



THE COMMERCE SOCIETY

SHRI RAM COLLEGE OF COMMERCE



GLOBAL SUPPLY CHAIN DISRUPTION AND RESILIENCE STRATEGY



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Global Supply Chain Disruption and Resilience Strategy

Abstract

The aim of this research report is to analyse the global supply chain and resilient strategies that were incorporated in case of disruptions. The analysis ranges across various industries which includes the Automobile industry, Oil and Gas industry, Pharmaceutical industry, Fashion/Apparel industry, Electronics industry and Agriculture industry, to have a wide array for understanding the concept of global supply chain. The paper revolves around the history of SCM (Supply Chain Management), its key players, functions and types of supply chain, optimisation, the causes of disruptions and mitigation strategies that were used to curb the same.

The focus was on utilising the existing articles, publications and reports available on the internet and synthesising relevant articles published by verified authors on Google Scholars, ResearchGate, Mendeley etc. Top news articles were also taken into our study for the preparation of this report. The inclusion criteria of these academic materials was based on its credibility, data backing and depths of insights provided. It is to be noted that the information provided is based on the above inclusion criteria which may include any inherent biases which in turn may affect the overall findings.

The research traces SCM's developmental history and examines entities which steer global supply network activities. The paper looks at

fundamental supply chain operations while identifying various chain types together with optimization methods which enhance operational efficiency and decrease chain vulnerabilities. The study must examine all causes leading to supply chain interruptions by analyzing both geopolitical tensions along with natural calamities and economic recessions and worldwide pandemics and failures in technology platforms. Organisations together with industries explored diverse strategies to decrease disruptions while upholding operational stability as part of their analysis within the report.

The study uses diverse sources from reputable academic articles together with industry reports and case studies which all come from Google Scholar, ResearchGate and Mendeley to establish reliable research findings. Real-time insights of modern supply chain challenges and their responses are provided through top news articles as part of the study. The assessment process aimed to include materials according to three factors: their credibility combined with robust data and deeper insight potential. Researchers recognize that the selection process of sources contains its own built-in biases that can affect the complete research results. The research outcomes present meaningful insights which benefit organizations and authorities in addition to researchers and professionals who want to make their supply chains more resistant to upcoming disruptions.

Introduction

• Meaning

In the world of business and commerce, the term "supply chain" holds immense significance. The supply chain is the interconnected journey that raw materials, components, and goods take before their assembly and sale to customers. It is the network of all the individuals, organisations, resources, activities and technology involved in the creation and sale of a product. From sourcing materials to delivering the final product to the customer, a supply chain covers every step of the production and distribution process. These networks may span worldwide, across several countries and continents to supply and source goods. The global supply chain is dynamic and ever evolving and plays an integral role. To ensure efficiency and timely delivery, coordination of various activities, such as sourcing, manufacturing, logistics and distribution is required in a supply chain.

For example, if an organization sources raw materials in Germany, manufactures the product in China, and sells it to customers in this country, its supply chain is global. Key activities in a global supply chain may include material purchasing, production planning, sales forecasting, and customer servicing. Companies often manage this chain to ensure that the international network of suppliers, vendors, distributors, transportation companies, warehouses, and retailers operates smoothly.

• History of Supply Chain Management

The fascinating path of supply chain management (SCM) is characterised by pivotal moments that have moulded the contemporary

business environment. The origins of the supply chain can be seen in the trading networks of ancient civilizations, when the flow of goods was essential to the expansion of economies. Globalisation, the Industrial Revolution, and technical developments have had a significant historical impact on supply chain management (SCM), with an emphasis on coordination and efficiency. Examining the historical foundations reveals the constant interaction between innovation and adaptation that shapes supply chain tactics to this day. Navigating the modern SCM challenges requires a thorough understanding of this progression, particularly when it comes to risk management.

Supply Chain Management's Beginnings

Logistics was the foundation for both industrial engineering and operations research in the supply chain business. The Principles of Scientific Management, written by industrial engineering pioneer Fredrick Taylor in 1911, focused on improving the manual loading process. The usefulness of operations research in analytics was first recognized in WWII for military logistical operational solutions in the 1940s. Historically, operations research and industrial engineering have made an effort to operate independently of one another. However, they have found success when using integrated frameworks to supply chain and logistics problems. This integration is now known in the industry as "Supply Chain Engineering."

The Early Years of Supply Chain Management

Pallet and pallet lifts mechanization was the research focus of logistics circa 1940 and 1950 to obtain better warehousing space, racking and layout. The “unit load” concept and pallet use became popular, extending to transportation management in 1950 by utilizing intermodal containers together with ships, trains, and trucks to transport them. This set the stage for supply chain globalization. This function fits more as fundamental applications of industrial engineering rather than it’s own discipline of ‘warehousing’. The 1960s saw a shift in the mode of freight transportation from railroads to trucks, due to time constraints. "Physical Distribution" (warehousing, material handling, and freight transit) evolved into a shared necessity. Due in large part to the emergence of computing in the 1960s and 1970s and the ensuing paradigm change, a great deal of research and training was conducted with widespread industrial and scholarly acknowledgment when the National Council of Physical Distribution Management organization assumed leadership of the area in 1963. Prior to 1960, logistics planning was primarily done by hand. However, data computerization opened up new possibilities and breakthroughs in the field, like randomized warehouse storage, truck routing, and inventory optimization. To go from theory to practice, researchers only needed to look at theoretical models because there were no other tools accessible, especially for operations research.

Logistics’ Coming of Age

In the 1980s, supply chain management significantly improved as a result of a shift in personal computing toward logistics. The

availability of computers accelerated planning with previously unheard-of graphical user interfaces. The development of new technologies such as map-based interfaces and flexible spreadsheets led to a major advancement in logistics planning and execution.

The Production and Distribution Research Center was first to develop in supply chain design and distribution planning by combining optimization models with connecting map interfaces. The Material Handling Research Center was also a leader in the development of innovative control technologies for automation in material handling. The Computational Optimization Center built massive algorithms for flexible airline schedules. These new technological avenues immediately helped commerce. The 1980s saw a rise in the popularity of logistics, which was then known for being very expensive to acquire and difficult to run but vital to business earnings.

By 1985, the National Council of Physical Distribution Management became the Council of Logistics Management (CLM) “to reflect the evolving discipline that included the integration of inbound, outbound and reverse flows of products, services, and related information.” Beforehand, the term had been mostly reserved for military logistics.

The Technological Revolution in Supply Chain Management

Following the success of Material Requirements Planning systems in the 1970s and 1980s, and amid the logistical boom of the 1990s, Enterprise Resource Planning (ERP) systems were

developed. In addition to being a successful failsafe for Y2K readiness, the difficult plan to merge the disparate, disjointed enterprise databases also significantly improved data access and accuracy. A new generation of "Advanced Planning and Scheduling (APS)" software was created as a result of ERP software's identification of the planning and integration requirements for logistics components.

Globalization and Supply Chains

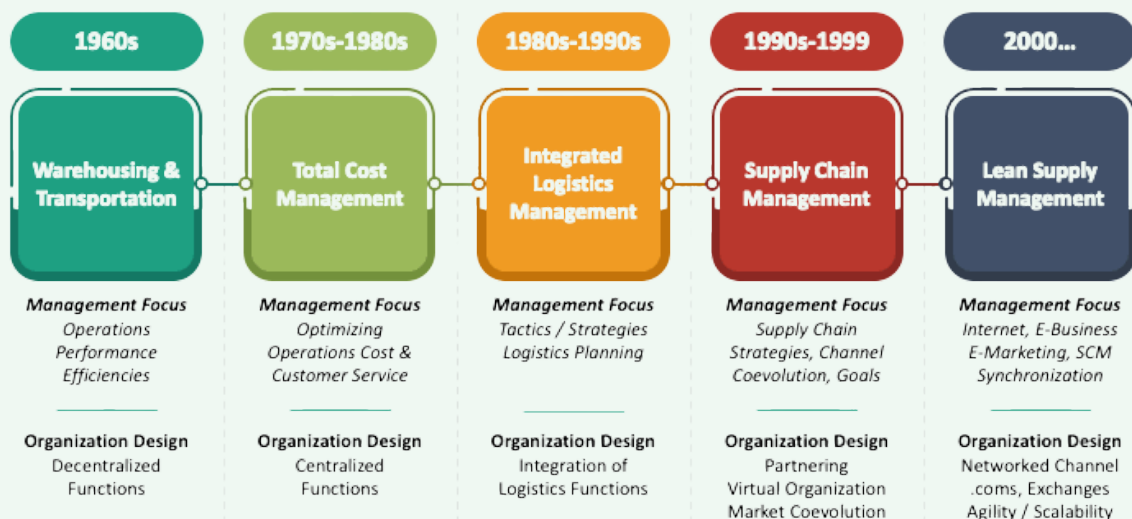
The phrase "supply chain" gained popularity as a result of globalised industry, particularly the expansion of manufacturing in China in the mid-1990s. China's annual exports to the United States increased from \$45 billion in 1995 to over \$280 billion by 2006. The extreme complexity of international networks brought to light the importance of logistics strategies—now known as "supply chain management"—for business tactical and operational concerns as well as successful strategic challenges. The Council of Logistics Management changed its name to the Council of Supply Chain Management Professionals in 2005, further demonstrating the

integration of supply chain management and strategy.

Supply Chain and Logistics in the Future

Computer technology has advanced significantly since the 1980s, outpacing supply and logistics usage. The exponential rise in internet usage has altered our understanding of communication. Planning for supply chains and logistics, however, is still based on distributed models even after the introduction of personal computers. A new generation of supply chain and logistics planning technologies based on centralised planning with dispersed collaboration is achievable with the help of academic research. Research has a tremendous impact on the development of conventional supply chain and logistics fields including manufacturing logistics, transportation, and warehousing and distribution. Traditional supply chains and logistics will also be extremely beneficial to many non-traditional sectors, such as health care and humanitarian logistics. Additionally, systematic supply chain and logistics performance research provides global insights that are extremely important to global markets.

HISTORY OF SUPPLY CHAIN



• What are the Functions of Supply Chain Management?

Managing the supply chain is crucial for keeping things in balance between what's needed and what's available in a company. It involves handling everything from getting the materials to turning them into final products and making sure they reach the customers on time. Basically, it's the lifeline that keeps an organisation going smoothly, like a well-maintained machine. The Role of global supply chain management primarily comprises five functions mentioned below:

1. Purchasing
2. Operations
3. Logistics
4. Resource Management
5. Information Workflow

maintain consistency, as variations in raw material quality could negatively impact the production of finished goods, potentially harming the product's integrity and the company's reputation.

Timely delivery of materials is essential for smooth order fulfilment and uninterrupted production. Striking the right balance in purchasing—avoiding excess to prevent financial and space constraints—requires vigilant oversight. Purchase managers must stay informed about orders and material requirements in real-time to facilitate on-time execution and maintain a continuous production flow without disruptions. This meticulous approach is crucial for effective global supply chain management.



a. Purchasing

Purchasing is one of the first functions of supply chain management. It pertains to procuring raw materials and other resources that are required to manufacture the goods. Collaborative effort with suppliers to ensure timely deliveries, and how we handle it significantly impacts a company's sales and profitability.

Ensuring the quality of sourced raw materials is a major responsibility of Supply Chain Management (SCM). Continuous efforts are needed to make sure the materials meet the company's standards. Regular testing is vital to

b. Operations:

The operations team plays a crucial role in demand planning and forecasting within the supply chain. They initiate and coordinate activities related to inventory management, production, and shipping. Before issuing a purchase order for raw materials, the organisation must determine the necessary production quantities. Overestimating demand can lead to excessive inventory costs, while underestimating it may result in revenue loss. Operation managers bear the responsibility of aligning production with demand. It is their duty to guarantee the proper functioning of machinery, and ensuring the

availability of essential items like packaging materials, labels, and stickers for products scheduled for delivery.

Another significant aspect of Supply Chain Management (SCM) within operations is space organisation. Given the high cost of real estate in most Indian cities, storage space is a valuable commodity. Supply Chain Managers must efficiently manage available storage space, storing only essential goods in company warehouses. This necessitates strategic planning for both raw materials and finished goods to prevent excess or insufficient stock.

c. Logistics:

This particular aspect of supply chain management demands extensive coordination. The production of goods has already started, requiring adequate storage space before they are shipped for delivery. Local warehouse arrangements become necessary, especially when the delivery destination is outside the city, state, or country boundaries, bringing transportation into the picture. Outstation warehouses may also be required.

