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# From Demand to Distortion: Unraveling the Bullwhip Effect in Indian Supply Chains

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**ABSTRACT**

The bullwhip effect is a significant issue in supply chain management and it impacts the supply of goods from manufacturer to the end consumer. This effect occurs when a small shift in market demand causes a greater variation in orders at the various supply chain nodes (retailer, wholesaler, distributor, manufacturer and supplier). To put it simply, when the real market demand is not communicated well with all members of the supply chain, each player in the chain starts taking decisions on assumptions resulting in over-ordering or under-ordering. This results in over-stock, stock-out, shipment delay, higher cost of operation and unsatisfactory customer service. The Indian supply chain is huge and multifaceted with industries such as FMCG, farm sector, medicines, automobiles, e-commerce, and retail. The presence of several middlemen, long distance transportation networks, uneven demand across regions, celebration of festivals, transportation infrastructure issues and unexpected market fluctuations aggravate the bullwhip effect in the Indian supply chain. The issue was prominent during the COVID-19 pandemic when panic buying, scarcity of products and transportation issues disrupted business activities. This research paper aims to explore the reasons behind the bullwhip effect in the Indian supply chain and to suggest methods to control the effect. The research is conducted using secondary data from journals, books, reports and recent case studies of companies. The research reveals that inaccurate demand prediction, order batching, promotional schemes, lack of communication, shortage gaming, and long lead time are the key causes of the bullwhip effect. It also proposes that improved forecasting techniques, real-time information communication, ERP systems, collaborative planning and IT can assist enterprises to reduce demand variability, and enhance supply chain performance in India.

**Keywords:** Bullwhip Effect, Supply Chain Management, Demand Forecasting, Inventory Management.

## Introduction

In the current business scenario, supply chain management is a critical function for all organisations. Supply chain is a process from procurement of raw materials to delivery of finished products to the end customer. This includes procuring raw materials, manufacturing, holding inventory, transporting and storing products, distribution and delivery. Efficiency in supply chain allows companies to cut cost, enhance service, and meet the customers' needs. However, if the supply chain is not well coordinated, it

leads to delays, waste, excessive inventory cost, and missed business opportunities. So, today companies attach great significance to the efficiency of their supply chains.

The bullwhip effect is one of the common challenges faced by global supply chains. This is the phenomenon where a small variation in demand from the customer causing larger variations in orders in the upper echelons of the supply chain. The term was popularised by Lee, Padmanabhan and Whang (1997) who explained that as information flows from customer to retailer, retailer to wholesaler, wholesaler to manufacturer, and manufacturer to supplier, the demand signal gets distorted. As a result, the members of the supply chain respond in different ways, and typically order more or less than needed.

Let's say the actual increase in demand for packaged milk by final customers is 5%. The retailer may interpret the demand as increasing and increase the order to the distributor by 10%. The distributor may order 15% or 20% more to be safe. The manufacturer may then increase production. Eventually, raw materials suppliers may buy more components. This results in excess inventory, warehouse storage, transportation and production. Likewise, if there is a sudden drop in demand, the company may have excess stock.

The bullwhip effect can be the result of inaccurate demand prediction, order batching, marketing promotions, price fluctuations, long lead time and poor communication between supply chain partners. In many companies, each stage of the supply chain considers only the customer orders and makes decisions based on them. So the actual market demand is masked and incorrect planning is made. The best way to manage this issue, as per the supply chain experts Chopra and Meindl, is by the timely and accurate exchange of information between all members of the supply chain.

The problem is very pertinent in India. India has a vast and intricate supply chain. These include manufacturers, wholesalers, transporters, warehouses, distributors, retail stores (kirana), supermarkets, e-commerce retailers, and millions of consumers in rural & urban regions. In India, demand is driven by income, culture, festivals, seasons, weather, and geographical preferences. For instance, demand for confectionery, processed food, clothing, and other consumer items rise during Diwali, Eid, Holi and wedding seasons. Demand for cool drinks, fans, and air conditioners increases during summer, whereas agriculture supply chain and transportation is impacted by monsoon.

Apart from these factors, India also suffers from supply chain-related issues such as road traffic, port congestion, reliance on railways, fuel prices, and inadequate warehousing infrastructure in certain parts of the country. This adds to the lead time and uncertainty, thus contributing to the bullwhip effect. This was the case in India during the COVID-19 pandemic. The rush to stock up groceries, medicines, sanitizers and masks led to a spike in demand. Meanwhile, supply was impacted by lockdowns and restricted transport. This led to product shortages and, later, excesses.

This is a common problem faced by many industries in India such as FMCG, pharmaceutical, automobile, agriculture, electronics and e-commerce. For instance, car manufacturers had a lack of semiconductors, online retailers had problems with warehouse management during the sales season, and farmers had price fluctuations as a result of lack of timely market information. This demonstrates that the bullwhip effect is not just theoretical but real.

This study explores the bullwhip effect in Indian supply chains, its main drivers, effects on business practices, and how to control it. The paper also provides recent examples from the industry along with the use of IT tools and techniques such as enterprise resource planning (ERP), forecasting using artificial intelligence (AI), tracking using internet of things (IoT) and collaborative planning to stabilise the supply

chain. This is an important concept for managers, students and policy makers as managing the bullwhip effect can lead to increased efficiency, reduced costs and a more resilient supply chain system in India.

