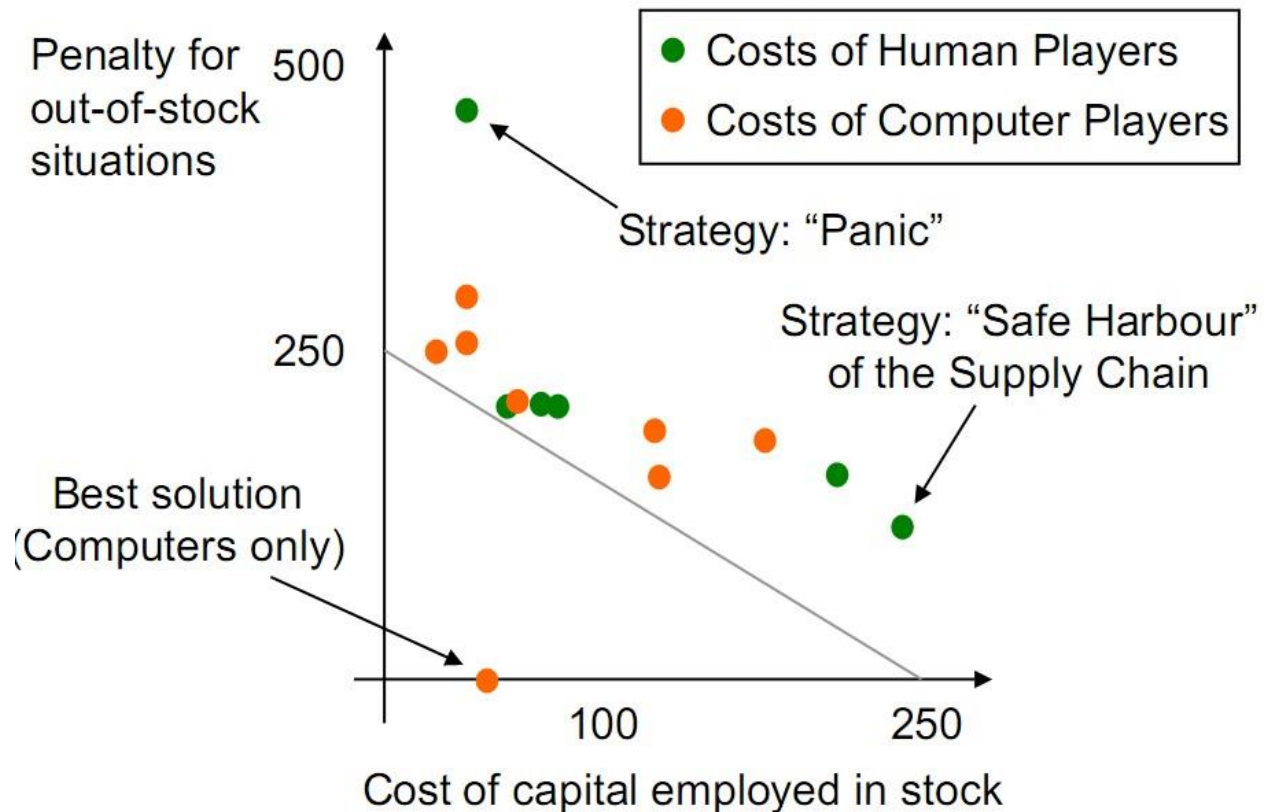
This shows another aspect, human behaviour has a huge impact on the fluid like operation of the supply chain. The best solution for the players involved is not even a central one. Each player passes on the extra orders of his customers to his suppliers and in the meantime maintains a constant level of stock.

Humans tend to be extreme in their behaviours in dealing with the problem of out of stock situations (Nienhaus, 2002). Computers tend to be more rational in these types of decisions. Lowest costs achieved by a group of computer players was 250\$ and highest was by human

players 1500\$. So we can see that behaviour and rational decision making also plays an integral part in aggravating the BWE.

The Role of Human Behavior

Humans tend to an extreme behavior.

