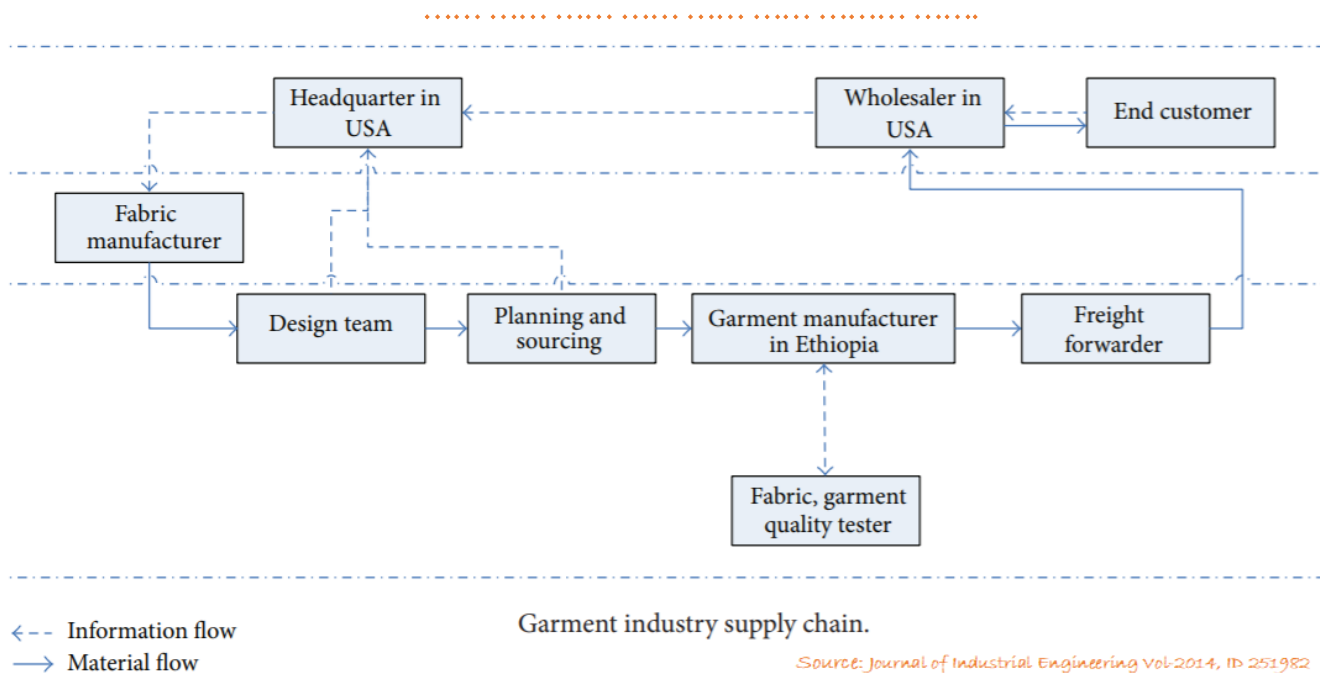




Impact of Uncertainty in Network:

- Globalization and supply chain
- Risk management in global supply chain
- Demand forecasting in supply chain
- Role of information technology in forecasting.



The primary purpose of a **supply chain network** design is to assess company policies and programs and to meet targets to accomplish long-term strategic objectives, and most business units or functional areas within a company are impacted by a network design project.

The term “globalization” refers to the free movement of goods, services, and people across the world. In regards to supply chain management, globalization refers to the process in which a business operates on an international scale.

Globalization offers companies the opportunity to reach new customers in new markets, which dramatically upsets how manufacturers need to operate to be successful. Exposure to new markets means exposure to greater competition and greater risk – but also greater reward.

Business today is in a global environment. This environment forces companies, regardless of location or primary market base, to consider the rest of the world in their competitive strategy analysis.

Firms cannot isolate themselves from or ignore external factors such as economic trends, competitive situations or technology innovation in other countries, if some of their competitors are competing or are located in those countries.

Companies have changed the ways in which they manage their operations and logistics activities. Changes in trade, the spread and modernization of transport infrastructures and the intensification of competition have elevated the importance of flow management to new levels.