**Literature Review**

Research into the Bullwhip Effect continues to be an important focus area for Supply Chain Management due to its substantial influence on operational performance and cost control. This phenomenon was originally introduced by Jay W. Forrester (1958) through his Industrial Dynamics work which showed how delays in Information Flow and Feedback Loops would cause fluctuations in Production Levels and Inventory. Subsequently, Hau L. Lee et al., (1997), provided formal definitions for the bullwhip effect and outlined its primary contributing factors. These included Demand Signal Processing; Order Batching; Price Fluctuations; and Shortage Gaming.

Following this, there have been many other studies conducted to expand upon these initial findings. One example includes the study done by Chen, Drezner & Ryan (2000). They were able to show that inaccurate demand forecasts are one of the most common contributors to the magnification of demand. Additionally, they demonstrated that companies who rely primarily on limited historical data will typically overestimate or underestimate demand resulting in inefficiencies throughout their entire supply chain. Similar to the findings of Chen, Drezner & Ryan (2000); Geary, Disney & Towill (2006) determined that the lack of coordination among supply chain participants and inadequate communication regarding information exchange greatly increases the variability of orders within the supply chain.

The role of technology in addressing the bullwhip effect has been another focus area of interest for researchers. Cao & Zhang (2011) discussed how information technology (IT) and enterprise resource planning (ERP) systems improve coordination of suppliers, customers, etc. as well as reduce uncertainty. Further, Kumar & Putnam (2008) discussed that promotions and/or purchasing large quantities of products creates distorted demand signals in particular in the consumer goods industry.

Moreover, Gaur, Fisher & Raman (2005) emphasized that complex supply chains and long lead times significantly amplify the bullwhip effect. Their study suggested that shortening lead times and increasing demand visibility will help to significantly reduce variability of supply chain operations. Furthermore, Sodhi & Tang (2012) mentioned that global supply chains, particularly those in emerging markets, are generally more susceptible to variability in demand due to infrastructure issues and numerous middlemen involved in the supply chain process.

Additionally, in India, the bullwhip effect is extremely prevalent because of the country's diverse and fractured nature of its supply chain. According to Chakraborty & Chan (2011), the pharmaceutical sector in India is plagued by a lack of visibility of demand and less than adequate logistics networks which results in misalignment between inventory levels at different points of the supply chain. Further, Sheffi (2015), stated that externalities such as natural disasters and global health crises compound the volatility of supply chains.

There has been an abundance of documentation about the COVID-19 pandemic and its effects on supply chains. Specifically, Raut, Gardas & Narkhede (2020) pointed out that the increased demand caused by fear based shopping and supply shortages resulted in extreme amplification of demand for fast moving consumer goods (FMCGs) and healthcare items. More recently, research by Giri & Sarker (2021), and Singh & Singh (2022), have shown that advancements in technology such as Artificial Intelligence (AI), Internet of Things (IoT), Cloud Based Systems etc. provide greater ability to mitigate the bullwhip effect by providing greater clarity around forecasting accuracy and visibility into supply chain operations.

Generally speaking, while traditional sources of the bullwhip effect continue to exist (i.e. demand forecast error and batch size), modern day challenges include adapting to new technologies, constraints associated with developing infrastructure in emerging markets, and global disruption events. Therefore, effective mitigation requires a combination of strategic coordination among stakeholders, integration of technology to facilitate better coordination/visibility within the supply chain, and real time sharing of information.

There are four theoretical foundations upon which the bullwhip effect in supply chain management exists. Each of these theories addresses how information distortion, behavioral issues, and system dynamics create demand variation throughout the supply chain. Thus, the foundation for the bullwhip effect lies in each of these areas.

Firstly, Information Processing Theory by Jay R. Galbraith (1977), suggests that organizations are only able to process a certain volume of information per unit of time. Therefore, if an organization requires more information than it can effectively process, then the likelihood of making poor decisions increases. Additionally, in supply chains there are numerous organizational entities involved; including retailers, wholesalers and manufacturers. Each entity relies on similar types of information regarding demand to be able to develop strategies that will support the development of products or services. However, in many cases, the information used is either delayed, inaccurate, and/or unavailable at the point-of-sale.

Therefore, the limitations in processing and availability of information creates over-compensations with regard to decision-making. For example, when demand data is unclear, a retailer may place additional orders so as to have a buffer against potential shortfalls in the future. When this distorted data is passed through the supply chain, each subsequent level (upstream) of supply chain members further magnify the variability experienced by the original ordering process. This phenomenon is referred to as the “bull-whip” effect. The key elements of Galbraith's theory focus on providing real-time data to facilitate improved communication among supply chain participants. Real-time data facilitates faster decision-making that reduces uncertainty.