Coordinating transportation for goods is a challenging task. When it involves international shipping, it becomes imperative to ensure that all documentation is meticulously handled by staff members. Incorrect paperwork can lead to complications at both export and import ports, resulting in delays in delivering goods to customers. The logistics manager needs to be well-versed in the formalities required when sending goods to different countries, considering that various countries have specific testing

requirements for different products.

Even in local material transport, unforeseen issues can arise. Vehicle delays due to mechanical issues are not uncommon, and supply chain managers must be ready to arrange alternative transportation promptly. Weather conditions and road challenges can also impact material deliveries, requiring the manager to be informed and make necessary arrangements to ensure timely delivery. Implementing a reliable tracking system is essential to keep customers informed about the status of their orders.

d. Resource Management:

Companies universally rely on essential elements such as raw materials, technology, time, and labour. Efficient and effective management of these processes falls under the domain of the resource management team. This team plays a pivotal role in optimally allocating resources to specific activities, ensuring timely production at minimised costs. A key responsibility is the strategic assignment of personnel to tasks, guaranteeing the punctual completion of all work, given the crucial role of the workforce in moving goods and executing orders.

In factories employing the same machines for various products, resource managers face the challenge of determining the allocation of machines based on the quantity of orders for each item. The supply chain department encompasses various machinery, including those for packing and labelling, essential for finishing product manufacturing.

Time becomes a critical factor when dealing with

substantial order volumes. Resource managers must assess whether a single shift suffices or if additional shifts are necessary, ensuring ample manpower for extended hours. Simultaneously, they must calculate the costs of deploying more resources to increase production, always mindful of maintaining profitability.

e. Information Workflow:

Smooth functioning of the supply chain management relies heavily on effective information sharing and distribution. In this intricate process, any lapses in communication or workflow can disrupt the entire chain, leading to mismanagement. The exchange of data is a two-way street, especially in the logistics realm. It's imperative for information to flow seamlessly between internal and external entities

Downstream information, such as current orders and market trends, is pivotal. This data is essential for ensuring an adequate supply of raw materials, as it aids in understanding market demands. Knowing market trends from retailers and distributors is invaluable for crafting accurate sales forecasts, enabling companies to plan their production effectively. In cases of sudden spikes in demand, organisations must secure additional finances to scale up production.

One of the critical responsibilities of supply chain management is sourcing raw materials. To execute this role effectively, the responsible party needs precise information on material availability. Early warnings of shortages allow for proactive purchasing to maintain smooth

production. Timely updates on price fluctuations are equally crucial for adjusting finished goods prices or exploring alternative economical sources for these items.

• Parties involved in Supply Chain

In the intricate dance of the supply chain, several key players contribute at different stages:

1. Suppliers: These are the entities, ranging from local artisans to global manufacturers, that furnish the raw materials or components essential for the production process.

2. Manufacturers: Tasked with the alchemy of turning raw materials into finished products, manufacturers oversee production, quality control, and the assembly of goods, which can span from end-user products to components for further manufacturing.

3. Distributors/Wholesalers: These middlemen acquire goods in bulk from manufacturers and funnel them to retailers or other intermediaries. Their responsibilities include managing inventory, warehousing, and the efficient distribution of products.

4. Retailers: The face of the supply chain to consumers, retailers operate through physical stores, online platforms, or a blend of both. They handle inventory, marketing, sales, and customer service.

5. Logistics Providers: This category encompasses freight forwarders, transportation firms, and third-party logistics providers. They handle the intricate web of moving, storing, and distributing goods, offering services from transportation to order fulfilment.

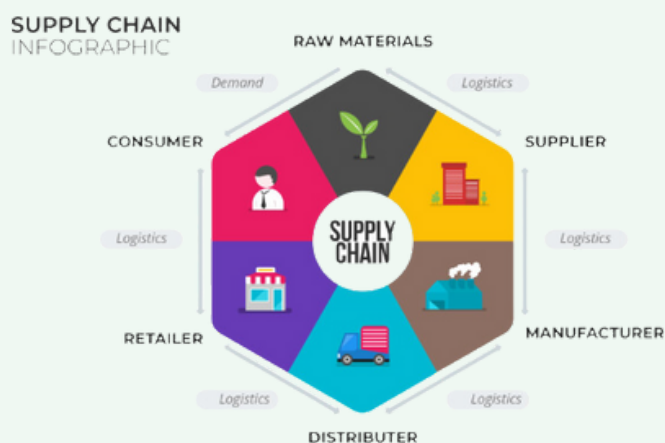
6. Customers/End Consumers: These are the ultimate users of the products or services within the supply chain, whether individuals, businesses, or institutions.

7. Financial Institutions: Banks and lending organisations can be integral in providing financial services, facilitating transactions, and extending credit within the supply chain.

8. Regulatory Authorities: Government agencies or industry-specific bodies that enforce compliance with laws, regulations, and standards governing the supply chain, covering aspects like product safety, labour practices, and trade policies.

9. Service Providers: A diverse group offering support to the supply chain, including IT companies with software solutions, consultants specialising in optimization, and maintenance or repair services for equipment used in the supply chain.

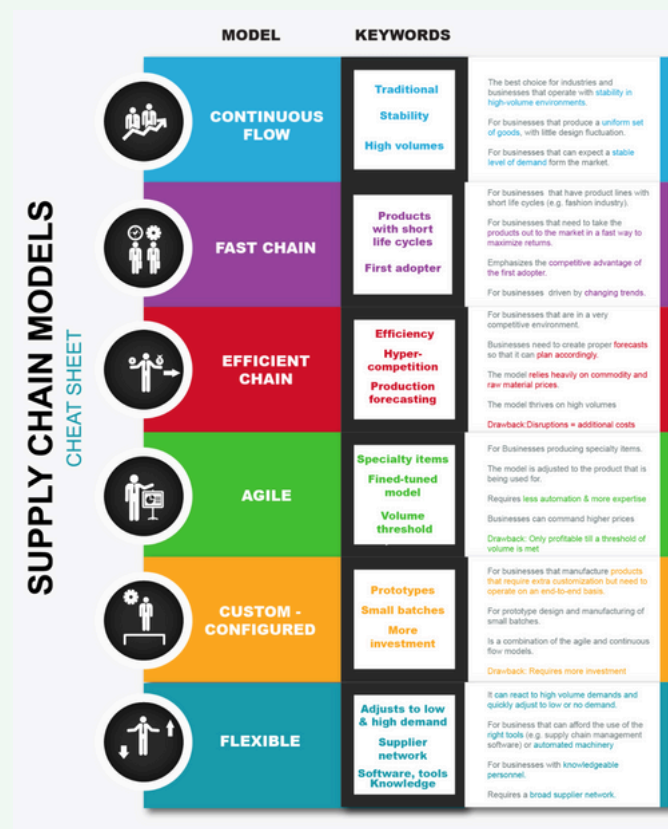
It's crucial to note that the specific composition of parties involved can vary based on industry, the complexity of the supply chain, and the nature of the products or services being supplied.



• Types of Supply Chain

The world's economy, a big mix of connected businesses and trade, is held up by the detailed web of supply chains. They help move things and services around smoothly. These detailed paths stretch across lands and seas, making

sure products get to people all over. Within this complex scene, you find different kinds of supply chains. Each one is designed for specific industries, product lifespans, and what the market needs. Knowing these different kinds is very important for businesses. It helps them find their way through the maze of world supply chains and tweak their work for success.



The six different models are:

1. Continuous Flow Model:

A continuous model is a supply chain that is intended to distribute goods on a predetermined, continuous basis. A steady flow of products and resources is ensured by this paradigm. It can only survive in an environment where supply and demand are steady, usually one with established supply chains for well-known brands and minimal fluctuations in the demand profile of the clientele.

Productivity is at the core of the continuous

flow paradigm. In heavily trafficked environments, it offers stability. This conventional model works best for businesses that regularly offer the same product with few design changes or adaptations. When it comes to manufacturing commodities, these kinds of SCM are fantastic. The product's low cost is a sign of its high effectiveness. Three key competencies should be used to assist supply chain integration. Electronic transactions, which are utilised to cut down on the number of transactional operations needed during the order cycle, as well as the sharing of data on sales and stocks to enhance demand management, are some of the early phases of this. Planning collaboratively with important clients aids in foreseeing demand trends at the most advanced stage. The appropriate supply chain models are response oriented when customer demand is highly unpredictable. The “agile,” “custom-configured,” and “flexible” models are among them.

2. The Fast Chain Model:

The fast chain model is one of the newest terms for supply chain management logistics kinds. It makes sense for businesses whose product lines have short life cycles. A fast model is typically used by companies that manufacture finished goods with a short shelf life, which makes it common for the supply of products that are viewed as modern. This is a suitable approach for businesses that frequently introduce new products right as a trend is beginning to lose its allure.

This approach emphasises the competitive advantage of the first adopter. But the main

driving forces of the fast-food firm are the designer and the marketing department. Put another way, if you can establish your trend, you'll be the first to market.

A fashion designer, for instance, might have a particular line of designs for a season. Since the fashion line is typically based on current trends, the company must introduce it to the market to maximise profits. This model is typically regarded as the finest among the various types of supply chain management since supply chain efficiency can boost a company's competitive edge.

3. The Efficient Chain Model:

For businesses in fiercely competitive marketplaces where keeping a competitive advantage necessitates high levels of efficiency in delivery logistics, the efficient chain model is perfect. Making the most of manufacturing personnel and equipment, as well as effective inventory management, are given top importance in this strategy.

The efficient chain model is suitable for highly competitive industries where end-to-end effectiveness is the primary objective. This method mostly depends on production forecasts in order to appropriately burden or sweat machinery assets. In the efficient approach, the price of commodities and raw materials plays a big part. Effective chains face capacity issues in the post-pandemic period. The primary reasons for this are labour constraints, material shortages, and delays. The efficient chain model was created because of the fiercely competitive industries. Maximising efficacy is this model's

ultimate goal. In order to reserve the necessary raw materials and equipment, the organisation must create precise production forecasts using the efficient chain model.

This approach's main weakness is how easily modifications to the manufacturing or sales cycle can impact the supply chain network. For example, problems such as a shortage of personnel or raw materials could lead to long-term delays and additional costs for the company because of the supply delay.

4. The Custom-Configured Model:

For the specially customised model, specific configurations are needed during the assembly and manufacturing stages. It integrates continuous flow and agile development approaches and necessitates that the final product work flawlessly, possibly with some extra modification. Two examples of these applications are prototype design and small-batch production.

The company needs to invest more in the custom-configured model than in more traditional models. When numerous product variants are required, a custom-configured approach—basically a combination of the agile and continuous flow models—is helpful. When a consumer has customization options, a custom-configured model is most likely being utilised.

With this higher-touch version, smaller batch quantities and quicker turnaround times are achievable. Agile models and continuous flow are fundamentally combined in the custom-configuration idea.

5. The Agile Model:

The agile strategy is best suited for companies that deal with specialty items, where products could require additional care within the supply chain. This model is usually customised for the product it is being used for. The agile strategy is well-known for the knowledge required to move objects from point A to point B, not so much for the degree of automation or technologies involved.

Companies in the agile supply chain may charge extra for their services. The efficient chain model thrives on massive quantities, whereas the agile approach is profitable only up until a specific threshold is achieved. It could get expensive to keep using this model after that.

Four requirements must be met by a supply chain in order to be considered an agile model: virtual integration, process alignment, network base, and market sensitivity. To execute virtual integration, the business needs to keep an eye on changes in the market demand in real time. Process alignment is about distributing supply chain responsibilities throughout the company. This is achieved through collaborative product creation, supply chain coordination, and the upkeep of a cooperatively managed inventory. Network-based supply chains imply equal contributions from all link participants.

The market responsiveness component quickly modifies the manufacturing rate in response to variations in demand. This concept will work effectively for companies that operate in markets where there is a lot of demand volatility.