In commerce, supply chain management, the management of the flow of goods and services, involves the movement and storage of raw materials, of work-in-process inventory, and of finished goods from point of origin to point of consumption.

It's the broad range of activities required to plan, control and execute a product's flow, from acquiring raw materials and production through distribution to the final customer, in the most streamlined and cost-effective way possible.

With the advent of globalization, managing supply chain activities has become more complex. Today a company operating in the United States may have its manufacturing facilities in China, Mexico or Taiwan and its customers throughout the world.

Many companies in order to manage its global operations may outsource their supply chain activities to third-party organizations around the globe. Outsourcing reduces the supply chain operating cost but when not managed effectively proves otherwise.

Globalization has dramatically changed how manufacturers operate, offering an opportunity to reach new customers in new markets while at the same time exposing firms to greater competition. Meanwhile, raw materials and supplier relationships must now be managed on a global scale. Just as there are benefits and costs of globalization, there are similar pros and cons of a global supply chain. In particular, companies need to manage the related risks.

Pros and Cons of Globalized Supply Chain:

Pros:

- **Reach new customers in new markets around the world** – Globalization simplifies communication between business owners, vendors, and customers and therefore makes it easier to reach new markets and stay connected with customers no matter where they are in the globe.
- **Expand sourcing opportunities** – Globalization makes it possible for businesses to secure a diverse selection of workers, materials, and products from regions of the world that were previously out of reach.
- **Offer a larger selection of goods and services** – Globalization increases your sourcing opportunities which means it also increases the range of products and services that you can provide for your customer.
- **Grow and expand the scope of their business** – Globalization makes communication near effortless, which make it easier for markets to expand and diversify, thus providing more opportunities for businesses owners to capitalize.
- **Save money and increase profits** – more options to source from and to capitalize on means more chances to save on spending and a greater chance of profit.

Cons:

To take advantage of the benefits of globalization, you need to know the negatives and how to respond to them.

- **Greater complexity** – Global supply chains have global problems. As companies globalize they must scale up all aspects of their business, especially their supply chain.
- **Increased risk to your supply chain** – When your materials, factories, and customers are spread around the globe that means your business is entirely at the mercy of global events, like natural disasters, port and border closures and changes to the geo-political landscape.
- **Increased competition** – You can bet that if your company broke into a new market that there are several companies just like yours with the have access to the exact same supplies, products, labor pool, and customers as you. To stay in global market supply chains, you need to be as lean and efficient as possible.
- **Greater data collection challenges** – When different aspects of your supply chain are scattered around the globe, the process data collection and oversight grows in complexity and becomes more difficult.
- **More legal issues** – Operating across borders means operating in countries with different legal systems, which can get complicated and expensive very quickly.

Benefits of a Globalized Supply Chain:

- **Expanded sourcing opportunities:** A world market offers businesses opportunities to secure a diverse selection of workers, materials, and products. This larger selection of goods and services often means the opportunity to select higher-quality or lower-cost options.
- **The opportunity to reach new customers in new markets:** Just as globalization offers more materials and laborers, it also offers new customers in new locations with new needs.
- **More room to grow:** New technologies and a shrinking globe mean that it is easier for companies to grow generally: to produce more, offer more, and sell more. Expanding borders also means expanding businesses and corporations.
- **More opportunities to save money:** Globalization's biggest benefit is that increases options: options for source materials, options for workers, and options for transportation. More options mean more chances to save on spending and increase profits.

Driving Forces of the Globalization Process:

The last two decades have seen the evolution of the global manufacturing environment. Majority of the manufacturers have global presence through exports, strategic alliances, joint ventures or as a part of a committed strategy to sell and produce in foreign markets.

The factors shaping the global environment and driving the development of global operations strategies of multinational firms fall into four categories.