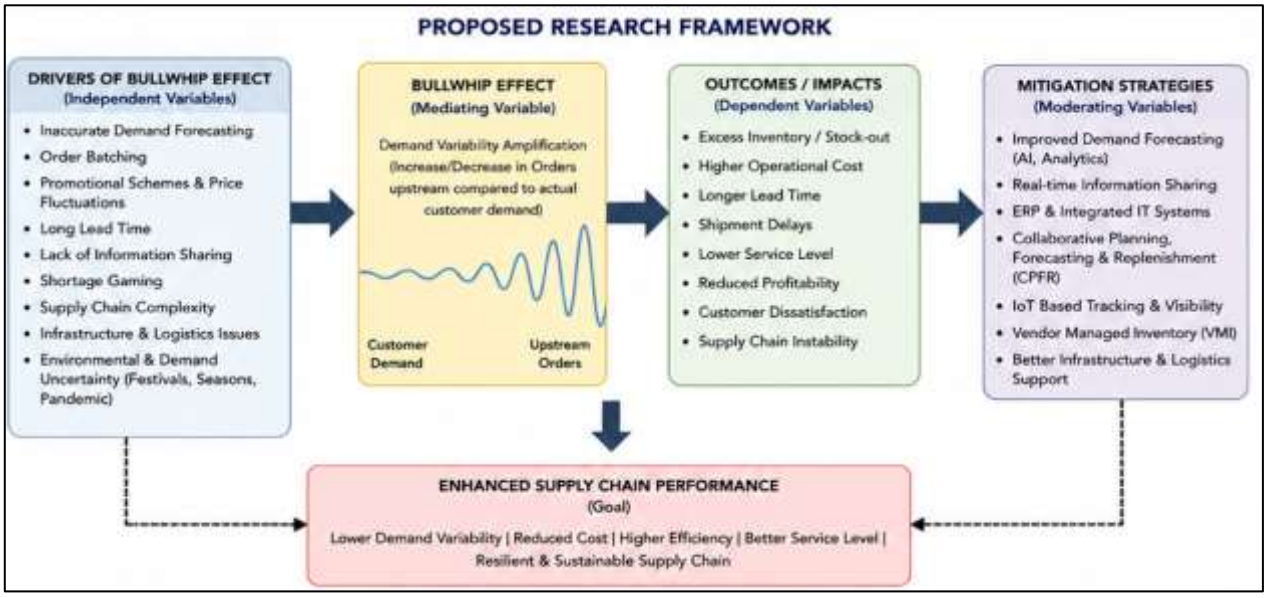
Secondly, Systems Theory was first developed by Ludwig von Bertalanffy (1968). Systems theory considers an organization as an interconnected and interdependent collection of subsystems. With respect to Supply Chain Management, the entire supply chain (from supplier to customer) is viewed as a single system. Actions taken at one level impact the operation of other parts of the system. This concept of Systems Theory provides insight into the bullwhip effect. Small changes in customer demand can cause large changes in downstream activities (e.g., production, inventory levels) as each level of activity reacts to its immediate environment. Each level does not consider the total effect of those activities on other levels. Therefore, the Systems Theory supports the use of integrated decision-making processes across all supply chain partners to reduce variability and enhance overall performance.

Thirdly, Agency Theory was established by Michael C. Jensen and William H. Meckling (1976). Agency Theory examines relationships between principals (those who own) and agents (the managers and intermediaries). It also identifies the problem of conflicting interests and lack of alignment between individuals in an agency relationship leading to inefficient operations and opportunistic behavior.

Each player in a supply chain (retailers, distributors, manufacturers) act in his best interest rather than seeking maximum performance from the entire supply chain. An example of such behavior includes retailers using shortage gaming practices. Shortage gaming occurs when retailers purchase excess product during periods of low availability with the intent of having a higher quantity available should another period arise in which product is scarce. Similarly, manufacturers offer incentives (bulk pricing) to encourage order batching. Both types of behavior distort true demand signals and contribute to increased

variability. Agency Theory therefore provides a behavioral explanation for the bullwhip effect and recommends solutions that include aligned incentives and contracts along with cooperative planning efforts to resolve differences and improve coordination.

Fourthly, Information Asymmetry Theory, formulated by George Akerlof (1970), asserts that inefficiencies exist when one party in a transaction possesses more or better quality information than the other. In Supply Chains, various stakeholders typically have different degrees of access to demand related information (inventory status, market conditions, etc.). Retailers have direct exposure to customer demand whereas Manufacturers receive demand data indirectly via intermediary orders. The difference in access to information creates misunderstandings and reactions beyond the intended scope. Consequently, when upstream participants do not receive current and complete information about actual demand they react to incomplete/biased data by placing exaggerated orders. The differing levels of information possessed by participants contribute substantially to the bullwhip effect.




An understanding of the theoretical basis for this study will be developed from an analysis of four interrelated concepts: independent variables, mediating variable, dependent variables, and moderating variables. Each concept has its own significance in illustrating the development, transmission and reduction of demand variability in the supply chain. Independent variables (factors driving the bullwhip effect) illustrate the major causal elements that create demand distortions in the supply chain. They affect the occurrence and degree of the bullwhip effect.

Demand forecasts are a highly significant driver of inaccuracies in demand predictions. Firms use limited or out-of-date data to predict demand. Jay r. Galbraith's Information Processing Theory (galbraith 1977) describes an organization's inability to deal effectively with complex information, which results in errors when making decisions related to forecasting. Order batching is another important element creating artificial peaks and troughs in demand. Companies implement batch orders to minimize their costs associated with placing orders; however, these artificial peaks and troughs result in increased volatility in demand. Price fluctuations, promotions (e.g., discounts and seasonal offerings), and other incentives cause customers to purchase in greater quantities than would normally be required to satisfy their needs. Demand volatility occurs because of these purchases. Lead time also contributes to uncertainty, as there is a delay

in receiving products after they are ordered. As a result, it becomes increasingly difficult to assess and respond to actual demand. Lack of communication among all stakeholders within the supply chain contributes to decentralized decision-making practices, whereby each party makes decisions based upon localized knowledge rather than an assessment of total demand across the system. Shortages artificially increase demand. Behaviorally, shortages can cause parties involved in the supply chain to act uncooperatively. Michael C. Jensen and William Meckling's Agency Theory (jensen & meckling 1976) illustrates the interests of various stakeholders competing against One another within the supply chain. Supply chain complexity, infrastructure problems, logistics difficulties, and demand uncertainty (due to events such as festivals, seasonality, or pandemics) add additional variability to the system. All of these factors fall under the umbrella of Ludwig von Bertalanffy's Systems Theory (von bertalanffy, 1968). Disturbances at One point in the system may spread to other points in the same system.