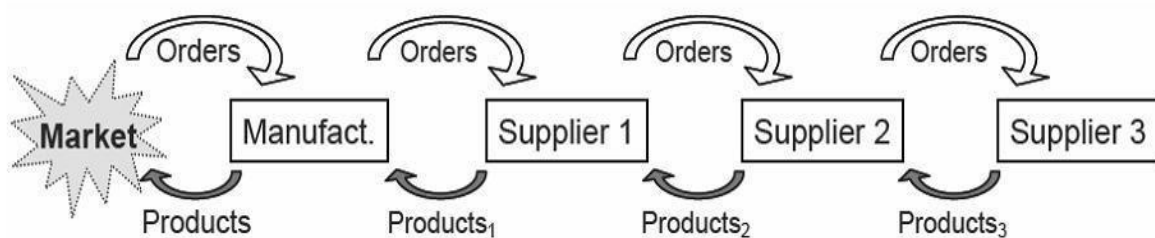


Lee and Lee and the EM-S studies gave us theoretical results. But nevertheless it cannot be said that these solutions are not applicable on a practical basis. Much work is needed before we can apply this model and reduce the effects of the BWE. The starting point should be a real time application on the paper industry.

According to (Warburton, 2004) BWE may be defined as the fluctuation in the order variability in the supply chain. Once the inventory has been fulfilled to the desired value the order rate reaches zero.

Lastly we will look at the study done by (Meters, 1997) which highlights the effect of stock keeping policies on the BWE. We consider for this a periodic review system with a single item supply line in 4 stages.

“There are no stock capacity limits, no production limits, and one order per period is assumed for each stage in the chain. Order sizes are rounded. Order and deliveries are made in the same period.”



There are two cases which are simulated.

- 1) Stable demand with a single 5% change in demand
- 2) Changing demand with 5% up and down changes

The results are as follows:

Table VIII: Max/Min ratios of stocks for applied policies P₁ – P₇.

Stock keeping policy	Max/Min ratio (Stocks)			
	Manufacturer	Supplier 1	Supplier 2	Supplier 3
P ₁	1,05	1,11	1,25	2,00
P ₂	1,05	1,11	1,31	1,75
P ₃	1,05	1,18	1,86	1,95
P ₄	1,05	1,18	1,59	2,11
P ₅	1,05	1,17	1,60	2,75
P ₆	1,02	1,03	1,05	1,08
P ₇	1,03	1,04	1,06	1,11

Remark: Market's Max/Min demand ratio: 1,05

The BWE is measured by the standard deviation between orders. These show that the BWE is present and sometimes there is a wildly fluctuating pattern. The following three things are concluded as a result in altering the BWE.

- 1) Safety stock should be decreased at the upstream level
- 2) Demand pattern should be studied in changing demand
- 3) A rational safety stock limit must be decided and should not be exceeded

2.2 Affect of Forecasting Techniques on BWE:

A study was also conducted to look at the linear trend demand case effects of exponential forecasting techniques. The study was the same as the one mentioned before. The study concluded:

- The scope of demand variability had a direct impact from the forecasting technique used to foreknow future demand variances and from the kind of demand pattern
- Bullwhip Effect happens once the retailer appraises the order up-to-point based on the forecast values generated by the computer.
- The lead time was directly proportional to the demand variability
- Trying to achieve smoother demand forecast by using the demand information only led to decreasing the effect

How important the event of information sharing and inventory control by using uniform and exponential demand patterns was shown by (Gavirneni et al. 18). Furthermore (Cachon, 2005) worked by examining a two staged supply chain network with stochastic stationary demand, and hence compared the importance of information sharing with the case in which only demand information to the one in which both demand and inventory information is available. The results were consequential in showing that there is no marked difference in between the two.

Numerous examples of P&G and HP and other industries reveal how the BWE came to be recognized as a major phenomenon that caused inefficiencies in the supply chain. As these companies moved up and down the supply chain they highlighted the variability's that were caused in order demand.

3 Research:

3.1 Research Problem:

Bullwhip effect is a cause of many problems in the supply chain network. This paper attempts to analyze and find ways to mitigate and/or reduce the Bullwhip effect in supply chain networks.

3.2 Study Purpose:

The rationale of this study is to find out and identify the main causes of the bullwhip effect on supply chain management. The study is being conducted to build upon a framework of variables that are the main causative factors for the bullwhip effect. Additionally, the study would also provide possible solutions to in effect reduce the bullwhip effect on supply chain management.