1. Global Market Forces
2. Technological Forces
3. Global Cost Forces
4. Political and Macroeconomic Forces

1. Global Market Forces

There is tremendous growth potential in the foreign developing markets which has resulted in intensified foreign competition in local markets which forces the small – and medium-sized companies to upgrade their operations and even consider expanding internationally. There has also been growth in foreign demand which necessitates the development of a global network of manufacturing bases and markets. When the markets are global, the production-planning task of the manager becomes difficult on one hand and allows more efficient utilization of resources on the other. Few industries remain today in which the international product life-cycle theory still applies. Product markets, particularly in technologically intensive industries, are changing rapidly. Product -cycles are shrinking as customers demand new products faster. In addition, the advances in communication and transportation technology give customers around the world immediate access to the latest available products and technologies. Thus, manufacturers hoping to capture global demand must introduce their new products simultaneously to all major markets. Furthermore, the integration of product design and the development of related manufacturing processes have become the key success factors in many high-technology industries, where fast product introduction and extensive customization determine market success. As a result, companies must maintain production facilities, pilot production plants, engineering resources and even Research and Development (R & D) facilities all over the world. Apple Computer, for example, has built a global manufacturing and engineering infrastructure with facilities in California, Ireland and Singapore. This network allows Apple to introduce new products simultaneously in the American, European and Asian markets. Companies use the state-of-the-art markets as learning grounds for product development and effective production management, and then transfer this knowledge to their other production facilities worldwide. This rationale explains why Mercedes-Benz decided recently to locate a huge manufacturing plant in Vance, Alabama. The company recognizes that the United States is the state-of-the-art market for sport utility vehicles. It plans to produce those vehicles at the Vance plant and introduce them worldwide by 1997.

2. Technological Forces

A peculiar trend which was prevalent in the last decade, besides globalization, was a limited number of producers which emerged due to diversity among products and uniformity across national markets. Product diversity has increased as products have grown more complex and differentiated and product life cycles have shortened. The share of the US market for high-technology goods supplied by imports from foreign-based companies rose from a negligible 5 per cent to more than 20 percent with the last decade. Moreover, the sources of such imports expanded beyond Europe to include Japan and the newly industrialized countries of Hong Kong, Singapore, South Korea and Taiwan. There has been diffusion of technological knowledge and global low-cost manufacturing locations have emerged. In response to this diffusion of technological capability, multinational firms need to improve their ability to tap multiple sources of technology located in various countries. They also must be able to absorb quickly, and commercialize effectively, new technologies that, in many cases, were invented outside the firm thus overcoming the destructive and pervasive ‘not-invented-here’ attitude and resulting inertia. There has been technology sharing and inter firm collaborations. The well-known joint ventures in the auto industry between US and Japanese firms (GM-Toyota, Chrysler-Mitsubishi, Ford-Mazda) followed a similar pattern. US firms needed to obtain first-hand knowledge of Japanese production methods and accelerated product development cycles, while the Japanese producers were seeking ways to overcome US trade barriers and gain access to the vast American auto market. As competitive priorities in global products markets shift more towards product customization and fast new product development, firms are realizing the importance of co-location of manufacturing and product design facilities abroad. In certain product categories, such as Application Specific Integrated Circuits (ASICs), this was the main motivation for establishing design centres in foreign countries. Other industries such as pharmaceuticals and consumer electronics also have taken this approach.

3. Global Cost Forces

New competitive priorities in manufacturing industries, that is product and process conformance quality, delivery reliability and speed, customization and responsiveness to customers, have forced companies to reprioritize the cost factors that drive their global operations strategies. The Total Quality Management (TQM) revolution brought with it a focus on

total quality costs, rather than just direct labour costs. Companies realized that early activities such as product design and worker training substantially impact production costs. They began to emphasize prevention rather than inspection. In addition, they quantified the costs of poor design, low input quality and poor workmanship by calculating internal and external failure costs. All these realizations placed access to skilled workers and quality suppliers high on the priority list for firms competing on quality. Similarly, Just-in-time (JIT) manufacturing methods, which companies widely adopted for the management of mass production systems, emphasized the importance of frequent deliveries by nearby suppliers. A number of high-technology industries have experienced dramatic growth in the capital intensity of production facilities. A state-of-the-art semiconductor factory, for instance, costs close to half a billion dollars. When R & D costs are included, the cost of production facilities for a new generation of electronic products can easily exceed \$ 1 billion. Similarly, huge numbers apply for the development and production of new drugs in the pharmaceutical industry. Such high costs drive firms to adopt an economies-of-scale strategy that concentrates production in a single location, typically in a country that has the required labour and supplier infrastructures. They then achieve high-capacity utilization of the capital-intensive facility by aggressively pursuing the global market. Besides this the host government subsidies also become an important consideration.