6. The Flexible Model:

Thanks to the flexible strategy, businesses can meet both stretches of low demand and big demand surges. A supply chain must meet three criteria in order to be considered a flexible model: part segmentation, accurate stocking algorithms, and flexible planning. Diversifying suppliers and implementing automation on plant floors enable this.

The flexible model aims to achieve the best of all worlds. Conversely, companies with flexible models are able to adjust to and endure times when there is little or no demand. Turn it on and off as needed.

To run a flexible model with great efficiency, a firm requires the right supply chain management system and the right people with a strong foundation in knowledge.

• Goals of Supply Chain Management

1. Efficient Order Processing:

To generate revenue, a company must fulfil customer orders swiftly and in line with their expectations. Collaboration across the supply chain is vital to ensure goods are available when needed, leading to successful order fulfilment. Utilising effective software can streamline order processing, eliminate redundant tasks, and ultimately accelerate processing speeds—a crucial element in supply chain management offering various advantages.

2. Balancing Supply and Demand:

A well-managed supply chain is essential for ensuring the availability of goods for order fulfilment. Supply chain managers play a crucial role in coordinating between sales and purchase teams to avoid shortages of high-demand products. The seamless flow of information is key to predicting market trends using analytics, ensuring sufficient materials are on hand to meet customer needs effectively.

3. Minimising Wastage:

Waste reduction is a critical aspect of supply chain management. Steering clear of excessive raw material stocking prevents waste, particularly for products with limited shelf life. Maintaining an optimal quantity of both raw and finished goods requires constant communication between supply chain managers and marketing teams. Implementing a robust inventory management system is essential for achieving and sustaining optimum stock levels.

4. Enhancing Delivery Speeds:

In the age of e-commerce, swift delivery is a

customer expectation. Supply chain managers face the challenge of finding ways to expedite the movement of goods. Strategies include situating warehouses closer to customers and ensuring the timely availability of delivery vehicles. Collaboration with transporters is crucial for maintaining an uninterrupted supply chain and meeting customer expectations.

5. Real-Time Information Management:

Timely information is paramount in supply chain management. Delays in one part of the process can have ripple effects. Therefore, maintaining up-to-date status information is crucial for all stakeholders. Customers now demand real-time updates on their orders, and timely information about raw material needs is essential for purchasing teams. Implementing effective tracking mechanisms is a key function of supply chain management.

6. Cost Optimization:

In highly competitive markets with slim profit margins, companies must focus on cost reduction. Supply chain managers grapple with various costs, including raw material prices, storage costs, and transport rates. Seeking new partners for better rates and maintaining solid relationships with existing suppliers, transporters, and warehouse owners are essential for cost reduction. Constantly seeking ways to enhance efficiency in the process is a priority.

7. Managing Disruptions:

Operational disruptions can arise from various factors, such as machine failures, raw material

shortages, or unexpected price surges. Supply chain managers must be prepared to navigate these challenges to ensure neither the company nor its customers suffer. Implementing risk management methods to assess and mitigate these threats is a crucial aspect of supply chain management.

8. Enhancing Customer Experience:

In a competitive landscape, providing an exceptional customer experience is paramount. Supply chain management plays a vital role in this by exploring ways to deliver goods to customers quickly and cost-effectively. Reducing delivery expenses and providing real-time information on order execution contribute to a positive customer experience. Customers receive improved satisfaction through efficient delivery expenses reduction which results from advanced logistics systems.

9. Boosting Revenue and Profitability:

The supply chain significantly impacts cost reduction, involving aspects like purchasing, storage, and delivery of goods. Maintaining strong vendor relationships helps reduce raw material costs, and having multiple suppliers ensures competitive prices. Optimising storage space and selecting suitable transport and distribution partners contribute to cost reduction. Ultimately, the combined effect of reduced costs and increased sales contributes to improved revenue and profitability. Despite the numerous benefits it provides, managing a supply chain is a challenging task that requires addressing various operational challenges for successful company operations.

Mitigating Global Supply Chain Risks: Top Challenges and Strategies

Just a few years ago, supply chain risk was a behind the scenes business term. But today, it has become one of the most talked about topics in the world. In this globalised world, risks associated with the supply chain are becoming increasingly interconnected and interdependent which makes it crucial for professionals to identify and mitigate the same.

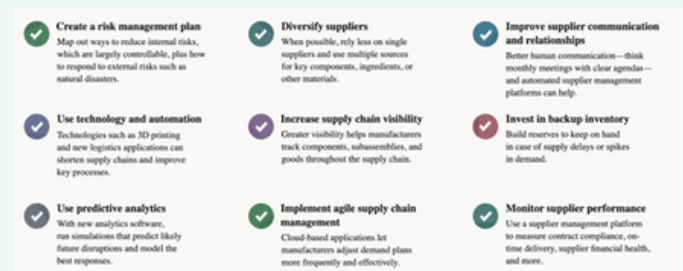
Following are the top 9 challenges that impact the supplier's ability to tend to business needs:

1. Poor Supplier Performance
2. Demand Planning Complexity
3. Global Shortage of Labour
4. Rising Inflation
5. Complex Regulatory Environment
6. Geopolitical Risk
7. Reputational Risk
8. Natural Disasters and Climate Risks
9. Cyber Risk



Integrated supply chain risk management is crucial in today's business land. By integrating elements of risk identification, assessment, mitigation, and response across the supply chain, firms can safeguard against disruptions.

In the changing world of international trade, reducing supply chain interruptions has become extremely important for companies aiming to operate efficiently and with strength. This illustration outlines strategic methods designed to reduce disruptions and maintain seamless operations throughout the supply chain.



1. Poor Supplier Performance:

Poor or inconsistent supplier performance can cause delays, defects, cost overruns, or reputational damage. The financial health of a supplier is a reliable indicator for assessing the performance of the supplier. However, there are other factors that need to be accounted for like: Political Disruption, Financial Structure, Exposure to Natural Disasters, etc.

Mitigation Strategies:

- i) The first step is to identify the root cause of the supplier's poor performance by conducting audits or communicating with the supplier directly.
- ii) Then the cause is to be categorised whether it is internal or external, temporary or chronic, or isolated or widespread.
- iii) The next step is to establish timelines, milestones and assign responsibilities to the supplier, and also discuss the non-compliance

agreements.

Apart from that, it is advisable to diversify to different suppliers, ideally in other parts of the world to potentially reduce external risks.

2. Demand Planning Complexity:

Demand Planning is the process of forecasting future demand for products or services as accurately as possible and using that to estimate the required number of output to meet consumer needs. It comprises the following steps:

- **Data Collection:** Gather required internal and external data
- **Data Analysis:** Analyse and understand the collected data
- **Forecast Model Composition:** Create an appropriate forecast model
- **Forecast Creation:** Prediction of available observations
- **Forecast Accuracy Measurement:** Check the forecast accuracy
- **Forecast Model Optimization:** Adjust and finally validate the forecast model
- **Sales Plan Transition:** Derive an actionable plan from the results

This forecasting becomes a complex process due to all the elements involved in it:

i) **Volatile Consumer Behaviour:** Since consumer behaviour is related to human psychology which is highly subjective, the accuracy of the forecast becomes volatile. Moreover, different people react differently to external events which can result in these predictions becoming unreliable.

ii) **Seasonality:** Predicting the demand for peak and lean seasons, especially for seasonal

products may become complex which leads to stock-outs and lost sales. Finding a consumption pattern during a particular time for non-seasonal products also requires a huge amount of data comparison and analysis.

iii) **Data Complexity:** Lack of sufficient data for sales, especially for new products or new markets makes the data analysis a complex task as they do not provide historical contexts and analysis.

iv) **Human Factor:** Another cause of complexity that cannot be neglected is the human factor. Everyone will have a different approach or estimate based on different assumptions. Since forecasting is not an exact science, there has to be some premises that make it difficult to get everyone on board, hindering the decision-making process.

v) **Number of SKUs(Stock Keeping Units):** Companies having a diverse range of products and services need to maintain individual forecasts for each of the ranges which adds to its complexity. Forecasting at the SKU level is a very time-consuming and complicated process.

Mitigation Strategies:

i) **Artificial Intelligence and Machine Learning:** AI and Machine Learning speed up the process of demand planning. Advanced AI applications automatically make prescriptive decisions using predictive forecasting, simulation, and optimization of data.

ii) **Collaboration:** Due to dynamic environments and uncertainties, forecasting can never be accurate. This is why collaborative planning is

necessary. When all the departments plan individually, but in line with all the stakeholders by taking ownership of the business outcomes as they are closer to the KRAs, complexities gets lowered.

iii) **Segmentation and Rationalisation:** Products having similar attributes are grouped, allowing management of larger groups of products at the same time. Different SKUs are linked together having some correlation to reduce the number of SKUs and minimise complexities.

iv) **“What if” scenarios:** This approach is followed by leading tech companies as well like Google where in they think of all the scenarios which might go wrong and plan an alternative for each of the scenarios. Then it is ensured that none of the scenarios take place or the suitable alternatives are put into action immediately, in case of diversion.

3. Global Shortage of labour:

Supply chains in the present times are facing a lot of global shortages of labour majorly due to external factors like rising inflation, and the economic recession which is causing unemployment, pandemic, political instability, workforce migration affected due to ongoing wars, etc. Labour shortages in every industry create a domino or ripple effect in multiple sectors, making this even more difficult to solve due to the interdependence of the industries. The lack of available workers causes production to slow and in severe cases, causes it to completely stop resulting in skewed inventory levels, with distributors feeling the highest impact of losses. In logistics, the labour shortage impacts the transport of goods between parties, hence affecting the price and unhappy customers. The long-haul truck driver shortage has created

capacity shortages among trucking carriers, making it difficult for shippers to move inventory from ports to distribution centres promptly.

Mitigation Strategies:

i) Re-evaluate the hiring process, retention practices, and compensation, and strive to create a balanced work environment for all employees.

ii) Automate the work method, ramping up the investments in technology to reduce the dependence on labour.

iii) Train and develop employees' skills to manage modern supply chains.

iv) Improve the compensation to attract higher quality talent and provide more reliable and efficient services. Firms having poor compensation practices are more susceptible to labour shortages as labourers will be hesitant to work for undercompensation.

4. Rising Inflation:

In an inflationary environment, the supply chain might not run smoothly. And this could result in shipping delays, production line bottlenecks and warehouse stockouts among other obstacles. Inflation is a phenomenon caused by an imbalance between supply and demand, leading to a general increase in the price of products and services over a given period of time. This overall surge in prices means that people's purchasing power is diminished. This causes a demand constraint in the supply chain. This also causes the price of raw materials to rise creating an input price constraint and thus a leftward shift in the supply curve. Inflation results in shortages of raw materials and semi-finished products, posing a challenge to supply chains

worldwide, procurement becomes more complex during inflationary periods, fewer goods or services may be required by customers, etc.

Mitigation Strategies:

Logistics planning is an effective strategy for reducing the effects of inflation on the supply chain. When businesses lack foresight and fail to keep tight control of their stock, they make unplanned purchases that could drive up logistics, transport and/or production costs. There are three ways to curb the effects of inflation on supply chain:

- i) **Visibility.** A supply chain control tower provides you with the information you need at any given time to make sound decisions. This digital tool fosters end-to-end supply chain visibility, letting you detect errors and inefficiencies quickly — before they become a real problem for the functioning of the supply chain.
- ii) **Predictability.** You can incorporate digital twins in your supply chain to simulate its performance in inflationary and volatile scenarios. This type of simulation enables your company to be more prepared to foresee disruptions and improve responsiveness in uncertain environments.
- iii) **Flexibility.** Flexible logistics facilitates having multiple suppliers. It also enables you to create alternative logistics networks to adapt your

5. Complex Regulatory environment:

A complex regulatory framework poses significant risks to supply chains. The regulations are dynamic and often unclear which makes it difficult for businesses to comply with

them, often leading to penalties. Strict and complex regulations mean significant rise in administrative costs in order to comply with them. These involve the costs for hiring specialised personnel such as legal counsel and investment made in training and technologies in order to adhere to the laws. Frequent changes in regulations can disrupt business activities as supply chains need to be adjusted as per the new guidelines. Sanctions imposed on industries disrupt supply chains blocking off the sources or making them highly costly. Non-compliance can lead to fines, penalties, seizures of inventory and even suspension of activities. All these lead to huge legal liabilities, which can at times extend to criminal prosecutions.

