ISB CTO

Week 14: Digital Supply Chains

The Bullwhip Effect

Inventory management is a critical driver within the supply chain, and it often represents a significant cost factor. Recent developments in this field have focused on improving the cost efficiency of inventory management, with particular attention to the concept known as the bullwhip effect, considered one of the most significant developments in supply chain analytics in the last five decades.

The bullwhip effect is a term coined to elucidate the need for improved supply chain coordination. Within supply chains, various partners, including suppliers, wholesalers and retailers operate as distinct entities and companies. Historically, these entities aimed to maximise their individual profits, which is a natural inclination for any business. However, in the late 90s, Professor Howley from Stanford introduced the concept of the bullwhip effect, proposing a shift in perspective. He suggested that supply chains should focus on minimising the total cost of the entire supply chain, rather than solely seeking individual profit maximisation.

The Coordinated Approach and its Challenges

The shift towards a coordinated approach is driven by the idea that when the entire supply chain collectively generates greater profit, all participants can share the benefits. Without this coordination, some participants may experience financial losses. Achieving this level of coordination, however, is not always straightforward. Several factors, including strategic concerns and technological limitations, can impede effective communication and collaboration between supply chain partners.

In some cases, concerns about sharing sensitive information with competitors have hindered effective coordination. For instance, Boeing's reticence to share information with its suppliers was rooted in the fear of data leakage to competitors. Similarly, within the retail industry, companies often hesitate to share information with supply chain partners due to concerns about unintentional data transfer to competitors. Additionally, inadequate IT infrastructure can pose a significant barrier to effective coordination.

Bullwhip Effect: Causes

Failure to share information within the supply chain can lead to the bullwhip effect. This phenomenon results in increased fluctuations in demand as information moves upstream from the retailer to the supplier. To comprehend the issue fully, it is essential to examine the sequential order of demand fluctuations at various supply chain stages, from retailers to suppliers.

At the initial stage, customer demand at the retailer level tends to have relatively minor fluctuations, especially in stable products such as toilet paper and diapers. However, retailers often opt not to share this demand data with wholesalers. Instead, they directly place orders with wholesalers, which leads to more significant fluctuations in demand.

This pattern persists as wholesalers transmit their orders to manufacturers and manufacturers further place orders with suppliers.

The cumulative effect of these fluctuations is termed the bullwhip effect. The term alludes to the way fluctuations in demand resemble the movement of a bullwhip – more pronounced and farther-reaching as they move up the supply chain. If retailers were to share their demand data with wholesalers, and this practice continued throughout the supply chain, the fluctuations would be significantly reduced, enhancing supply chain efficiency.

Bullwhip Effect: Implications and Mitigations

The bullwhip effect not only results in increased costs but also diminishes responsiveness to customer demand due to a lack of coordination. In addition to coordination issues, lead times play a role in exacerbating the bullwhip effect. When lead times are extended, organisations are compelled to order in advance and deal with increased uncertainty.

To address the bullwhip effect,

- Organisations are advised to begin by collecting data on the phenomenon across the entire supply chain. A third-party, such as a consulting company, can facilitate this data collection without necessitating direct data sharing among supply chain partners.
- Once quantified, the focus shifts to devising solutions without complete data sharing, a process that demands commitment and coordination at all levels. Top management commitment and resource allocation are vital components of this approach. The use of technology for real-time data sharing is another key aspect.
- Finally, when cost reductions are achieved, the benefits should be distributed equitably, not necessarily equally, to ensure fairness and cooperation in the supply chain.

In conclusion, effective inventory management and addressing the bullwhip effect are vital to enhancing supply chain performance and reducing costs, requiring a shift in mindset and proactive coordination among all supply chain partners.

Reduction of the Bullwhip Effect

Enhancing Supply Chain Coordination

Achieving successful coordination entails the collection of relevant data and its strategic application through technology. It is imperative to recognise that the primary goal is to reduce safety inventory and consequently to curtail the overall cost of the supply chain.

An exemplary illustration of effective coordination can be observed in the collaboration between Procter & Gamble and Walmart. Procter & Gamble identified considerable variability in the demand for diapers at the manufacturing end and expressed their concerns. They engaged Walmart in this discussion, a company renowned for its bold approach to data sharing. One of the reasons for this openness is their substantial

influence in the industry. Such vision in data sharing and collaboration is pivotal for successful coordination.