3.3 Type of Study:

The study is systematic as we have researched and made an opinion of the topic and have presented the interpretations of the causal relationship in the study. We not only have focused on the characteristics but also have analyzed and explained why the BWE occurs.

3.4 Study Setting:

It is a non-contrived study as we have not undergone primary research and have not manipulated any of the concerned variables.

3.5 Time Horizon:

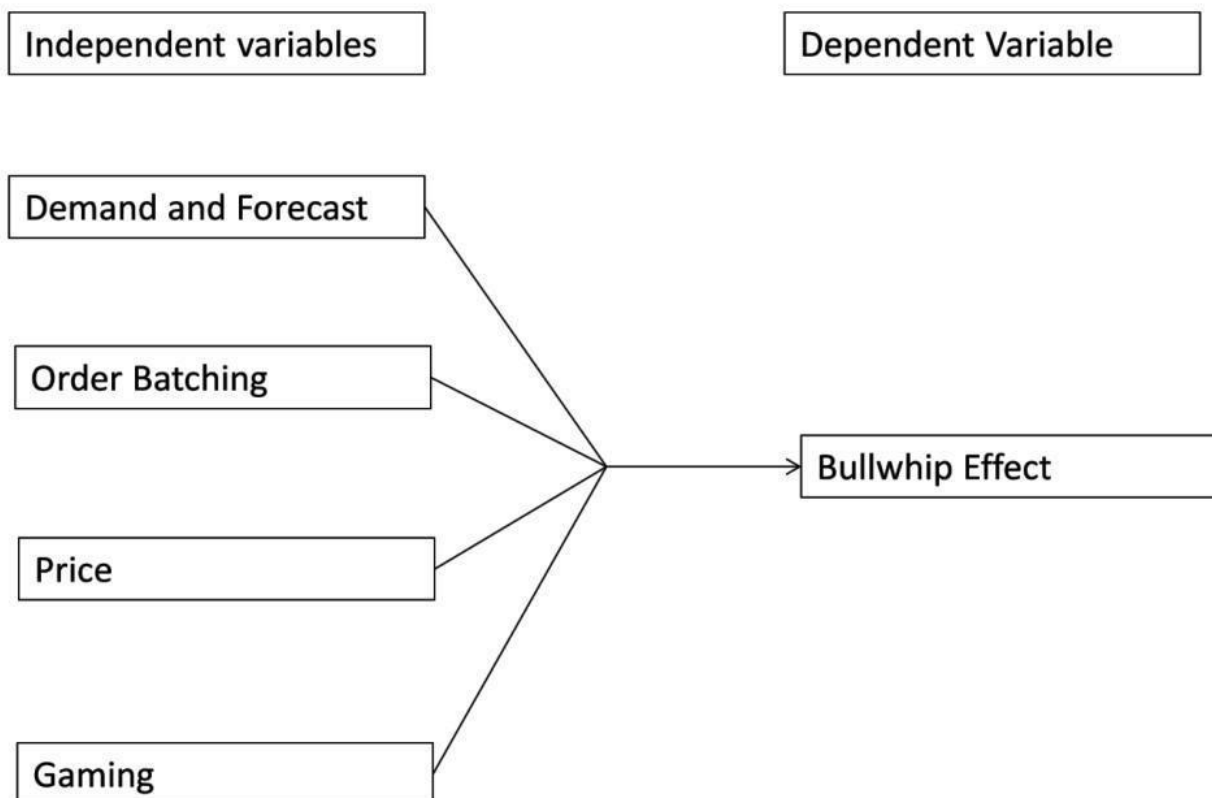
The data for our research was gathered just once, and therefore the study is cross sectional. Our study is also time bound, and may not be valid after the research period has elapsed.

3.6 Data Collection:

The data for the paper was gathered through secondary research, by going through several journals and carefully investigating the work done by the previous researchers. The whole data was also collected through the different articles examined from the store.

3.7 Theoretical Framework:

For our theoretical framework, we have identified four different independent variables that have a direct effect and are the causes of the bullwhip effect in the supply chain management. The independent variables are Demand and Forecast, Order Batching, Price and Rationing Gaming Principle. The dependent variable is the Bullwhip Effect.