For eg: If the government bans the import of a certain metal, then the supply chains of industries using it as raw material are disrupted and they need to look for domestic sources.

Mitigation Strategies:

- i) **Seek expert help-** Companies need to consult and regulatory experts, in order to ensure they are complying with all the rules and regulations. A specialised team needs to be designated in order to monitor the changes in laws and ensure compliance. These regulatory experts need to conduct audits to ensure zero non-compliance. Lawyers need to be hired to minimise liabilities in case of any violations.
- ii) **Establishing relationships-** Building relationships with regulators can help businesses to understand regulatory expectations and to resolve issues more quickly and stay updated about any upcoming changes. This will also help assess any potential risks and develop

contingency plans.

iii) Diversification- Companies need to diversify their supplier base and reduce dependence on a single source in order to minimise disruptions in case of trade restrictions or sanctions. If import of raw material is banned from a particular country, there needs to be an alternate source available.

6. Geopolitical risks:

Recent conflicts between Russia and Ukraine, and tensions between China and Taiwan highlight this year's major geopolitical risks towards the supply chain. The conflict between Russia and Ukraine clearly shows the interdependence of global events to even the local supply chain and its management. Hundreds of ships laden with wheat and corn have been stranded at Ukrainian ports, as the war restricts shipping in the Black Sea, leading to food shortages and inflation around the world. Ukraine and Russia being the dominant suppliers of agricultural produce, covering almost 75% of the market have severely impacted the prices, especially in the Eastern Europe. In turn, these price hikes directly impact a company's raw material costs in select markets and transportation spending in nearly every market. The impact is felt across industries, from food and beverage to technology-intensive sectors. The gas supply chain in Europe was severely impacted, again due to the Russia-Ukraine war after the suspension of gas supply from the Nord pipeline. Similarly, tensions between China and Taiwan pose significant risks to global supply chains, particularly in the tech industry, where many companies rely on Taiwanese suppliers for critical components such as semiconductors. Moreover, China's use

of economic coercion to achieve political goals has become a significant concern for supply chain managers.

Mitigation Strategies:

- i) Vertical integration- Vertical integration is where a company controls multiple stages of production and distribution by acquiring businesses positioned at different points along the supply chain. This enables companies to mitigate risks and extract value from their supply chains.
- ii) To mitigate the impact of geopolitical risks, supply chain managers must remain informed about global events and policy changes.
- iii) Diversify their supplier base, establish contingency plans for supply chain disruptions, and negotiate contracts that protect them from unexpected changes.
- iv) Understanding and following foreign policy and global events will become even more critical for supply chain management success as the world becomes increasingly globalised.
- v) Develop alternate commodity strategy for products that comprise material deemed vulnerable due to single-source nature or globalisation risk. A prime example would be the setting up of assembly units in India by Apple amidst the soaring trade tensions with China. This is also termed as the '**China plus one strategy**' by experts.

7. Reputational Risk:

Reputational risk refers to potential harm to an organisation's name and credibility. This can occur due to ethical lapses, through actions of the organisation itself or through third-party associations. Organisations must be aware of

several reputational risks in the supply chain, especially concerning Environmental, Social and Governance and achieving sustainability.

1. Ethical Violations- Unethical business practices are the most critical reputational risks to businesses. Supply chain ethical lapses are associated with instances of unethical practices, such as bribery, corruption, and collusion. These may involve instances of goods or services being misrepresented or kickbacks to award a supplier a contract. Consumers are becoming increasingly concerned about how the things they purchase will affect the environment, and so companies who do not follow environmentally sound practices can suffer reputational damage. A company that is found to be using unsustainable practices in its supply chain like deforestation, using harmful chemicals or illegally dumping waste will face backlash. Human rights abuse can be equally devastating. A company that is found to be using child labour or forced labour in its supply chain or is found to be using its workers in unsafe conditions or paying them below minimum wage can expect to face negative publicity and consumer backlash.

2. Product Quality and Safety- Flaws in the quality or safety of the products can have adverse impact on the company's reputation. Issues occur when suppliers source and provide products not adhering to industry regulations. Failure to resolve these issues can lead to problems, potentially requiring a product recall and directly harming the organization's end customers. A company found to have sold an unsafe product can negative publicity and, at times, even lawsuits and penalties.

Mitigation Strategies:

- i) **Code of Conduct:** Companies should develop a strong code of ethics and supplier code of conduct that outlines the company's values and expectations for its suppliers. It should include the company's expectations for ethical and sustainable sourcing, labour practices, environmental impact and human rights.
- ii) **Regular Audits:** Supplier audits need to be conducted regularly with due diligence. This will help ensure that their practices meet the company's ethical and sustainability standards. The suppliers' performance needs to be closely monitored and in case of any discrepancies, either a resolution needs to be found with them or the suppliers need to be switched.

8. Natural disaster and climate risks:

The pandemic is "a temporary problem," while climate change is "long-term dire," said Austin Becker, a maritime infrastructure resilience scholar at the University of Rhode Island. An increase in the global temperature leads to the melting of ice caps, which are causing sea levels to rise. This not only threatens coastal communities but also disrupts critical infrastructure, including ports and transportation networks. This is potentially the biggest climate threat to supply chains because coastal areas are experiencing disruptions in the pisciculture systems, causing an overall disruption of fish and other seafood worldwide. Apart from these, supply chain disruptions caused by hurricanes, floods, wildfires, and other forms of increasingly extreme weather are jolting the global economy. Some of the samples of climatic impact on supply chains are as follows:

i) The Texas freeze in February 2021, caused the worst involuntary energy blackout in U.S. history. That forced three major semiconductor plants to close.

ii) Heavy rainfall and snowmelt caused some banks of the Rhine River, Europe's most important commercial waterway for inland transport, to swell and rise the water to extremely high levels, triggering a halt in river shipping for several days.

iii) Hurricane Ida, the fifth-costliest hurricane in U.S. history, struck the Gulf of Mexico Coast in late August, damaging vital industrial installations that generate an array of products, including plastics and pharmaceuticals, and forcing a diversion of trucks, already in short supply across the country, for use in relief aid.

Natural disasters like earthquakes, tsunamis, hurricanes, floods, etc. which are ultimately caused by some climatic disruptions can significantly halt production within the domestic economy or at the international level as well.

Mitigation Strategies:

i) The first step is to identify the potential weather risks that could disrupt the product supply chain. Depending on where a company and its primary suppliers are located, the risks may vary. However, it must be noted that these risks may not be localised and can originate far from the point of contact.

ii) Once the potential risks have been identified, you need to assess your vulnerabilities. This includes making a list of your most critical suppliers, those that provide you with the most important products or services. Consider your suppliers' locations, their track record with

weather-related disruptions and their disaster preparedness plans.

9. Cyber risks:

In many cases, organisations that don't adequately manage their supply chain risks are more likely to fall victim to a cyberattack – one that could potentially cause severe disruption.

Types of Cyber risks that might cause a disruption in supply chain are:

i) **Data Breaches:** The average cost of a data breach in 2021 amounted to almost \$4.2 million. Even with the right regulatory and compliance standards in place, it often takes organisations a long time to identify a data breach once it has occurred. Some of the most common data breaches caused by third-party vendors result from unauthorized access via company email account, hacking of an email provider, lack of encryption, and unsecure websites and improperly stored login information.

ii) **Cybersecurity Breaches:** Cybercriminals attack in two major categories, IOT and IIOT. IoT usually refers to consumer devices such as personal fitness trackers or smart thermostats and IIoT refers specifically to equipment powering enterprises on a much larger scale. Cybercriminals know that IoT and IIoT security isn't at its finest, making it an easier target for a cyberattack and impacting by way of loss of production, revenue impact, data theft, significant equipment damage, industrial espionage, etc.

iii) **Malware and Ransomware Attacks:** Any intrusive software that can penetrate your computer systems in order to harm, destroy, or

steal data from them is known as malware. Trojan horses, worms, viruses, and ransomware are the most frequent forms of malware attacks. Ransomware attacks are another common kind of malware. This type of malware encrypts the files of its victims so that the attacker can demand money in return for a key that unlocks the encryption. In order to conceal the identities of the attackers, cryptocurrencies like bitcoin are typically used in the financial exchange for a decryption key that allows you to retrieve your data.

Mitigation Strategies:

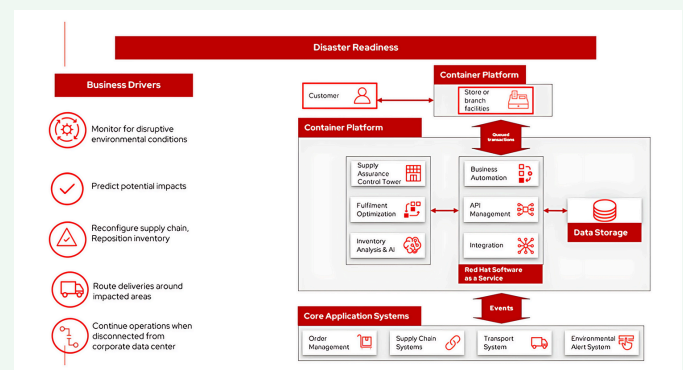
- i) Establishing backup controls to safeguard your data backups.
- ii) Regularly updating your software solutions including antivirus, anti-spyware, and firewalls.
- iii) establishing and recording data stewardship guidelines, identifying the owners of particular data and the uses to which they are permitted.
- iv) Working with vendors in your supply chain network to develop a unified disaster recovery plan to assure business continuity.
- v) Adopt advanced cybersecurity measures such as DNS filtering and network access control.
- vi) Establishing security controls and clearly defining user roles will help you limit who may access your systems and what level of authorization or clearance they have.

• Supply Chain Optimisation

Supply chain optimization is the process of strategically managing and modifying a supply network's activities to maximise efficiency. The aim is eliminating wasteful activities and offering customers products at the lowest possible total cost while maintaining the maximum profit

margins. Managers must balance the expenses of manufacturing, inventory control, transportation, and satisfying consumer expectations in order to accomplish these goals. It involves the use of mathematical modelling through softwares as well as traditional management based qualitative methods.

Businesses adopt a three phase structure for optimising supply chains:



1. Design: This phase involves network design processes like where warehouse facilities are located and how product flows between them. It also addresses strategic objectives such as demand forecasting, establishing supplies, and planning and scheduling manufacturing operations.

2. Planning: This phase involves creation of a production and inventory plan. This encompasses developing a strategic supply chain deployment plan, and coordinating assets to enhance the efficiency in delivery of goods, services, and information from suppliers to customers, thus balancing the demand and supply.

3. Execution: This phase involves putting the plan into action and implementing it. It focuses on execution oriented processes and applications like warehouse and inventory management,

transportation management, global trade management, and other execution applications, such as real-time decision support, supply chain visibility and order management systems.

Benefits of supply chain optimisation:-

1. Reduces costs, boosts revenue and profitability:

Supply chain optimisation helps in increasing the profitability of the business by reducing costs and boosting revenue. Supply chain infrastructure expenses can be better managed by optimising delivery processes, logistics, and warehousing capabilities. It helps eliminate unnecessary costs and automate the ineffective processes. With supply chain cost optimization, a company can have a lower inventory which helps free funds and prevents stock from going obsolete. The focus can instead be placed on meeting customer requirements. The customer benefits from a better customer experience and is more integrated into the process than before. The company is far more receptive to customer needs, and the right orders are delivered on schedule, which drives customer loyalty and leads to rise in revenues.

2. Improved supply chain collaboration: Supply chain optimization fosters collaboration and transparency among supply chain partners, enabling better coordination and decision-making. By sharing data and insights, businesses can optimise the flow of goods and information across the entire supply chain network.

3. Reduced Risk: Optimising the supply chain helps businesses adapt quickly to market changes and reduces the risk of disruptions like natural disasters or economic shifts. It involves identifying and assessing potential risks early on

and developing contingency plans to minimise the risk factor. It also helps increase the agility and responsiveness to changes in the market.

4. Improved supplier performance: This is a result of digitisation of the process. Digital supply chains provide in-depth, real time data on the performance of every supplier. Visibility is core to supply chain optimization, meaning you can see which suppliers are performing well and which are under-performing. Equipped with this knowledge, one can take the required actions to enhance supplier performance and renegotiate agreements on the basis of actual performance.