Walmart assured Procter & Gamble that the demand for diapers at their end remained relatively stable, attributing the volatility to the latter stages of the supply chain. This phenomenon, known as the bullwhip effect, was among the earliest instances of its identification. Walmart, in a pioneering move, offered to provide Procter & Gamble with real-time point-of-sale data, specifying which stores were selling diapers. This exchange eliminated the bullwhip effect throughout the supply chain, significantly reducing costs and establishing a precedent for other supply chains.

Walmart subsequently extended this approach to other suppliers, including Coca-Cola and Pepsi, encouraging them to manage their inventory based on Walmart's point-of-sale data. This proactive method necessitated comprehensive data collection and coordination, setting the standard for supply chain efficiency. Companies that proactively employ analytics to mitigate the bullwhip effect have proven resilient in the face of disruptions. This recommendation applies universally to both traditional manufacturers and service-oriented sectors.

Reduction of Lead Time

In addition to data-driven coordination, another effective strategy to alleviate the bullwhip effect revolves around the reduction of lead time. Lead time introduces uncertainty into the supply chain, requiring organisations to place orders without insight into customer demand.

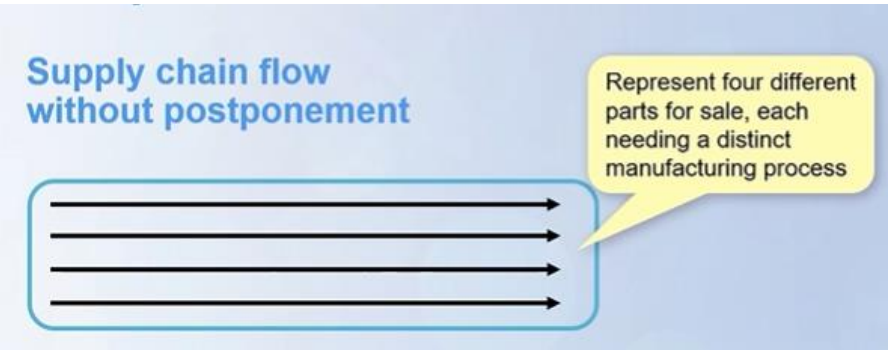
A recent example demonstrates the reduction of lead time in the context of spare parts. This is where the integration of supply chain principles and analytics comes into play. The demand for individual spare parts can be highly variable, making precise demand forecasting challenging. To address this, companies have been actively moving towards 3D printing technology, aiming to eliminate lead time entirely.

Despite the relatively higher cost associated with 3D printing, it has demonstrated effectiveness in reducing supply chain costs. The holistic approach of combining supply chain and manufacturing costs stands as the next frontier. This approach relies on data and has been actively employed in the spare parts industry, showcasing its potential to transform supply chain cost dynamics. This intersection of supply chain principles and data analytics serves as the core of supply chain analytics.

The fusion of supply chain principles, data analytics and innovative technology underlines the transformative potential of supply chain coordination. Data sharing, lead time reduction and adoption of innovative solutions like 3D printing not only improve supply chain efficiency but also reduce costs.

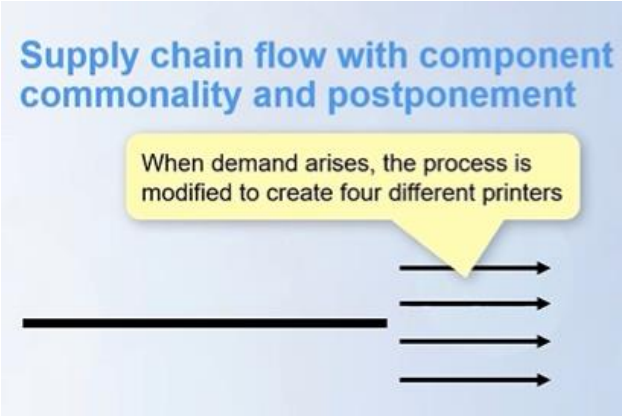
Postponement Strategy

To enhance supply chain efficiency, it is imperative to first scrutinise the various drivers of the supply chain and reduce associated costs. Subsequently, collaborative efforts with partners should focus on minimising the total supply chain expenditure. In addition to these factors, a comprehensive assessment of the manufacturing process is vital in order to curtail overall costs. One effective strategy for achieving this is the concept of "postponement."