Mediating variable (bullwhip effect) the bullwhip effect functions as a mediator i.e., it demonstrates how independent variables lead to supply chain outputs. It describes how demand variability increases as information travels up the supply chain. Poor forecasting, order batching and lack of coordination lead to distorted signal demands. This distorted demand is transmitted along the supply chain causing an exaggeration of ordering patterns. George Akerlof's Information Asymmetry Theory (Akerlof, 1970) is the most effective theory demonstrating why information asymmetries cause inefficiencies and incorrect interpretations of demand signals. Therefore, the bullwhip effect is the main connecting force between causals (the independent variables) and consequences (the dependent variables).

Dependent variables (supply chain outcomes) illustrate the final outcome of the bullwhip effect on supply chain effectiveness. Excess inventory or stockouts are typical end results of under-forecasted or over-forecasted demand. Excess inventory and stockout conditions increase operational costs e.g., storage cost, handling cost, shipping cost. Long lead times and shipment delays often occur as a consequence of fluctuation in orders affecting manufacturing and delivery schedules. Reduced service level occurs because of difficulty providing accurate customer service. Customer dissatisfaction and loss of trust occurs because of unreliability in meeting customer expectations. Reduced profit margins arise from inefficient operations and waste; reduced stability in supply chains reduces likelihood of disruption. Systems theory supports these outcomes. Systemic inefficiencies can propagate through the entire supply chain resulting in decreased overall performance.

Moderating variables (strategies reducing variability) describe how strong or weak relationships exist between independent variables and the bullwhip effect. These are strategies to reduce variability in demand and promote coordination among supply chain entities. Use of advanced forecasting techniques utilizing AI or analytical tools improve forecast accuracy and decrease uncertainty. Real-time information exchange improves clarity regarding potential distortion in demand signals thereby minimizing distortion in demand signals illustrated by Information

Processing Theory Technology utilized by supply chain entities including enterprise resource planning (ERP) and integrated it systems promote coordination among supply chain partners. Collaborative Planning, Forecasting, and replenishment (cpfr) enables supply chain partners to engage in collaborative planning processes reducing conflict described by Agency Theory.

Internet of things (IoT)-based tracking systems provide increased visibility into inventory and shipments. Vendor Managed Inventory (VMI) provides increased alignment by shifting inventory management responsibilities to suppliers. Infrastructure improvement and logistical improvement reduce lead times and operational inefficiency. In conclusion, the conceptual model presents independent variables generating

distortion in demand, which is mediated by the bullwhip effect producing adverse outcomes for supply chain entities. Furthermore, moderating variables such as technological advancements, cooperation among supply chain entities and infrastructure improvements greatly reduce the negative aspects of these phenomena resulting in improved performance of supply chains.

**Objective of the research**

1. To determine what are the main causes of the bullwhip effect with regard to errors in demand forecasts; batch orders; price volatility; and the inability of firms to share information regarding their orders.
2. To analyze how the variance of demand and distortions of information may amplify the bullwhip effect at all phases of the supply chain.
3. To investigate how supply chain complexity, physical limitations within supply chains, and demand uncertainty (i.e., seasonal/festival demands), will affect the magnitude of the bullwhip effect in India.
4. To examine the role that the bullwhip effect plays as an intermediary between supply chain drivers and performance outcomes.
5. To assess whether or not modern strategies used to mitigate the bullwhip effect (e.g., advanced forecasting models; real-time sharing of information; use of enterprise resource planning systems; and collaborative planning) can reduce variability in demand.
6. To research the potential of emerging technologies (e.g., AI; IoT) to improve transparency and coordination within supply chains.
7. To create a new model for minimizing the bullwhip effect while increasing total supply chain productivity and resiliency.

**Research methodology**

The research methodology adopted for this study was a combination of a Descriptive Design and an Analytical Research Design. a descriptive design was applied to systematically describe the major drivers of demand volatility, i.e., inaccurate forecasts of demand; order batching; pricing volatility; and lack of transparency with respect to information sharing among stakeholders. a descriptive design will be able to provide insight into the effects that the bullwhip effect has upon the overall performance of the supply chain, specifically through increased inventory levels and cost of operations and decreased customer satisfaction. An analytical research design was used to analyze the inter-relationships between the various variables identified by the researcher. the study analyzed how independent variables (drivers of the bullwhip effect) affected the mediating variable (bullwhip effect), which in turn influenced dependent variables (performance indicators of the supply chain). This analytical research design provided an opportunity to understand the causal relationship between variables in the supply chain system.

The research methodology for this study was mainly secondary data and included articles and reports from credible resources such as peer reviewed academic journal articles, books, industry reports, and case studies. the use of secondary data allowed researchers to obtain a broad and well-researched understanding of the concept across multiple industries including FMCG, E-commerce, and Pharmaceuticals. The main purpose of using this research methodology was that it enabled a detailed descriptive and critical evaluation of a specific issue affecting a supply chain system without the necessity of collecting large amounts of primary data. therefore, it was considered especially suitable for conceptual or exploratory research studies whose purpose is to create a theoretical model and develop practical application.