5. Enhanced Sustainability and Compliance:

Supply chain optimisation contributes to environmental and regulatory compliance by reducing waste, improving resource efficiency, and lowering carbon emissions. By streamlining transportation routes, adopting energy-efficient warehousing, and minimising excess inventory, businesses can reduce their environmental impact. Additionally, optimised supply chains ensure adherence to industry regulations and sustainability standards, enhancing corporate social responsibility and brand reputation.

6. Faster Order Fulfilment and Delivery: Supply chain optimization enhances order processing speed and ensures quicker deliveries by reducing bottlenecks and inefficiencies. With improved logistics, automated workflows, streamlined operations, and better inventory management, businesses can fulfill customer orders faster and more accurately. This leads to higher customer satisfaction, increased repeat business, and a stronger competitive advantage in the market.

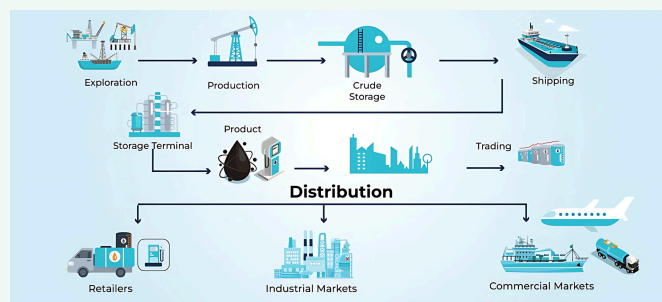
Case Studies

Now that the prior sections have already provided ample knowledge and background about Supply chain, its functioning, disruptions, and resilient strategies, we have compiled few real life case studies for a better understanding on how the supply chain gets disrupted and how the companies use strategies to mitigate the crisis at hand. Companies use real time data to know the direct as well as the indirect factor of disruption for better analysis of the situation. They apply solutions to not only the effect of disruptions but also study the cause of them. Hence a cause-effect relationship analysis is done before opting for the most effective mitigation strategy. This report includes a comprehensive supply chain analysis across six sectors namely: Oil and Gas Sector, Automobile sector, Pharmaceutical Sector, Fashion Sector, Electronics Sector and Agriculture Sector.

• Oil and Gas Sector

The Oil and Gas Sector is considered to be one of the most crucial and impactful sectors of the world. It accounts for numerous of the world's top ten companies in terms of revenue in the Fortune Global 500 list. Due to scarcity and rare availability, oil and gas sector have had a discernible impact on the international landscape and politics. Any disruptions in the oil and gas sector has numerous effects in the finance sector primarily, but also has spillover effects on various other sectors. The supply chain of the oil and gas industry involves domestic and international transport, shipping, inventory visibility, trading, controlling, and ordering. Other supply chain elements also

comprise of material handling, distribution of refined energy products, and import/export facilities. The supply chain is primarily divided into three different segments, namely, the upstream segment which locates and produces natural gas and crude oil, the midstream segment overviews the storing, transportation, and processing of energy commodities, and the downstream segment includes retail outlets, natural gas distribution, and oil refineries.



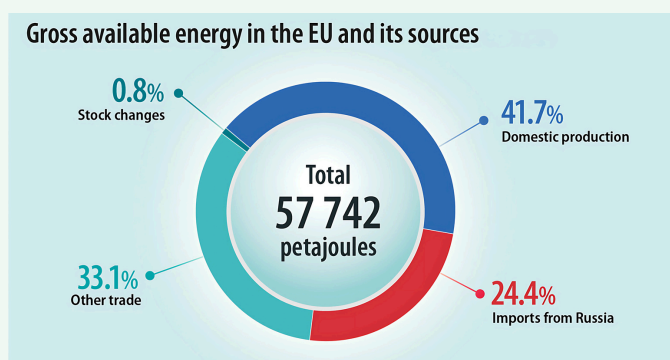
This industry relies on a complex, interconnected supply chain to ensure the seamless flow of equipment, resources, and services. The efficiency of this supply chain plays a crucial role in overall operations, impacting production, geopolitical relationships, and pricing dynamics. Disruptions in this global chain can have widespread negative effects on the industry and the world. We'll explore case studies on two primary factors causing large-scale disruptions.

1. Geopolitical Tensions: The Russian-Ukraine Conflict

The Russian invasion of Ukraine has had a deep economic, human, and business impact. It has uprooted and disrupted the lives and livelihoods of millions of people, and has also affected supply chains, economies, and large-scale

industries. The brunt of this impact has been faced by the energy industry, primarily consisting of Oil and Natural Gas. This unprecedented invasion has caused a massive wave of sanctions to land on Russia banning any imports from it, including hydrocarbons, energy, oil, and gas. But before delving deeper into the nuances of this issue, we first have to understand the dependence of the EU on Russia for Oil and Gas supply.

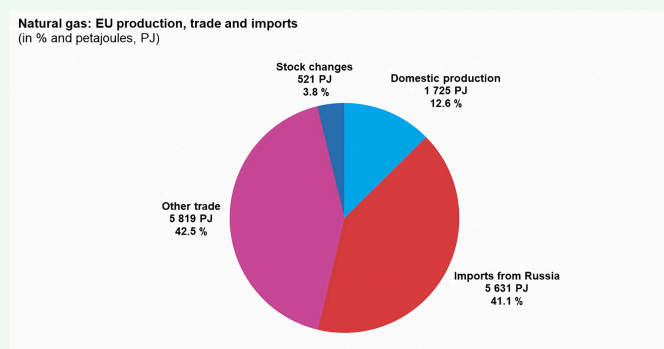
European Union: talking about its energy mix, as well as oil and gas supply, the EU is heavily dependent on Russia for a majority of its imports in this sector. Discussing the energy import sector, the EU depends on Russia for 24.4% of all its energy needs. Even though the origins of EU energy imports have rapidly fluctuate during the recent years, Russia has maintained its position as the largest supplier of main energy commodities to EU. Some countries like Lithuania, Slovakia, and Hungary owe more than 50% of their imported energy to Russia.



The Natural Gas sector arguably has the biggest share of Russian exports.

Given the intensity of winters in Europe, Natural Gas has become a necessity for numerous countries in Europe. The dependency on Russia has increased over the past few years, reaching a gross value of 41.1%. Therefore, the

EU has been largely dependent on Russia for Natural Gas.



Moving on to the Oil sector, despite the reduction in consumption from the peak of two decades ago, petroleum and crude oil still holds the highest share in the EU energy mix at 34.5%. Russia is the second largest producer of oil in the world, and is the world's largest exporter of the same. The reliance of the EU on Russia for Oil stands at 25.7% of its aggregate crude oil imports.

Impact: The US Government, post the invasion of Ukraine by Russia, banned imports of Russian Oil, coal, and natural gas. Many other countries followed the example set by the USA Government, and banned all hydrocarbons import from Russia. Due to these sanctions, the prices of oil and gas went soaring, as the supply chain had taken a major hit. Another factor to take into consideration is that the demand for hydrocarbons, oil, and natural gas had become stagnant during Covid-19. However, with economies reopening and entering recovery phases, the demand for all these items had started increasing. Thus, these sanctions interrupted the supply chain during a crucial period of rising demand. This disruption in the supply chain not only has had an impact on prices, but also on all activities even remotely related to these items. Stock exchanges in

different markets also sank, including exchanges situated in France and Germany, among other countries. Due to this massive hit on the supply chain, many countries started facing severe shortages. As highlighted earlier, Russia was a major player in the Europe economic landscape, especially revolving around oil, hydrocarbons, and natural gas. Seeing the negative consequences of their sanctions and foreseeing calamities, many countries rolled back their sanctions to preserve their economies as they recognized their dependence on Russia for the aforementioned items.

Mitigation: Numerous strategies have been used to deal with the consequences of the war on the global oil, hydrocarbons, and natural gas prices. The members of the Organization for Economic Cooperation and Development were releasing 60 million barrels of oil, which was roughly equivalent to 12 days of Russian exports, from their strategic reserves. The USA has also augmented its supply of these items to curb down the soaring prices. Another tactic has been to pressurise gas and oil producers to enhance their production output to meet the void in the supply chain created due to the sanctions. Numerous countries dependent on Russia have also started exploring other sourcing options to meet their needs, and have also started reanalysing their energy security policies and their respective energy mixes.

2. Calamities: The Deepwater Horizon Oil Spill

Calamities, caused by both nature as well as humans have several detrimental consequences that not only affect the supply chains of the

world, but also result in immense collateral damage. Due to the uncertain and unpredictable factor involved in such cases, its difficult to create an accurate mitigation plan in order to minimise the damage caused by such incidents. Incidents caused in drilling sites are the most common of the calamities. Due to the complexity of the technology involved, its a herculean job to manage the site as if a malfunction is not detected and solved immediately, it will cascade into a sequence of terrible malfunctions which will eventually result in something catastrophic. Oil Spills are the most common type of calamities that are experienced in the Oil and Gas industry. Such spills have a huge impact on the supply chains. They also have a severely damaging impact on the marine life around the oil rig. The effect of such spills on nature is incomprehensible and irreversible. One such oil spill that caused huge shockwaves around the world was the Deepwater Horizon Oil Spill on April 10, 2010. Often termed as the largest marine oil spill in history, this horrific event was caused due to an explosion on the Deepwater Horizon oil rig situated in the Gulf of Mexico, approximately 66 kms off the coast of Louisiana, USA. It subsequently sank on April 22nd.

On the unfortunate night of April 20, a surge of natural gas blasted through a concrete core, recently installed by a contractor in order to seal the well for later use. The cores were likely too weak to withstand the pressure because they were composed of a concrete mixture that utilised nitrogen gas to speed curing. Once released by the fracture of the core, the natural gas travelled up the Deepwater rig's riser to the platform, where it ignited, killing 11 workers

After the damage control was completed, it was estimated that nearly 4.9 million barrels of oil had already leaked into the gulf. Only 800,000 barrels had been captured and sealed.

Impact:

The economy of the Gulf Coast suffered a severe blow due to the oil spill, which had devastating consequences beyond just the Oil and Gas industry. Various other industries that formed the backbone of the region's economy were severely affected, leading to widespread financial distress. Among them, the Fishing Industry took the hardest hit, as marine life in the affected areas suffered massive casualties. Fish populations plummeted due to oil contamination, making it nearly impossible for fishermen to sustain their livelihoods. Shrimping and oyster farming, key industries for the Gulf Coast, faced long-term damage, as the toxicity of crude oil and dispersants led to reduced harvests and declining seafood exports. The tourism industry also suffered significant losses, as the once-thriving coastal economy—dependent on beautiful beaches, marine biodiversity, and recreational activities—saw a dramatic drop in visitors.



Additionally, the oil supply chain experienced major disruptions. The immediate impact was seen in production delays and the shutdown of several offshore oil rigs, leading to a reduced supply of crude oil in the market. Extensive exploration efforts were launched in South America, particularly in Brazil and Venezuela, to identify new reserves and stabilize global oil distribution. However, the environmental repercussions of opening new oil fields led to further debates on sustainability and corporate responsibility. The supply chain's logistical network also faced challenges, as companies had to adapt to new routes and transport methods to ensure continued oil distribution while navigating regulatory changes and environmental concerns.

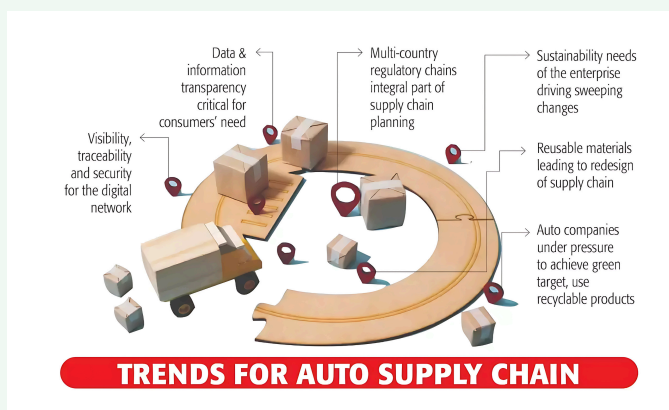


Mitigation: Such incidents are oftentimes caused by human negligence and indifference. In order to eliminate the human factor involved in such incidents, new regulations have been formulated and entirely new regulatory bodies have been established to mitigate such processes from ever happening again. After the disaster, the frequency and number of mandatory inspections also increased. According to certain reports, inspection per facility has increased by a whopping 96%.