The visual representation above depicts the supply chain flow without postponement. In this illustration, four distinct arrows signify four different products, each with its unique manufacturing process. Estimating the demand for each product separately in this manner introduces significant uncertainty, leading to the accumulation of excessive safety stock and, consequently, increased supply chain costs.

A more effective approach is to consolidate the processes up to a certain point, marked by the bold line (refer to diagram below), where the manufacturing process remains identical for all four products.



Let us look at some examples

- Rather than producing four separate printers, HP opts to create an identical product up to a certain stage. When demand arises, they make slight alterations to create four distinct printer models. This approach raises manufacturing costs but significantly reduces supply chain costs, a strategy that has enabled HP to outperform competitors.

- Another notable example is Asian Paints, a company facing similar spare part challenges. Instead of producing final paints, and accumulating safety stock, they amalgamate the demand for various products and prepare components that can be used to create paints easily.
- Zara, a leading retail clothing company, has also embraced a similar strategy in their manufacturing process. The approach involves delaying the production of final products until shortly before they are needed by customers. The concept of commonality and postponement has the potential to address widespread shortages, as witnessed during events like the COVID-19 pandemic.

Commonality and Postponement

The principles of commonality and postponement are equally applicable to service supply chains. These chains often exhibit higher variability across processes and demand more significant safety stock. Consider the example of McDonald's, which standardises the production process for sandwiches regardless of the location, thereby creating commonality and postponement. The concept also extends to different types of sandwiches.

The ability to create commonality and postpone changes until close to the customer is a powerful strategy that merits reflection across various industries. Implementing this approach, bolstered by robust data analysis, can lead to substantial improvements in supply chain efficiency and reduced costs.

A prime example of this ongoing trend is the "store-in-store" concept, where retailers rent space to suppliers, enabling them to manage their inventory within the store. The result is reduced bullwhip effect, enhanced coordination, and a shared data framework. Leveraging analytics and information technology is pivotal in achieving transparency and accuracy in inventory management.

The adoption of commonality and postponement is a gold mine for companies aiming to enhance supply chain efficiency and reduce costs. To succeed in this endeavour, businesses need to harness data, foster collaboration, understand the implications of the bullwhip effect and employ analytics effectively. Achieving accuracy in inventory management is essential for achieving a streamlined and cost-effective supply chain.

Supply Chain Optimisation: Example

In a vendor-built hospital located in Nashville, Tennessee, a critical challenge emerged - the optimal management of the operating rooms. Operating rooms represent a significant investment in terms of both cost and human resources, making their efficient utilisation imperative.

The core issue revolved around determining the ideal timing for patients to be brought to the holding room, which precedes the operating room. The goal was to seamlessly transition patients to the operating room as soon as it became available. Timing was critical - too early posed medical complications, and too late resulted in underutilisation.

Addressing Variability in the Operating Room

The operating room is known for its inherent variability, making it one of the most unpredictable processes in healthcare. Asking surgeons to reduce the variability in surgery time was not a feasible solution. Therefore, alternative approaches were necessary. Initially, the hospital had 39 separate operating rooms, each managing their patients independently. To reduce variance and safety stock, the creation of a centralised control desk was proposed. This desk would aggregate and manage the allocation of patients to various operation rooms. By implementing centralised decision-making, efficiency was significantly improved, resulting in a reduction in the average holding room length of stay by three minutes.

Addressing Variability in the Surgery Time

Asking surgeons to alter their surgical procedures was not feasible. Instead, an app was developed for non-active personnel in the operating room who observed but were not directly involved in the surgery. These individuals maintained and updated an "anticipated out time" through the app in real-time. This crucial data was then used to plan the timing of bringing patients to the waiting room. Leveraging this information, the centralised decision-making process and the app collectively contributed to a 10-minute reduction in the holding room length of stay.

Impact of Supply Chain Analysis

Implementation of centralised control, real-time data collection and informed decision-making not only enhanced efficiency but also reduced blood loss during surgeries.