**Result and Conclusion**

The study's results provide clear evidence of the bullwhip effect being an important issue for Indian supply chains. There are five important themes that have been developed from analyzing secondary data and industry-specific examples: Demand variability has a disproportionate impact on upstream supply chain activities. A relatively small increase in consumer demand around 10-15% has resulted in larger increases in distributors' orders 45-90%; this finding validates the earlier research conducted by Hau L. Lee et al. (1997) in identifying demand signal distortion as the primary reason for the bullwhip effect. Forecasting inaccuracies and promotional activities have played a large role in contributing to demand amplification. For example, during festival periods (i.e. Diwali and Holi) actual sales may experience moderate growth while order placement grows significantly ahead of sales stabilization resulting in post-festival overstocking; these findings validate other earlier studies highlighting forecasting errors and price volatility as two major drivers of the bullwhip effect (Lee et al., 1997).

There appears to be a positive correlation between lead time and safety stocks required. In addition, increasing the lead time from 2 days to 8 days greatly increases the amount of safety stock needed; these findings illustrate many of the structural issues in India (transportation delay, infrastructure constraint and general supply chain inefficiency) and support the Systems Theory principles illustrating how delays in one section of a system affect the whole supply chain. Revenue trends and market behavior indicate that revenues at companies such as Hindustan Unilever have remained stable yet have experienced moderate growth. However, under such revenue trend conditions, supply chain partners typically over-order because they do not know what future demand will look like and/or future prices. These behaviors exemplify some of the key tenets of Agency Theory; specifically, Agency Theory assumes that each actor makes decisions solely based upon their own interests (profit maximization) without consideration for how those decisions ultimately affect the total effectiveness of the overall system. The bullwhip effect exists throughout various industries within India. While each industry (FMCG, agricultural, pharmaceuticals, automotive and e-commerce) presents its own unique set of challenges (seasonal demand, supply shortages, logistics constraints etc.), each faces similar demands variability and a lack of coordination and communication among supply chain partners.

Modern technology (ERP systems, Artificial Intelligence [AI], Internet of Things [IoT]) represents a number of opportunities to significantly enhance demand forecasting accuracy and supply chain transparency. Enhanced information sharing via real-time reporting and collaborative planning represent potential methods to reduce uncertainty and facilitate alignment among supply chain partners. These findings support Chopra & Meindl (2016) who identify coordination and information sharing as essential elements to mitigate the effects of the bullwhip effect.

The study has demonstrated that the bullwhip effect represents a critical challenge facing Indian supply chains. The bullwhip effect was found to be caused primarily by behavioral (forecasting errors and promotional schemes) and structural factors (long lead times and lack of information sharing). Furthermore, the bullwhip effect creates severe consequences, including excessive inventory build-up, stock shortages, higher operational costs, longer delivery lead times, and lower customer satisfaction.

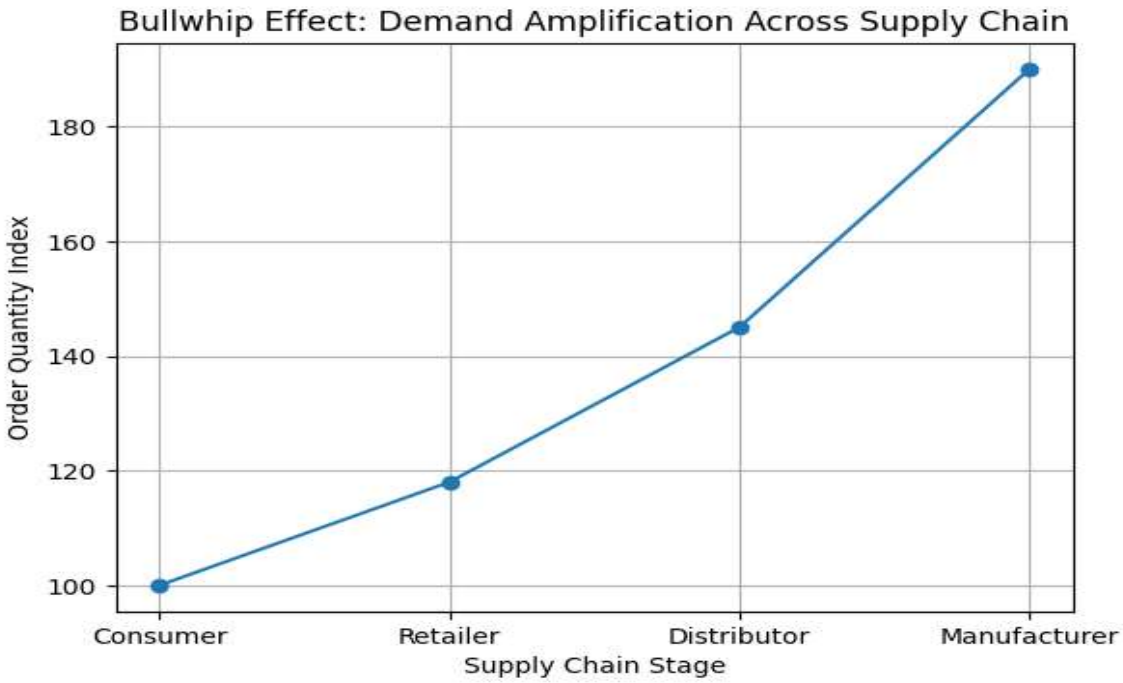
Additionally, the complexity of Indian supply chains characterized by geographic diversity, seasonal demand patterns, and infrastructural constraints exacerbates the bullwhip effect. Therefore, the study has confirmed that the bullwhip effect is not simply a theoretical construct but represents a practical challenge confronting numerous industries. However, the study has shown that the bullwhip effect can be mitigated through appropriate strategies. Better demand forecasting through the use of advanced analytical tools;

real-time information sharing; the adoption of Enterprise Resource Planning (ERP) systems; and collaborative planning among supply chain partners can all assist in reducing demand distortion. Moreover, recent technological advancements (Artificial Intelligence [AI] and Internet of Things [IoT]) can further enhance supply chain transparency and responsiveness. Therefore, organizations need to develop integrated and technologically sophisticated supply chains to reduce variability and increase efficiencies. Finally, policymakers and managers need to concentrate efforts on developing India's physical and digital infrastructure as well as coordination mechanisms to develop a more robust supply chain environment in India.