• Automobile Industry

The automobile industry is a prime example of complex and dynamic supply chain management. As one of the largest and most globally integrated industries, it showcases the intricacy and interconnectivity inherent in modern supply chains. From sourcing raw materials to assembly line production and distribution, the automotive sector relies on efficient logistics, innovative procurement strategies, and strong supplier relationships to meet consumer demand while navigating regulatory requirements and market fluctuations. Understanding the complexities of supply chain management within the automotive realm offers valuable insights into the broader landscape of global commerce and logistics.

The accompanying diagram provides a visual representation of key trends shaping the intricate network of suppliers, manufacturers, and distributors, offering insights into the industry's strategic direction and potential areas for innovation and optimization.



Ford

With a current net worth of more than \$48 billion, Ford Motor Company is one of the biggest automotive giants in the world. The

American-made company was founded in the early 1900s, and since then, it has remained one of the most successful companies worldwide. Ford doesn't just make one type of vehicle; they make a whole bunch of them. They produce cars, trucks, and SUVs. Therefore, Ford serves a diverse range of customers.

How Ford Manages Its Supply Chain

1. Inventory Management

Inventory management is all about keeping the right amount of parts and materials on hand without having too much or too little. For Ford, this is crucial because they rely on a vast network of suppliers to provide the components needed to build their vehicles.

- **Just-In-Time:** Ford often uses a “just-in-time” inventory system. This means they get parts from suppliers exactly when they need them. It helps reduce storage costs and ensures fresh components for assembly.
- **Minimising Waste:** By managing inventory carefully, Ford can minimise waste. Too much inventory can lead to unused parts, while too little can halt production. So, it's like a delicate balancing act.

2. Communication with Suppliers

Good communication with suppliers is like having a clear phone line in the supply chain. It ensures everyone is on the same page and can respond quickly to changes and challenges.

- **Regular Updates:** Ford maintains close relationships with its suppliers and

communicates regularly. This helps them understand each other's needs and plan for any changes in demand.

- **Problem Solving:** When issues arise, like delays or quality concerns, open communication allows Ford and its suppliers to work together to find solutions. This helps prevent disruptions in production.

3. Technology and Automation

Technology and automation are the secret ingredients that make Ford's supply chain efficient and adaptable.

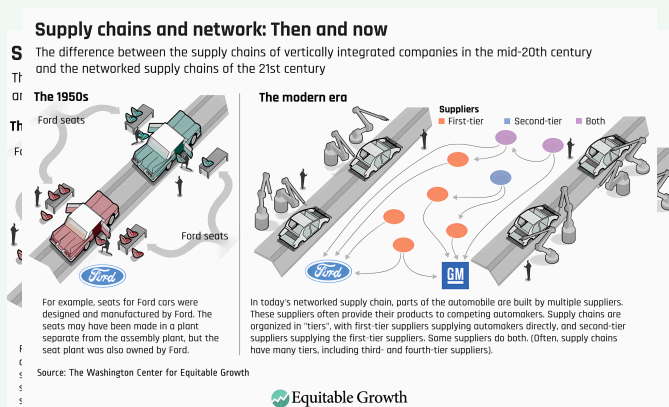
- **Data Analysis:** Ford uses data and analytics to predict vehicle demand. This helps them adjust production schedules and inventory levels accordingly.
- **Robotics:** Automation plays a big role in Ford's manufacturing process. Robots help with welding and painting, making production faster and more precise.
- **Supply Chain Software:** Special software helps Ford track the movement of parts and vehicles across the supply chain. It provides real-time information, helping them make quick decisions.

Strategic long term issues

Ford faces a significant challenge in managing its extensive database of business partners, suppliers, and sub-suppliers. With several thousand suppliers and complex business relationships, Ford's supply chain network is more intricate than that of companies like Dell. Unlike Dell, which requires fewer than a hundred parts to produce a single product, Ford needs several thousands. Additionally, Ford operates a wide chain of dealerships across the globe, adding further complexity to their supply chain management efforts. Managing both suppliers and customers in a single efficient supply chain had always been a challenge for Ford who is constantly looking for new ways to better control and manage their supply chain operations in a more productive and cost effective way.

Short term issues

- **Lack of up to date IT infrastructure:** The biggest obstruction in the supply chain is to stay up to speed with production as per schedule as there are lack of up to date IT technology within first and lower levels suppliers. The lack of proper IT technology results in miscommunication and bad coordination between the supply partners. The outcome could be a higher order, longer lead times, higher cost and operational hassle.
- **Lack of direct control of end users:** The sales structure through independent dealerships means that Ford lacks control over the end user of their product. This lack of control, combined with dealer markups, has



negatively impacted their ability to directly manage their customer service experience.

- **Workforce shortages:** Workforce shortages are also widespread as suppliers grapple with labor difficulties, making it challenging to uphold shipping schedules and quotas. Additionally, raw material costs have surged, and there is a shortage of semiconductor chips - essential in every industry and sector. Some of these challenges stem from the impact of the COVID-19 pandemic, while others are linked to inflation.

The First Moving Assembly Line



Ford's invention of the first moving assembly line revolutionised industry and had a significant impact on supply chain theory. When this innovation was implemented in 1913, it transformed the production of goods by allowing cars to move along a conveyor belt with specific tasks at each station. This efficient method reduced costs, shortened production times, and significantly improved efficiency. Initially utilised in manufacturing, the assembly line concept fundamentally altered the traditional supply chain model. It laid the groundwork for modern supply chain processes by emphasising coordination, speed, and

precision in production. Beyond its historical significance in the automobile industry, Ford's pioneering assembly line had a lasting influence on supply chain management strategies across various sectors.

4 Lessons from Ford Motor Company

1. Support Efficiency from Multiple Angles

Ford's innovations shaped global work culture. The company created the modernised assembly line and spearheaded the truncated work-week and the abbreviated work-day to boost efficiency from multiple angles.

2. Roll with the Punches

Cliches shouldn't always be observed, but sometimes they reveal essential truths. As Ford CEO Jim Farley Says, in response to manufacturing curveballs, "I don't think the labour market's going to ease any time soon ... we're kind of running our business now and have developed a bit of a rhythm around [these] challenges that we're seeing." Challenges may be unpredictable and inevitable, so the onus is on adaptability.

3. Continue Evolving

The Ford assembly line was realised by pondering what could be. Ford adheres to this principle today, pushing to achieve ecological accomplishments, and is set to achieve carbon neutrality no later than 2050. From 2017 to 2022, Ford reduced manufacturing facility emissions by 40%, and in 2022, 60% of its electricity was carbon-free. One way it has done

so is by conducting "30 supplier audits along select critical mineral battery supply chains at all tiers to the mine site."

4. Embrace the Wave of the Future

Ford is embracing the EV market, sourcing battery capacity and raw materials to

manufacture 600,000 new EVs by 2023 and more than 2 million by the end of 2026. Like many other major manufacturing movers, Ford hopes to achieve zero emissions and adopt "100% locally-sourced renewable energy for all manufacturing plants globally by 2035" as part of their carbon neutrality by 2050 outlook.

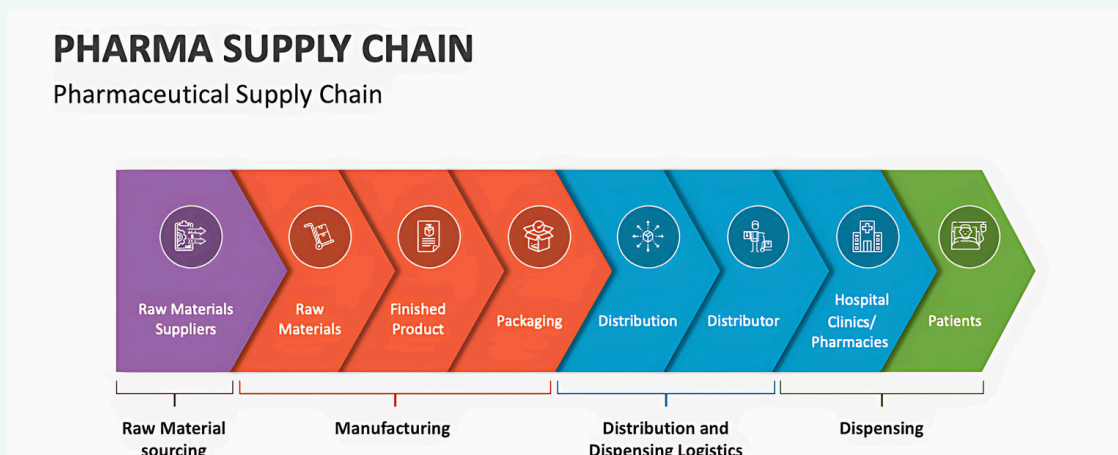
• Pharmaceutical Sector

The pharmaceutical industry is one of the most crucial ones for mankind. It plays a vital role in global healthcare. This sector is responsible for developing, manufacturing, and distributing life-saving drugs and medications. The supply chains and networks of this industry are extremely complex. The key components include research labs, manufacturing facilities, distribution and sales networks. However, this system faces vulnerabilities like geopolitical and economic instability, pandemics, cyber threats and natural disasters. These unforeseen events can cause drug shortages, increased costs and financial losses. Here we take the specific case of a natural disaster, Hurricane Maria that struck the Caribbean region in September 2017.

Hurricane Maria was a category 5 hurricane. It was the most devastating hurricane to hit Puerto

Rico in nearly a century. It caused over 3000 deaths, with the majority of them occurring in Puerto Rico. The storm disrupted months worth of power supplies and caused billions of dollars worth of damage to infrastructure.

Puerto Rico is a hub for pharmaceutical manufacturing, home to more than 50 plants. One-fourth of US pharmaceutical exports are produced there. Its pharmaceutical sector came to a standstill as the electricity on the entire island was lost. The supply chain networks and operations of pharma companies were disrupted. This led to financial losses to the companies as well as drug shortages. It revealed the weaknesses in the pharmaceutical industry's supply chains and infrastructure. The aftermath saw the adoption of resilience strategies to



1. Abbvie

Abbvie is a leading pharmaceutical company. It had a major manufacturing plant located in Barceloneta, Puerto Rico. Every month, it generated more than 4 million doses of Humira. The storm caused power outages and infrastructural damage to the facility, thus causing delays in Humira production. The impact on infrastructure and transportation disrupted the entire supply chain, causing delays in raw material deliveries and finished product shipments.

This Humira shortage had a negative impact on AbbVie's financial performance. The company reported a decline in revenue and earnings in the quarters following the hurricane. A 14% decline was seen in Humira sales in Q4 2017. To overcome the damage caused by the storm, the company adopted resilience strategies such as Diversification of Manufacturing footprint and suppliers. AbbVie took steps to make its manufacturing more secure and flexible by spreading production across different places like Ireland, Singapore, and the United States. This reduced the dependence on a single location. It worked with suppliers to improve supply chain resilience, including establishing backup suppliers and implementing alternative transportation routes. AbbVie incurred approximately \$150-200 million in additional expenses due to the hurricane. This involved repairs & restoration costs, increased logistics and transportation expenses due to supply chain disruptions as well as employee support and relief efforts in Puerto Rico. The company also invested in infrastructure upgrades, including backup generators and

water treatment systems, to minimise the damage from future disasters. It also contributed towards the relief and support efforts. It committed \$50 million to support Puerto Rico's recovery efforts over five years.

These investments, while initially adding to costs, ultimately improve operational resilience and mitigate future risks, potentially protecting profits in the long run.

2. Baxter International

Baxter International is a major producer of intravenous (IV) solutions. It operated three manufacturing plants in Puerto Rico. Just like Abbvie, all three of Baxter's Puerto Rican plants were severely impacted, experiencing power outages, flooding, and infrastructure damage. The disrupted production and damaged infrastructure led to delays in shipping and distribution, further worsening the situation. This led to production delays which resulted in national shortage of critical medications. The company's financial performance was also negatively impacted. Baxter estimated a \$70 million revenue decline in the fourth quarter due to the hurricane.