4 Findings & Analysis:

Causations of the BWE can be very important in helping managers look for steps to reduce it. Some companies have started programs to address this problem and help managers look for solutions.

We will look into how some companies can tackle the four causes that can cause BWE. We have tried to categorize the different steps and solutions on the basis of the coordination mechanism.

With data sharing, demand analysis at a downstream position is transmitted upstream in a timely fashion. Channel alignment refer to the harmonization of pricing, transference, stock planning, and the equation between the upstream and downstream sites in a supply chain.

Operational efficiency denotes activities that better performance, such as lowering costs and lead-time. This is the reference we will focus on in our discussion of the bullwhip effect. Now we will focus on how to counteract the bullwhip affect caused by the four variables that we have identified in our theoretical framework.

5 Solutions

An understanding of the driving force behind consumer demand and utilization of inventory is the first step towards diminishing the BWE. The issue here is that demand is not always visible. This can, however, be countered by employing the use to Point of Sale (POS) data through common availability amongst all channel members. Then, the mutual effort of the consumer along with the supplier should be focused on providing quality information more frequently. This will enhance communication. Arrangements like Vendor Managed Inventory (VMI) can be used here as a key tool. Unnatural, periodic amplifications in demand that spike up the estimated demand graph should be eliminated. For this, batch orders need to be cut down on since high costs of ordering are attached to them. Computer Aided Ordering (CAO) and Electronic Data Interchange (EDI) are some instruments that can help make this a possibility.

Policies regarding pricing are another area that needs tactical focus when trying to eliminate the Bullwhip Effect. Strategies like discounts on transportation in relation to volume need to take a back seat because anything that motivates the customer to holdup on ordering needs to be gotten rid of. Also, finding the root cause of order reduction/cancellation and addressing it will help form dependable, predictable demand patterns. Promotional pricing that causes sudden spikes in demand can also cause a hindrance. Hence, products should be offered at prices that are reasonable and constant. Contractual relations should be formed with buyers so that buying occurs after regular periods. This will bring manufacturing; release and acquisition in sync.

Management practices regarding channel health should be without kinks so that the transition from raw-material to consumption is obstacle free. This is of grave importance because company Return on Investment (that is, its final profitability) is dependent upon this. Prospects for enhancement can be found by studying case studies and material that outlines practices that are best. Wal-Mart and Dell are excellent real-life examples of companies with lean, efficient supply chains because their cross-docking and elimination-of-middleman-through-made-to-order-manufacturing (respectively) help cut down on “fat” like the Bullwhip Effect.

A good insight into the organizational culture, policies and practices is needed to achieve the lean-supply chain dream. In many areas, restructuring will need to take place. An open mind and acceptance of change is very necessary. Organizations need to realize that the benefits of a smooth, unhindered supply chain greatly outweigh the costs of having to let go of traditional practices and legacies.

5.1 More than One Demand Forecast:

Normally every substituent in a supply chain carries out one or another type of forecasting in relation to the planning of the supply chain. That is the production; logistics etc are all estimated using some technique. BWE are given birth to when substituent's use immediate downstream data to estimate own needs. And this in turn is done by other immediate downstream substituent's who also estimated using downstream data.

One solution to this domino effect of using and estimating data like this is to make production data at a lower substituent provided in real time to a substituent at a higher point or upstream. Making use of this both substituent's can apprise their facts with the same rudimentary estimates. Looking at the computer industry despite the fact that the data is not as whole as that of the chain partners, it still shows much more information than was obtainable before when manufacturers had no idea where the products went after shipping. A lot of companies even like IBM, HP, and Apple make use of the sell-through data as fragment of their contract with resellers. Supply chain partners effectively aim to use electronic data interchange to segment data.

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In the FMCG market, EDI use has been on the increase since the 1990s when 1/5 orders by retail companies were transmitted through EDI. After 2 years the transmitted data increased to 40% and

then 60% after another 3 years. EDI usage increasing means that information transformation and sharing will increase among constituents. Still, using same source data and using it to

generate estimates, the difference in methods and buying practices can create unnecessary highs and lows in the data transmitted to the upstream sites. A more fundamental method, the upstream substituent can limit the resupply from upstream to downstream and change its data accordingly.