**Discussion**

**Bullwhip Effect:** Demand amplification along a supply chain Analysis goes up through the supply chain beginning at consumers and moving towards manufacturers there is a direct upward trend in the quantity ordered. Retailers increased their orders by 18 percent. Distributors increased theirs by 45% and the manufacturer's production rose 90% it reflects that demonstrate the Bullwhip Effect. A minor change in consumer demand will cause bigger changes further back down the line in the supply chain. Thus, this data supports the findings of Hau L. Lee et al. (1997) that supply chains have issues related to demand signal distortion. Small fluctuations in consumer demand are magnified at each level in the supply chain because of distortions of the original demand signal caused by delayed communication, a lack of coordination and the independent decisions made by individual participants in the supply chain. Companies tend to increase their inventory levels by adding "safety stocks" to prevent stockout situations. These increased inventory levels then amplify the distorted demand signal. The findings illustrated above confirm that if all participants in the supply chain do not communicate properly with one another; variability will grow exponentially instead of proportionally. This supports the conclusions of Hau L. Lee, V. Padmanabhan and S. Whang (1997) who identified "Demand Signal Processing" as the key factor resulting in the bullwhip effect.

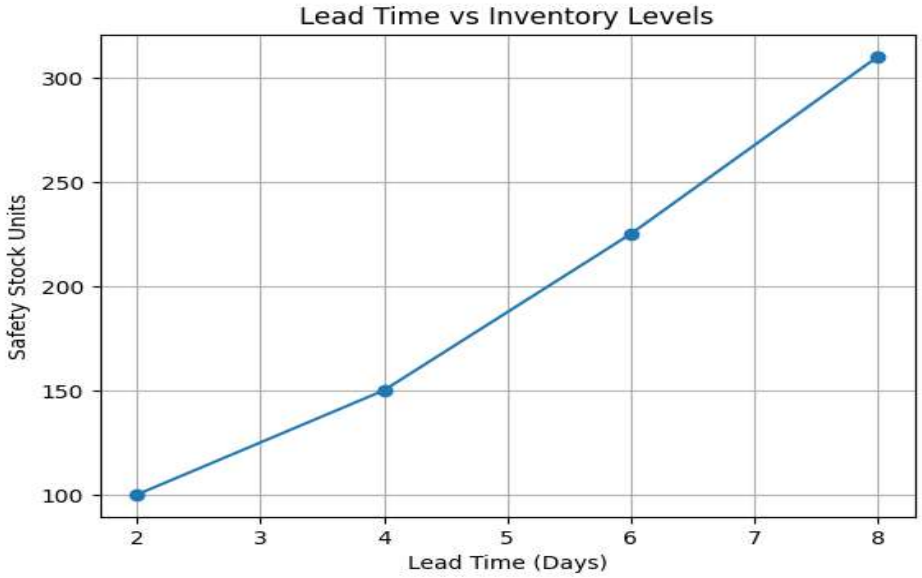
**Fig. 1: Bullwhip Effect: Demand Amplification Across Supply Chain**



**Lead Times Compared to Stocking Requirements:** As lead time goes up (from 2 to 8 days) so does the amount of product that needs to be stocked (increases from 100 to 310 units). There is an obvious direct correlation between lead time and required inventory. Increased lead times create greater uncertainty for the manufacturer resulting in increased amounts of product needing to be held as "safety" or reserve stock. Therefore, manufacturers are forced to hold additional stock in anticipation of possible stock out situations. Increased inventory results in increased storage/holding costs and creates inefficient use of resources within the organization. The reason longer leads times result in greater uncertainty in fulfilling demand is that firms will stockpile to mitigate this uncertainty at the expense of their operational efficiencies and increased holding costs. The lengthened lead times due to the constraints of India's infrastructure (transportation, etc.) reduce the operational efficiency of the firm's distribution network, thus increasing its total cost.

This can be explained from an academic point-of-view using Systems Theory. Systems Theory explains how if there are delays in one area of the systems, it creates ripples throughout the whole supply chain. Therefore, the best way for a company to minimize its inventory costs while creating stable operations is to reduce its lead times.