Supply chain principles are not limited to manufacturing processes like car production; they have widespread applicability across diverse domains.

Optimisation of Facilities

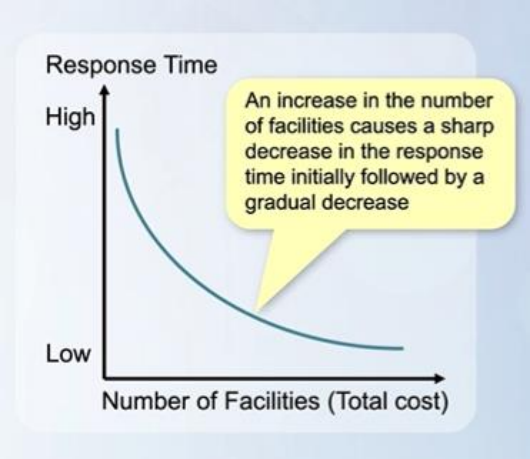
Supply chain analytics, an ever-evolving discipline, is vital for optimally positioning these facilities, thereby ensuring seamless operations and customer satisfaction. The location of facilities is intricately linked to data-driven decision-making, cost optimisation and service level management.

Facility Location Dynamics

The strategic positioning of facilities is an art rooted in data and optimisation. While warehouses' location traditionally pertained to proximity to suppliers and customers, the modern landscape is increasingly driven by e-commerce giants offering rapid deliveries – two-day, one-day or even 10-minute services.

To comprehend this complexity, a holistic perspective is required, one that factors in cost, response time and service levels expected by consumers.

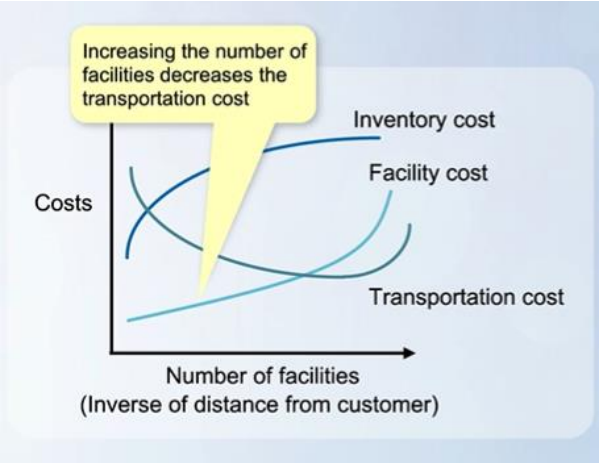
An intriguing insight into facility location lies in the correlation between the number of facilities and response time. As we increase the number of facilities, we witness an initial rapid reduction in response time, analogous to opening a new highway lane that momentarily alleviates congestion.



Yet, the graph reveals that this advantage diminishes exponentially with the addition of more facilities. Thus, an exponential growth in facilities is required as we move from three-day to next day to same day delivery.

Challenges in Facility Location

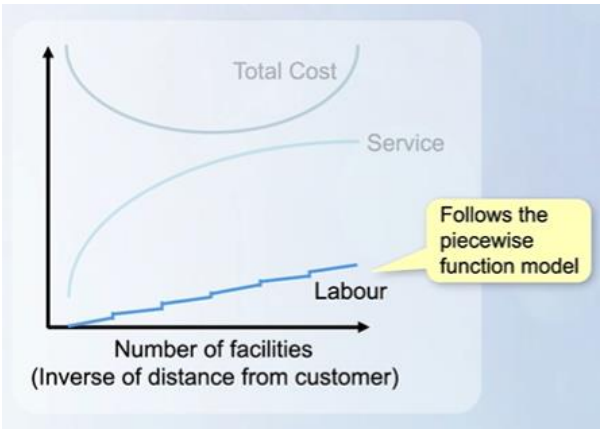
Challenges in facility location stem from the inherent complexities of balancing inventory costs, transportation costs and labour costs. With increasing facilities, inventory costs soar due to the doubling of inventory when two facilities serve one purpose.