Another method to get a forecast would be to access the downstream constituents directly. Such as Apple has a direct to consumer program, they sell directly to end users without going through hassles such as retail and distribution. It aids them to recognize designs in demand for its numerous products. Dell also does the same thing. Lastly, like mentioned before, delay in resupply times can aggravate BWE. Reduction in variable demand due to different forecasting techniques can be done by focusing on operational efficiency. JIT or just in time can help reduce volatility due to BWE.

5.2Batch Size:

Small order batching has a direct effect on the BWE; organizations need to devise methods that will result in smaller batches, and in short more resupplying. Added to this the method explained before i.e. of forecasting techniques can help mitigate BWE. When an upstream substituent is provided data on consumption for a sporadic, inflexible plan than its down-the-stream ingredients, a surge in batch orders is impossible.

A major issue in having numerous orders is the increased costs of replenishing and placing that order. "Electronic Data Interchange" can help diminish these costs, by using EDI's organizations such as Nabisco have reduced ordering costs by decreasing paperwork etc in placing an order and have shifted to small order batches and multiple orders. P&G has been the pioneer in making standardized systems for ordering across all business units to reduce costs dramatically and cut the quantity of invoices. GE is also using EDI's to match buyers and suppliers throughout the company.

Normally every substituent in a supply chain carries out one or another type of forecasting in relation to the planning of the supply chain. That is the production; logistics etc are all estimated using some technique. BWE are given birth to when substituent's use immediate downstream data to estimate own needs. And this in turn is done by other immediate downstream substituent's who also estimated using downstream data.

Some organizations persuade their distributors to order an amalgamation of products. So a shipment may have different categories of products from the same producer instead of having a full load of the same products. So a shipment contains different type of products from a distributor rather than the same product. This in turn increases order numbers. Efficiency, however, remains unaffected since distributors receive deliveries as per schedule. Companies like P&G offer discounts to supply channel members which are open to ask for mixed “Stock Keeping Units” orders for their products. Producers produce and send assorted SKUs to warehouses owned by retailers which would then be ready to deliver to stores.

The supply chain consists of the manufacturers, suppliers and transporters, warehouses, retailers and consumers themselves. The impact of BWE is to increase manufacturing cost, inventory cost, replenishment lead time, transportation cost, labour cost for shipping and receiving, cost for building surplus capacity and holding surplus inventories, and to decrease level of product availability and relationship across the supply chain.

The objective of the study is to point out the major reasons of the Bullwhip effect in supply chain and propose solutions which would reduce the effect across the network.

In the end the study concludes that learning the underlying causes and relations between the different levels in the supply chain is important to nullify the impact of the BWE on the supply chain.

In a similar manner a logistics company not related with companies can use this system to get to customers who are not competitors, such as a neighbouring store. If this method is used to replenish stores, then each customer can shift to daily resupplying. For a store that has low volume of sales this is a boon. Some wholesalers receive full shipments from producers and ship mixed shipments to retailers using logistics companies.

"Composite distribution" for fresh produce and frozen items make use of the same mixed-SKU concept to make resupply more regularly. Factoring in that such items have to be transported at different temperatures, trucks to transport them need to accommodate them accordingly. Keeping this in mind it is a common practice to use NFC for logistics in the United Kingdom, by Tesco and Sainsbury. Due to the awareness of the ECR initiative in the grocery industry, it won't be long before third party companies are handling the logistics and supply chain of these manufacturers.

P&G also uses a method that reduces negative effects of order batching. By coordinating with retailers they even out the replenishment appointments and hence even out the resupply over time. In this way all replenishments are spread over to other retailers over the week.

5.3 Prices:

As described before the BWE can be lessened by reducing frequency and level of discounting, which are caused by forward buying and diversions. Forward buying can be decreased by having in place a uniform wholesale policy. Huge players such as P&G, Kraft and Pillsbury in the grocery manufacturing make use of the strategy to an common low price or value pricing strategy. This is why over the past few years P&G has successfully managed to reduce its prices by 12 percent as well as During the past three years, P&G has reduced its list prices by 12 percent to 24 percent and greatly slashing the promotions they offers to trade customers. Just by doing so P&G reported its highest profit margins in twenty-one years and showed increases in market share. In addition to these, a provider can also negotiate with suppliers to have low cost at a daily basis.