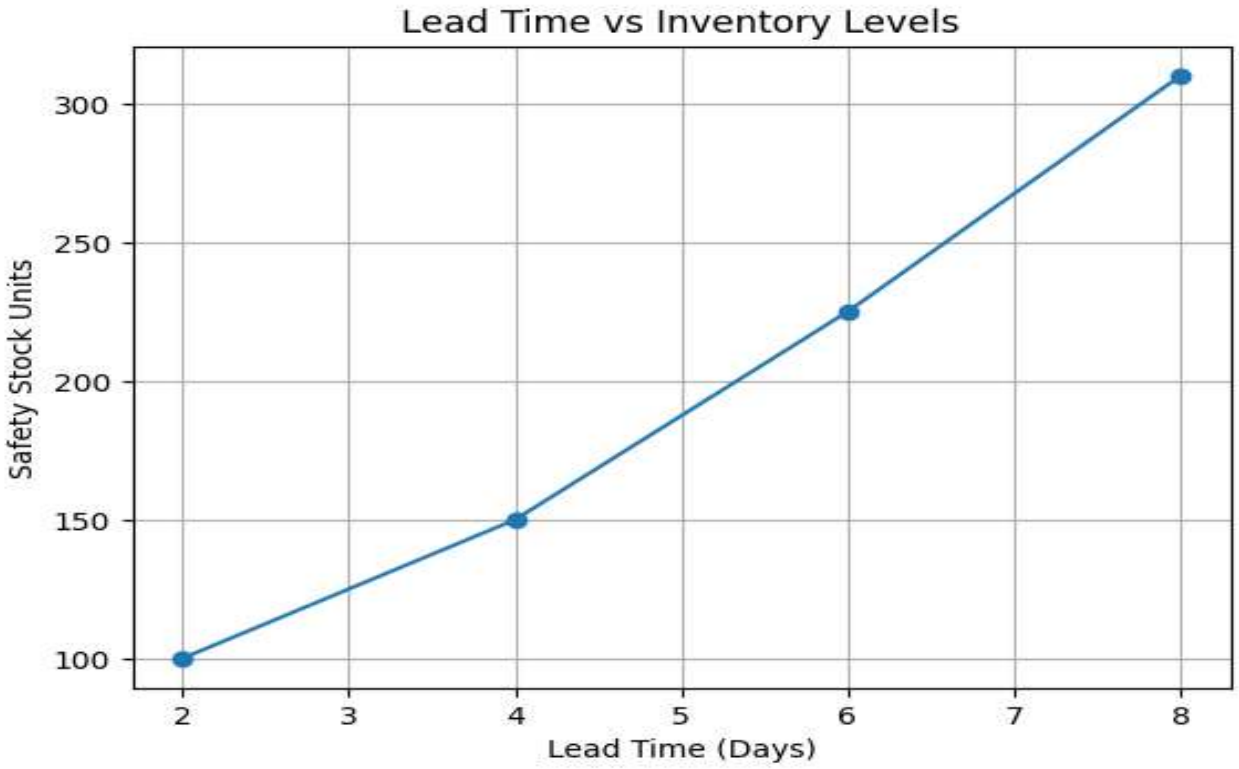
**Fig 2: Lead time vs Inventory levels**




**Impact of Promotional Activities on Demand Disruption:** This chart illustrates a comparison of the number of orders received at a particular time versus the number of items sold during a month. Although actual sales trended up from 100 to 125 units, an order for approximately 180 units was received in October. Anticipation and speculation by consumers resulting in over ordering because of promotional events and seasonal demand, as well as excessive inventory after the peak period. The data illustrate how fluctuations in pricing or promotion result in the bull whip effect. The evidence suggests that promotional and discounting methods cause artificially inflated demand for products. Distributors and retailers will also increase their orders based on an expectation of higher demand (due to anticipated increases in prices) due to expected high levels of demand during a promotion. Once the promotional campaign has ended, the product's demand should revert back to its pre-promotion level; however, this usually results in distributors and retailers having too many items in stock. This is an excellent example of how market distortions can be created through pricing and marketing practices. As a result, this is further proof that

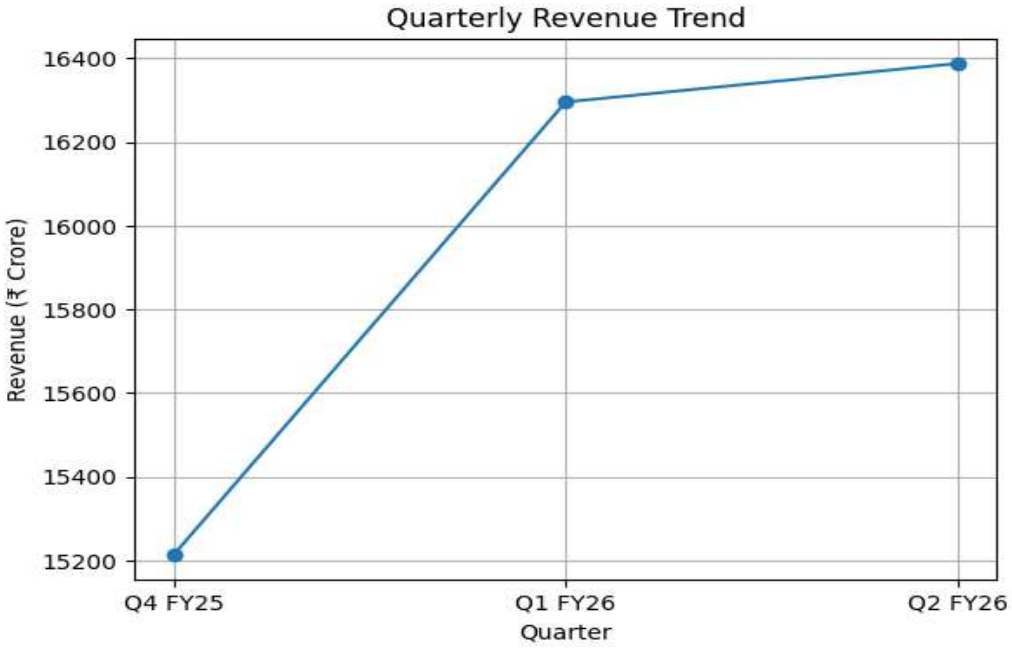
promotions are among the most influential causes of the bullwhip effect. These mismatches create inefficiencies in both distribution channels (i.e., excessive stocking and waste).