4. Political and Macroeconomic Forces

Getting hit with unexpected or unreasonable currency devaluations in the foreign countries in which they operate is a nightmare for global operations managers. Managing exposure to changes in nominal and real exchange rates is a task which the global operations manager must master. If the economics are favourable, the firm may even go so far as to establish a supplier in a foreign country where one does not yet exist. For example, if the local currency is chronically undervalued, it is to the firm's advantage to shift most of its sourcing to local vendors. In any case, the firm may still want to source a limited amount of its inputs from less favourable suppliers in other countries if it feels that maintaining an ongoing relationship may help in the future when strategies need to be reversed. Becton Dickinson has built a global manufacturing network for its disposable syringe business, with production facilities in the United States, Ireland, Mexico and Brazil. When the Mexican peso was devalued, the company quickly shifted its production to the Mexican plant, thereby gaining a cost advantage over its competitors' US factories. The emergence of trading blocks in Europe (Europe 1992), North America (NAFTA), and the Pacific Rim has serious implications for the way firms A? structure or rationalize their global manufacturing/sourcing networks. These trends are clearly apparent in many industries. For instance, before 1992, 3M's European plants turned out different versions of the same product for the various European countries. Today, 3M manufacturing plants produce goods for all of Europe and, in the process, realize significant cost savings. Similarly, Philips, Thomson, Electrolux and Ford are in the process of creating pan-European networks of factories (producing both components and finished goods). The trade protection mechanisms which exist in the form of tariff and non-tariff barriers effect the global operation strategy; but these are readily losing importance in the new borderless trade regime.

Effect of a Global Integrated Economy on Global Operations

Operations and logistics are forced to adapt to environment. The logistic framework is forced to integrate its activities to meet the challenges of an integrated economy.

1. Geographical Integration

Geographical boundaries are losing their importance. Companies view their network of worldwide facilities as a single entity. Implementing worldwide sourcing, establishing production sites on each continent and selling in multiple markets all imply the existence of an operations and logistics approach designed with more than national considerations in mind. This geographical integration has been exploited by the regional economic integration, a very good example being the European Union. After the integration process was triggered off on 1 January 1993. At that time, customs duties between European Economic Community countries were abolished. This elimination of borders caused companies to rethink their physical flow structures for Europe as a whole. The usual practice of setting up sales subsidiaries in each country and creating country-specific logistics support and production systems was no longer appropriate. For companies the production and marketing is not restricted to one country but is global. Geographical integration becomes possible not only because of data processing and communication technologies, but also thanks to an excellent worldwide new means of transport. Express delivery services such as Federal Express, DHL, UPS and TNT, with their planes, hubs, systems of collection, tracking and final delivery, allow companies to send articles long distances, in the shortest time possible, and at a much lower cost compared to the cost of carrying inventory.

2. Functional Integration

The world is moving at such a fast pace that the various functional activities are no longer sequential and compartmentalized. The responsibilities of the logistics and operations manager is not limited to coordinating the physical flows relating to production distribution, or after sales service; they are also responsible for functions such as research,

development and marketing. This functional integration improves flow management considerably. When setting up projects for developing new models, automobile manufacturers such as Renault in Europe have two teams working together: one from the R&D department and the other from the logistics group. The teams' assignment is to simulate the flows required in the procurement and manufacturing stages according to the elements prepared by the research unit. The logistics department, for instance, can affect the automobile design stage by recommending modifications in order to create savings in logistics.

3. Sectorial Integration

In traditional supply chains, suppliers, manufacturers, distributors and customers each work to optimize their own logistics and operations. They acted in isolation concerned only with their part of the flow system which resulted in creating problems and inefficiencies for other players in the channel hampering the smooth flow all of which add cost to the total system. Leading firms, realizing this situation, are beginning to extend their view beyond their corporate boundaries and work cooperatively with all channel parties in an effort to optimize the entire system. This cross-boundary cooperation is referred to as Sectorial Integration.