The viewpoint of operations and practices i.e. CRP combines with a wholesale policy on pricing can be used to control tactics used by retailers such as diversion etc. Using practices like CAO for ordering can also minimize such practices.

ABC costing can also help organizations to see the high costs of forward buying and diversions. In a promotion in any region by any company most retail companies buy in bulk and divert to other regions where promotions are not being held. These cost albeit high, may not be easy to recognize in traditional systems of accounting. ABC costing can show in detail the burden of inventory, storage, special handling, premium transportation and others that in other systems may remain hidden and exceed the advantages of promotions. It can be concluded then that ABC has assisted other companies to acknowledge and realize the advantages of EDLP.

5.4 “Gaming”:

In cases of shortage face by a supplier, rather than allocating product percentage based on orders, it can allocate it to past sales records. Therefore the end user will have no use of exaggerating an order. GM has used this method since the past many years, and companies like HP and TI are slowly shifting to it.

Gaming during shortages is at maximum when end user has no information or little to none on a supplier’s situation. Capacity and inventory information helps to increase end users anxiousness and helps reduce their incentive to indulge in gaming. But sharing capacity information cannot be used when there is a real shortage. Some producers work with end users to help them place orders in advance of the peak season. Hence this helps them to adjust scheduling and increase or decrease capacity with an increased knowledge of demand.

In conclusion an exaggerated return policy will increase gaming by the end user. If there is no penalty, then a retail company will inflate its order and return the unused inventory. Unsurprisingly some corporations in the computer manufacturing industry have caught on to these tactics and have stringent policies in place to reduce gaming.

6 Future Research

This research opens paths to numerous other areas for research. Numerous paths of research can arise from our research. Renowned researchers have pointed towards an assortment of reasons behind supply chain variability that go beyond common factors like demand discrepancy and manufacturing releases.

Various hybrids of strategies can be formed and studied to find the technique that best fits the purpose of a particular supply chain. Different lag times, costs of inventory holding and cross docking can be explored further as well as delays in custom.

It needs to be understood that there is no one recipe for success. What works for one supply chain may not work for another. No change in a single metric can guarantee that the Bullwhip Effect will be eliminated.

Variability boosts costs and lowers customer satisfaction. But, dilemmas like the need for custom inventory levels to satisfy some customers who are several levels ahead of the manufacturer also exist. It is hence a daunting task for the Supply Chain Manager to strategize in a way that incorporates all these elements. Success will only be possible if the manager knows where and how much variability their channel can withhold.

7 Conclusion:

BWE is a time consuming and causes inefficiencies and occurs due to a lack of coordination and information between supply chain constituents. In simple terms BWE is safety stock for hard times or a backup for a backup; because suppliers retain stock more than the required for their retailers and retailers hold more than extra for their customers. Hence suppliers need to backup the retailer's backup.

In places and supply chains where information is not communicated to all members of the supply chain, there might be a greater impact on the safety stock and may cause more costs to be incurred. In business terms the inefficiency is found in the backup stocks that would also result in quality complaints, high material costs, shipping and overtime expenses as well as storage costs. The worst possible case is that the business suffers in quality and control. To operate a smooth flowing supply chain is to mitigate and in the end reduce the BWE. Otherwise the costs of the supply chain might well go to high.

BWE was studied and its causes across the levels in the supply chain and also highlighted which steps and things could be used to mitigate the BWE. These steps offer a new approach to tackle the BWE and other problems in the supply chain.

The Forrester effect can be achieved from balanced decision making by associates in the supply chain. Companies can successfully offset the effect by methodically understanding its underlying reasons. Leader of the Industry such as Procter & Gamble are implementing creative strategies which pose new trials: assimilating new data systems, defining new organizational associations, and applying new enticement and measurement classifications. The choice which the companies have is very straight: either let the forrester effect paralyze you or find a method to master it.

In summary, it is concluded that the use of the Bullwhip Effect Index to categorize the variability of a Supply Chain is only a baby step forward in the world of process control and improvement. Customer desires, like always, need to be in eternal balance with organizational and channel costs. Mitigation of the Bullwhip Effect is definitely a step in the right direction but it is insufficient if we look at the bigger picture. Dynamic consumer demands is a diverse universe that the acumen of the Bullwhip Effect can not entirely encompass

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