**Fig 3: Lead time vs inventory levels**




**Trends for Quarterly Revenues and Variations in Demand:** The graph of revenues show a consistent upward trend in quarterly revenues from Q4 FY25 at ₹15,214 cr. to Q2 FY26 at ₹16,388 cr. Therefore, while there is a positive increase in market performance, it appears that the market has shown modest, yet constant improvement. While the revenue increase demonstrates a consistent pattern, when demand has an upswing, firms typically have an immediate reaction with increasing production. In most cases this will result in excessive stockpiling. The way that firms react to demand changes is due to their reactions to uncertainty; therefore, Agency theory applies as well, because supply chain participants make decisions primarily based on their expectations as opposed to real-time demand. These changes in sales volume cause decision making at every level of the supply chain. When firms see an increase in sales volume for one period, they believe that this is what the sales will look like going forward and make decisions about how much to produce and stock in each subsequent period. This causes firms to over-produce when demand does stabilize or decline after a period of high demand. Agency Theory explains this by stating that all parties involved with the flow of goods are acting on assumptions and self-interest instead of true information regarding demand. The discrepancy between the amount of goods being produced (and held) versus the number of items demanded creates inefficiency.

**Fig 4: Quarterly revenue trend**




The combined results from the graphs clearly demonstrate how the BullWhip Effect has its roots in both inefficient processes (the length of lead time, the amount of forecast error) and behavioral influences (over-reacting to changes in demand and using promotions to drive demand). The increased volatility in demand translates into an increase in inventory cost, lower customer service levels, and overall instability in the supply chain. These findings further reinforce the need for accurate and timely forecasting, communication of information across the supply chain on a real time basis, reducing lead times and improving the coordination amongst all parties in the supply chain. Technology including ERP systems, artificial intelligence and IOT will greatly help in addressing these issues and increasing the performance of your supply chain.

**Implication**

This research has a number of implications for managers, policymakers, and researchers in supply chain management. The results show that when an organization fails to manage its internal demand variability well, it will experience larger distortions throughout the rest of the supply chain. These distortions result in inefficiencies such as excess inventory, stockouts, higher operating costs, and dissatisfied customers. As such, organizations are moving toward using more proactive, data driven, and forward-thinking methodologies with respect to decision making rather than reactive methods.

The study emphasizes the use of accurate demand forecasting and near-real time communication by managers. Managers should utilize state-of-the-art forecasting tools (e.g. AI, Predictive Analytics) to increase their ability to see into future demand, thereby increasing accuracy and decreasing uncertainty. In addition to forecasting tools, managers should reduce lead times via improved logistics planning and investment in infrastructure that supports logistics. Reducing lead times will decrease the cost associated with holding inventory and improve response times.

**Limitation and future scope**

The current research provides several important insights regarding the bullwhip effect in Indian supply

chains. There are however some constraints to the research.

1. The research was conducted using only secondary data sources (such as journal articles, books, reports, case studies). While secondary data sources are typically credible; they do not always provide an accurate depiction of what is happening at the 'moment' in terms of market dynamics or firm-specific variations. Thus, while secondary data sources provide credible information, they limit the ability to directly verify findings through empirical evidence.
2. The research followed a qualitative/conceptual approach. Therefore, the study did not utilize statistical methodologies to test hypotheses. Rather than quantifying the relationship between demand variability and lead time and supply chain performance, the study conceptually explained these relationships.
3. The scope of this research study is limited to certain industries in india. Specifically, the research included fmcg, pharmaceuticals, ecommerce, agriculture. While the research sectors included are representative of a larger group of industries; the findings may not be universally applicable to all industries or geographic locations where different types of supply chain structures exist.
4. This study did not account for firm level strategies; organizational culture; nor internal operational capabilities that can influence the degree of the bullwhip effect experienced by companies.
5. External factors such as government policies; global disruptions in the supply chain; geopolitical risks and levels of technology adoption were not deeply analyzed, however they can significantly impact supply chain performance.
6. Due to the rapidly evolving nature of supply chains (particularly with respect to emerging technologies such as AI, blockchain and IoT); the findings from this study will likely become less relevant over time unless updated using recent data.

**References**

1. Akerlof, G. A. (1970). The market for “lemons”: Quality uncertainty and the market mechanism. *Quarterly Journal of Economics*, *84*(3), 488–500.
2. Akerlof, G. A. (1970). The market for “lemons”: Quality uncertainty and the market mechanism. *Quarterly Journal of Economics, 84*(3), 488–500.
3. Bertalanffy, L. von. (1968). General system theory: Foundations, development, applications. George Braziller.
4. Chopra, S., & Meindl, P. (2016). Supply Chain Management: Strategy, Planning, and Operation (6th ed.). Pearson.
5. Chopra, S., & Meindl, P. (2016). Supply chain management: Strategy, planning, and operation (6th ed.). Pearson.
6. Forrester, J. W. (1958). Industrial dynamics: A major breakthrough for decision makers. Harvard Business Review, 36(4), 37–66.
7. Galbraith, J. R. (1977). Organization Design. Addison-Wesley.
8. Galbraith, J. R. (1977). Organization design. Addison-Wesley.
9. Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics, 3*(4), 305–360.
10. Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics, 3*(4), 305–360.
11. Lee, H. L., Padmanabhan, V., & Whang, S. (1997). The bullwhip effect in supply chains. *MIT Sloan Management Review, 38*(3), 93–102.

12. Lee, H. L., Padmanabhan, V., & Whang, S. (1997). The bullwhip effect in supply chains. *MIT Sloan Management Review, 38*(3), 93–102.
13. Von Bertalanffy, L. (1968). General System Theory: Foundations, Development, Applications. George Braziller.