Baxter had in place hurricane preparedness plans, including backup generators and disaster response protocols. These plans helped to minimise the damage and expedite the recovery process. The company adopted the path of diversification in order to ensure future resilience. Production was expanded to other sites in the US and globally to reduce reliance on Puerto Rico.

• Fashion Sector

The 21st century apparel industry is characterised by fast changes in the consumer preferences, advancement in technology and weekly changes in the fashion trends. With the globalisation of fashion industry, as much as is contributed to revenue, the same is also posing serious disadvantages. Securing reliable suppliers irrespective of geographical and linguistic constraints, short production cycles due to fast fashion trends and on-time delivery, lack of transparency in supply chain along procurement, production and shipping, etc. The fashion industry being heavily dependent on labour, also fall prone to labour strikes. Three major category of challenges: operational challenges (caused in part by soaring demand), shifting industry dynamics and new waves of trade agreements and regulation have a pivotal impact in all the recent disruption cases. Brexit means more paperwork and delays at customs for businesses shipping between the EU and the UK. Supply chain interruptions could also be made worse by the US and China's ongoing trade disputes. However, this paper includes specific cases of disruptions like material and component shortages, transportation shortages, and retail supply disruptions, and how reputed brands have handled the disruption and what were the resilient strategies adopted by them.

1. Adidas

Adidas, the German sports apparel company which is the largest in Europe and second largest in the World with over 9,00,000 stores worldwide has one of the most efficient supply chains, playing a huge role in its success. However, its supply chain snagged in

2021 following factory closures in Vietnam and consumer boycott in China which had a lasting impact on sales worth 500 million euros which continued to hit the 2022 first quarter.

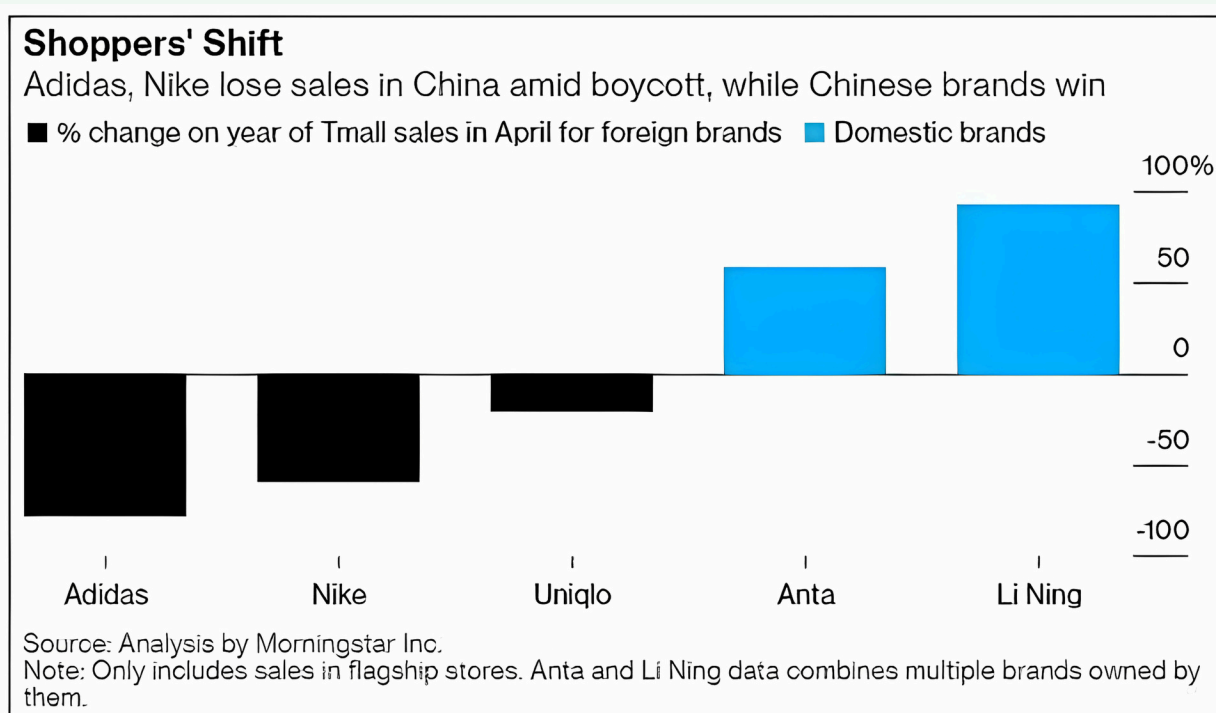
Vietnam usually accounts for 28% of Adidas sourcing and its factories mostly make shoes for the company, with a lag of three to four months before products hit the shelves. However, as COVID-19 infections started to engulf Vietnam, it led to numerous factory closures and labour shortages, causing a major gap in the supply of Adidas shoes and source materials.

Along with these ongoing disruptions, it also faced backlash online from Chinese buyers over past statements saying they would not source cotton from Xinjiang after reports of human rights abuses against Uyghur Muslims surfaced. China denied of any forced labour and human rights violations. As consumers ditched western brands, local Chinese sportswear groups Anta Sports and Li-Ning seized on the turn in sentiment by announcing that they would continue to use Xinjiang cotton. Anta's revenue rose more than 50 per cent in the first half of 2021 to Rmb22.8bn (\$3.6bn), as it snapped up more of the rapidly expanding Chinese market for sportswear. This led to Adidas losing the Chinese market share.

Adidas has reorganized its top management at its China business after this consumer boycott over its stance on Xinjiang cotton which caused the sportswear giant to lose market share to up-and-coming local brands. Jason Thomas, who oversaw the company's operations in Greater

China, was replaced by the German sportswear group. The action comes after sales declined by about 15% for two straight quarters of the previous year. Adrian Siu, who was previously serving as the company's Hong Kong chief replaced Jason Thomas in April, followed by a major hierarchy restructure. The changes in management structure was a part of the very wide revamping strategy to bring adidas back to the top in the Chinese Market, the market

which is the most important growth market. Adidas plans to increase the number of products specialised for the China market and to ramp up local marketing. It has undertaken the strategy on the social front rather than the capitalist front, of showing customers their appreciation and respect to earn the consumer trust back. They are still ongoing with the efforts as they can strengthen this global brand only after considering the local angle and understanding.



2. Mica in the clothing Industry

Mica is a major component in designing any traditional apparel in India and it also exports Mica to be crushed and sold as glitter which is used to add shimmer to any fabric, cosmetics etc. With India accounting for more than 60% of world's mica production, this industry is building its foundation on the backs of children who do not even know what minerals they are working with.

One-fourth of the world's mica is supplied by Jharkhand and Bihar alone where about 22,000 children are working as child labours. These mica-producing belt has one of the highest poverty ratios with approximately 37% of the population living below the poverty line and one of the lowest literacy rates. All these factors contribute to these forced child labour.

STATE	LEGAL PRODUCTION (TONNES)	EXPORTED MICA 2015 (TONNES)	ESTIMATE ILLEGAL MINING (TONNES)	ESTIMATE ILLEGAL MINING (%)
Jharkhand/Bihar	11,000	100,600	89,600	89
Andhra Pradesh	9,200	15,000	5,800	39
Rajasthan	4,700	20,400	15,700	77
Haryana/Maharashtra	0	0	0	0
Total	24,900	136,000	111,100	82

Indian Bureau of Mines

According to the Indian Bureau of Mines, there are only 2 legal mines in Bihar and no legal mines in Jharkhand. However these mines do not fulfil the demands of the market, leading to illegal mining of Mica. The above table shows the quantum of illegal mining which clearly depicts majority of mica mining falls in this bracket. Due to this reason heavy machinery and legally employable people cannot be employed which automatically captures children in this vicious industry. In addition to this, mica mines are extremely small in size having narrow tunnels which makes children the perfect labourers for this task.

Repeated exposure to mica while breathing in can enter the lungs and cause lung fibrosis. There is higher risk of the tunnels collapsing with the children inside causing them a life-time paralysis or even death.

A report by Terre des Hommes, a swiss non-governmental organisation was the first one to bring this forced child labour into light,

specially in the states of Jharkhand and Bihar. With no other industries in the region, the children are forced to enter this hazardous sector with 70% of the mines operating illegally.

Leading cosmetics company like L’Oreal and Estee Lauder faced some backlash and disruption in their supply chain of one of the most vital ingredients: mica. Clothing companies also faced the same disruption, after their Mica/Glitter sources came into light, most of which was linked with illegal practices.

In order to stabilise their tarnished image, Estee Lauder, L’Oreal, Coty, Chanel and Burt’s Bees have joined the Responsible Mica Initiative to abolish child labour by tracing the supply chain back to the mines. These companies have positioned themselves as ethical brands by sticking to the legal mines in India for a very limited quantity and the rest is now imported from North and South America. They have made their resource audits more public and have started monitoring these issues more closely.

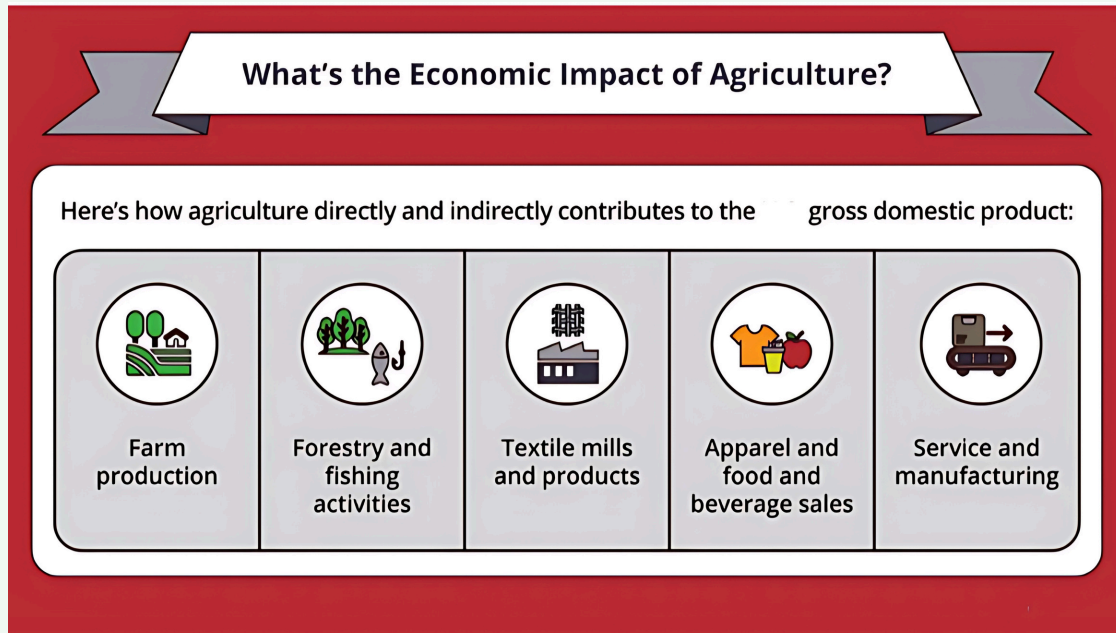
• Agricultural Sector

For thousands of years, agriculture has played a pivotal role in the evolvement of humanity. It is one of the few industries which has a discernible impact on every individual on the planet. Before agriculture, hunting and gathering was the way of surviving, but it was only after the transition to agriculture, did the human race begin to thrive and develop at a rapid pace. Agriculture is very important because among other things, it provides shelter, livelihood, and is essential to maintain our daily routines-from getting up, to driving to work, to surviving.

Viewing it from a fiscal perspective, agriculture is often considered as the backbone of the economy of numerous countries across the world. It forms a \$5 trillion global industry.

It has supported the livelihood of innumerable people from time immemorial, and constitutes as one of the most crucial aspect in the development of the human race. Due to it's substantial impact on the basic necessity of food, disruptions in the supply chain of agriculture usually has severely detrimental consequences on all of its stakeholders either directly or indirectly. It also contributes to global employment, owning a share of 1/4th of the aggregate employment.