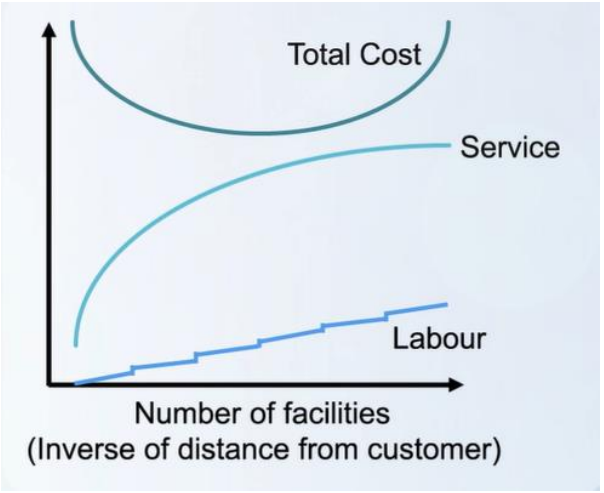
Here, Amazon's model of data-driven distribution centre optimisation is insightful. The granularity of data is essential to this process. On the transportation front, the scenario is equally intricate.

Balancing Costs and Service Level

While an increased number of facilities initially lowers transportation costs, this trajectory transforms into sudden growth as facilities become too numerous, leading to congestion in inbound and outbound traffic. Facility cost follows a linear progression initially, but as the number of facilities surges, a noticeable upward spike occurs.



Similarly, labour costs exhibit a piecewise linear function, characterised by linear growth followed by jumps when ascending salary brackets are traversed. Consequently, the challenge lies in optimising total facility costs, with the ultimate shape resembling a decline and rise – an effect that becomes evident only with a comprehensive supply chain view.



While the quest for cost efficiency remains an essential facet of facility location, a holistic approach recognises that cost alone cannot dictate decisions. Service levels must be aligned with customer expectations, industry standards and competitors' offerings. The graph illustrates that service levels increase with additional facilities but eventually taper off. Achieving the optimal balance between cost and service level is key to deriving the greatest benefit.

The Dell Example

Dell's experiment in offering customers the option to customise the colours of various laptop components provides a noteworthy lesson. By providing a high level of service, Dell inadvertently inflated their inventory costs, illustrating that an ultra-high level of service may not always align with customer preferences.

Coordination within the supply chain is non-negotiable. A breakdown in the sharing of information and overestimation of demand can lead to exponential increases in supply chain costs, as exemplified by Dell's experience. Tax considerations and transfer

pricing introduce additional complexities, with companies strategically positioning themselves in regions with favourable corporate tax rates to maximise profitability. Regulations like arms-length transactions aim to govern such scenarios, but companies often explore legal avenues to minimise tax liabilities.

The Future of Supply Chain and Value Chain

Blockchain is a technology that looms large in its potential to alleviate numerous pain points in supply chain management. Its significance transcends the realms of transparency, efficiency and fraud reduction. The blockchain journey does not stop at transparency and efficiency.

Walmart's Adoption of Blockchain

In 2019, Walmart issued an ultimatum to its lettuce and spinach suppliers, a bold move akin to its early 2000 mandate on RFID implementation. Collaborating with IBM's Food Trust blockchain, they sought to bring lettuce and spinach supply chains onto this distributed ledger. The choice of lettuce and spinach was deliberate; these leafy greens are notorious for E. coli outbreaks and food contamination. Blockchain promises efficient, near-real-time traceability, offering a solution to the challenges faced in the event of contamination.

Blockchain's utility is not limited to a single sector. It extends its reach to pharmacy supply chains, where it combats fraud, the payment industry and even meat traceability. Notably, Walmart led the way in tracking pork sales in China using blockchain. The technology is crucial in cold chain monitoring, ensuring pharmaceuticals remain within the specified temperature and humidity parameters throughout the supply chain. Smart contracts within blockchain enable the automatic identification of deviations and prompt action.

Eliminating Demand-Supply Mismatch

Supply chain analytics attains its zenith when it bridges the gap between demand and supply. Companies like Amazon and Netflix revolutionised their industries by recognising and addressing this discrepancy. They created 'long-tail economies,' capitalising on low-demand, niche products identified through data analytics.

Data Collection and Privacy

Amidst the data revolution, the responsible collection and use of data is paramount. It is important to uphold privacy and adhere to regulations and ethics while harnessing the power of supply chain analytics.