Also, a lot of other sectors are either dependent on or branches from the agricultural sector, so any disruption causes a cascading effect on all of these sectors. We'll be discussing two of the many factors that cause supply chain



1. Labour Shortages

In Agriculture, labour is crucial for planting to harvesting. However, even labour-rich countries are now facing problems of agricultural labour scarcity. This has happened even though the

disruptions in the agricultural sector. Wages salary basis has increased manifold in the last few years. This has happened primarily because of the migration of the labourers to other locally accessible jobs.

The unavailability of labour, all operations pertaining to agriculture are delayed, consequently reducing the overall yield and productivity. Due to this shortage, a lot of small farmers are migrating from this sector and moving on to other sectors where the costs are low and there is ease of conducting the operations. They are also leasing their lands off to other people and are going to the urban areas for better livelihood.

Labour shortages are caused by a lot of factors. The seasonal nature of the agricultural sector plays a major role, as for a major chunk of the year, the labourers remain unemployed. Therefore they start looking for better options with job security and regular income. Other industries also provide lucrative employment opportunities, which attract these labourers. The implementation of various social schemes have also incentivized people to pursue such programs due to higher wages. There is also widespread gender discrepancy when it comes to the salaries, and a lot of other psychological factors are also involved.

The consequences of these shortages are also dire, as it delays farm operations which consequently lead to reduction in profitability and productivity. It boosts the wage supply rate making it extremely expensive to hire workers. It delays the harvest, and also affects the cropping intensity.

Mitigation: The biggest mitigating factor that can be used to reduce the impact of such shortages is the mechanisation of agriculture. The operations that require significant power input and low control should be mechanised first. The farming architecture needs to be

converted to adapt to the mechanical operations. Plating architecture like spacing, soil type, plant height, and moisture content are necessary for operating machineries.

It is very difficult for small farmers to arrange the finances required to afford such machinery. However, in recent days, many private sectors develop small tools which are affordable and can be used to mechanise the operations. Cooperative custom hiring is also an important factor for efficient utilisation of farm machinery. It entails a group of farmers hiring machinery during the peak period, to reduce the hiring cost by pay-per-use basis, and to reduce the capital requirement of the farmers. Governments have also rolled out various social schemes, subsidies, and programmes to enable the farmers to have easier access to the credit required for affording such machinery, and assist them in the overall process.

Other factors that can help mitigate the impact of shortages are enhancing the seed production technology, utilising agrochemicals, eradicating bonded labour and provision for accommodation.

2. Climate

Agriculture is something that is deeply connected to nature. Crops are sown in the fields, they are nurtured and gain nutrients from the soil, they are watered from rainfall, moistened from the breeze, and survive due to sunlight and the atmosphere. Thereby, it is very sensitive to weather and climate.

Climate change is something that has grown to be a major problem in the past few decades.

With the rising emissions and CO₂ levels, change in rainfall patterns, increase in extreme weather events as well as invasive pests, rising temperature, and increase in sea levels, the landscape for agriculture is changing significantly.

Discussing more deeply about climate change and its impact, higher CO₂ levels can have a massive impact on the crop yields. Although some laboratory experiments indicate that elevated CO₂ levels can augment plant growth, other factors such as the ozone layer, water and nutrient constraints, and changing temperatures, may counteract these potential increases in yield. Elevated CO₂ in the environment has also been associated with reduced nitrogen and protein content in soybean and alfalfa plants, resulting in decreased quality.

Extreme temperature and irregular rainfall can stagnate crop growth. Extreme climatic events also have a huge effect on the supply chain.

With warmer temperatures, increased CO₂ levels, and wetter climates, numerous pests, fungi, and weeds also grow, causing increased expenses for farmers, which can lead to increased prices, causing widespread disruptions.

One of the key factors that can help mitigate the adverse consequences caused by the disruptions is incorporating sustainable farming methods. Agriculture also contributes a significant amount to climate change.

Hence, it's extremely crucial that we first take steps to reduce the emissions caused by our own methods. The farmers should adopt climate-smart farming methods, utilising tools such as climate forecasting tools, and plant cover crops among other things. They should also actively work towards reducing runoffs caused by irregular rainfall by strategically applying fertilisers. They should also boost crop resistance by using research-proven ways such as reducing the chemicals used in the production.



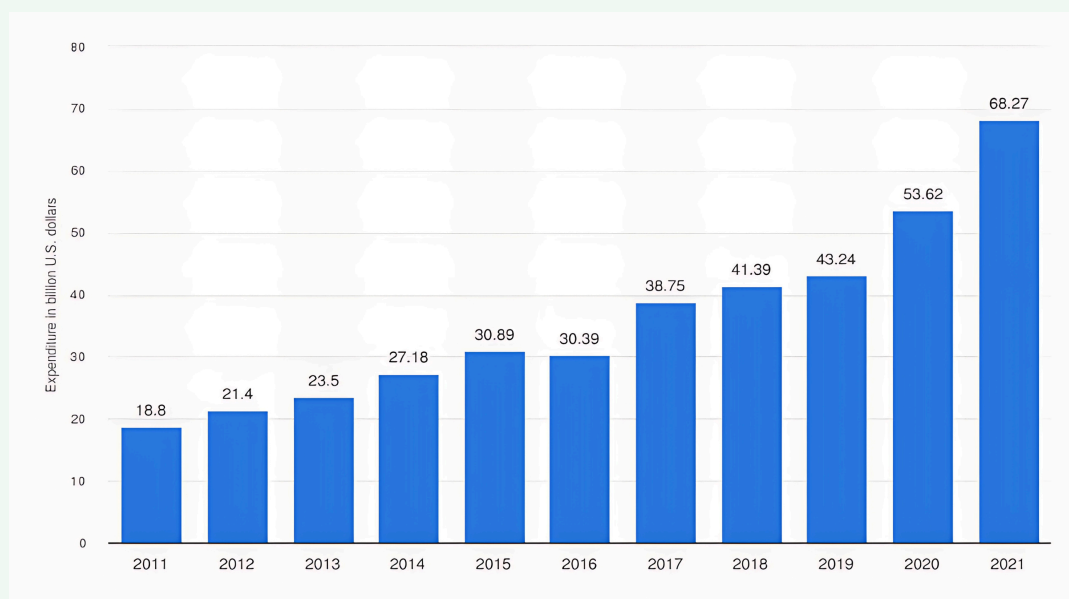
• Electronics Sector

The electronics industry is the backbone of modern technology. The industry is responsible for developing, manufacturing and distributing everything from smartphones, PCs, to smart homes and medical devices, and impacts every aspect of our life. During the unprecedented Covid-19 pandemic, it was the electronics industry that kept the world thriving. This industry runs on complex and globalised supply chain networks. The network of suppliers and manufacturers is often spread across multiple countries, which can expose the industry to diverse disruptions. Moreover this industry is rapidly evolving due to changes in technology. This even more complicates the supply chains. The key stakeholders of the supply chain include the suppliers of materials, components and subassemblies, the logistics providers, manufacturers and distributors. Disruptions at any level can create ripple effects. Disruptions can be caused by geopolitical issues, sanctions, natural disasters damaging the production and logistics, and in recent times the semiconductor shortage as well

1.Apple and chip shortage

Put simply, semiconductor chips are tiny yet crucial parts that act as the brains of electronic products. The Covid-19 pandemic triggered a worldwide semiconductor chip shortage. The pandemic related shutdowns not only halted the production but also disrupted the logistics and transportation of the chips. The limited supply was accompanied by a surge in demand for electronics like smartphones and laptops due to remote work and online learning. Chip manufacturers struggled to keep pace with the demand growth. Trade tensions and geopolitical issues further aggravated the situation. The shortage peaked in 2021 and gradually eased throughout 2022 and 2023. The lead time for chips rose upto 22 weeks due to these reasons. The shortage affected various industries. The electronics industry was severely hit. Apple faced the same chip supply chain issues as many other companies.

Given below is Apple's expenditure on semiconductor chips from 2011 to 2021.



The increasing expenditure on chips shows that despite the shortage, the demand for apple products like iPhones, MacBooks, iPads etc was rising rapidly. The production of popular apple products experienced delays. The shortages forced apple to cut down on its production targets of iPhone 13 series. This was a short term measure. iPhone 13 production faced delays, despite Apple prioritising it over other products. A shortage of chips resulted in an estimated 10 million fewer iPhones being produced in 2021. Even the products using its own M1 chip were affected. The company demonstrated resilience through various strategies. Apple secured long-term supply agreements with major chipmakers like TSMC and also diversified suppliers to reduce dependence. Apple prioritised the production of higher margin products like iPhones. There were stock shortages and delivery delays for Apple items like iPads, MacBooks, and Apple Watches. The company invested in R&D to explore alternative chip sources and in-house chip production. It also increased its R&D spending on internal chip development to reduce reliance on external suppliers. Apple also had to incur additional costs in order to negotiate long term agreements with suppliers. Apple passed on some increased costs to consumers through price hikes. Apple could successfully mitigate the impact and ensure future resilience. Though slowed, revenue still grew by 7-8% in fiscal year 2022.

2.Sony and 2011 Earthquake

The 2011 Tohoku earthquake and tsunami in Japan was a 9.0-magnitude earthquake followed by tsunami waves, which caused widespread destruction and loss of life.

Sony, a major player of the electronics industry based in Japan was also deeply impacted. Tohoku has long been an important manufacturing base for Sony. There were power outages as well as infrastructural damages to Sony's facilities. The logistics and transportation networks also faced widespread damage. The suppliers across Japan were also affected. As a result Sony's supply chain faced disruptions and various problems, affecting the availability and deliveries of components and materials. Production was disrupted at 10 sites of the company, because of direct damage from the natural disasters and electric failures. Two of the sites in that area, a Blu-ray disc factory and a research and development lab, were badly damaged by flooding; about 1,100 employees were trapped on upper floors. These disruptions caused delays and inventory shortages of various products like Blu-ray discs, semiconductors and cameras. Production of TVs, mobile phones, and other electronics was also impacted. The financial performance of Sony also took a hit. It reported a net loss of 456.7 billion Yen for the year 2011-12. Sony estimated an initial loss of 3.8 billion dollars directly due to the disaster. It also saw a 9.6% decline in its sales and operating revenue. Sony implemented various resilience strategies to minimise the impact and recover quickly. Sony began diversifying its supply chain, sourcing components from multiple regions and suppliers. New production facilities were established to reduce dependence on Japan. Investments in technology were also made such as disaster-resistant technologies. Sony also participated in relief efforts, providing financial aid and support to affected communities.

Conclusion

The case studies show how environmental conditions combined with natural disasters together with geopolitical conflicts along with trade wars and societal regulations restrict supply chain activities for established companies. Internal business factors which combine elements such as labor unrest together with insufficient technology along with less effective operational management practices substantially influence performance outcomes. The interruptions block merchandise and service transportation while setting off multiple impacts that spread across different business sectors resulting in worldwide business demands for resilient supply chains.

Company success demands better logistic systems and stronger risk controls as well as adaptable mechanisms that will safeguard operations from unexpected operational disruptions. Businesses should implement digital transformation to achieve real-time tracking capabilities and predictive analytics and operational automation. Organizations must spread their supply network among various suppliers to decrease their reliance on a single provider and maintain backup procurement systems. The joint effort between supply chain members will create better coordination and visibility that minimizes both delivery times and money wasted.

The assessment explores potential issues based on multiple different aspects while examining all practical outcomes of single disruptions. The worldwide pandemic created delivery complications, reducing market demand because a large number of stores remained closed.

Climate emergencies lead to long-lasting alterations in the automobile industry that creates consequences for the agricultural sector because of supply network relationships. Because of rising industrial interdependence economic disruptions in one section cause additional economic damages throughout different sectors.

The current business challenges demand that resilience strategies must move past classic risk management by embracing proactive planning together with regulatory compliance and sustainability strategies. A retail business can protect itself against volatility by building agility through regionalized supply chains and local manufacturing along with creating contingency plans for supply disruptions. The adoption of environmental social and governance (ESG) metrics enhances sustainability together with risk management by reducing exposure to unfriendly sourcing and environmental hazards.

Organizations need to adopt an integrated method that combines technological solutions with risk analysis and policy adjustments to maintain continuous supply chain operations. Swift response capabilities will determine the long-term success of supply chain networks since the uncertainty of the world is rapidly increasing.

Companies embracing resilience alongside innovation along with adaptability stand better prepared to handle disruptions which keeps them competitive in the market.

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