CONCLUSION: The world economy is becoming borderless and integrated, driven by global market forces, global technological forces, global cost forces and political and macro-economic forces. The integrated world economy and global competitive arena is changing the way in which companies traditionally operated. There is also geographical, functional and sectorial integration which gives a truly global playing field to the companies and results in global supply chains.

Factors Influencing Distribution Network:

- Distribution network performance evaluated along two dimensions at the highest level:
 - Customer needs that are met
 - Cost of meeting customer needs
- Distribution network design options must therefore be compared according to their impact on customer service and the cost to provide this level of service.
- Elements of customer service influenced by network structure:
 - Response time
 - Product variety
 - Product availability
 - Customer experience
 - Order visibility
 - Returnability
- Supply chain costs affected by network structure:
 - Inventories
 - Transportation
 - Facilities and handling
 - Information

OPTIMIZATION TOOLS - GLOBAL SUPPLY CHAIN MANAGEMENT

1. Shipping Status Alerts and Updates

Real-time alerts provide timely information on all [shipping](#) activities.

2. Order Processing

Order processing is massively important to any supply chain, and as such, solutions provide the tools needed to make this task easier and more efficient. These tools support all functions across order processing like sales order processing, order management, order fulfilment, billing and order to cash.

3. Lean Inventory

Lean production is a concept that dates back to the 1940s, created by Toyota and inspired by Henry Ford's [just-in-time production](#). The idea is that companies create only what's needed at the moment, determined by current and projected customer demand. Before lean production, manufacturers would create and house large surpluses of goods. This resulted in [massive inefficiencies](#), wasting time and effort.

4. Warehouse Management

Depending on the solution you choose, these tools may also help manage the day-to-day operations within your warehouses. Solutions provide a wide array of warehouse management capabilities as broad or specific as your company requires. Some

solutions provide advanced supply chain planning tools, allowing users to handle complex logistics related to receiving, product tracking, cycle counting, route planning and more.

5. Specialized Freight Handling

In addition to various shipping features, tools can also incorporate different types of industry-specific freight handling functionality. For example, the evolution of [cold chain logistics](#) and new regulations concerning perishable goods has changed compliance standards. To handle this, some platforms have integrated technology that can verify that those goods were kept at the proper temperature right up to the last mile of delivery. This tool is also offered by vendors as a standalone product but can be neatly integrated with a larger solution.

6. Bid and Spend

Sourcing and procurement are a major part of supply chain operations for many businesses. Therefore, tools that support these activities should be a top priority as well. Sophisticated tools for supply chain management can help you dig down and take a granular look at what you're spending on each item that you take in and send out during production. Bid and spend tools also automate much of the procurement process, reducing errors and resources spent. For instance, top tools can automate the entire procure-to-pay process.

7. Supplier Management

Tying in strongly with bid and spend tools, supplier management is a must-have when it comes to procurement. Along with assistive features for cost issues, supply chain management tools can also help businesses get a better understanding of how they relate to their suppliers. These tools show the history of a business partnership and how it affects the supply chain. Using supplier performance analysis, users can see how any given supplier has contributed to a business model.

8. Demand Forecasting

Based on past trends, supply chain forecasting tools help you anticipate your customers' demand. This provides the essential information to make crucial decisions regarding production planning, labor management and supplier relationships in order to meet this demand. Without forecasts, you risk stock shortages during periods of intense demand. On the other hand, when demand is unexpectedly low, you risk running high carrying costs you could've avoided otherwise.

9. Analytics and Reports

In addition to analyzing consumer demand and your suppliers' performance, this type of supply chain analytics tool performs analyses of your data from the entire supply chain. Analysis tools allow users full visibility not just into the physical location of inventory, but also into the health and performance of the company. Analytics can provide insight into the company as a whole or into individual sectors. Demand forecasts give visibility into the popularity of certain items, whereas warehouse analysis might tell you the most efficient way to store and move that product. This also allows users to analyze order processing which can uncover the source of delays and errors.

10. Collaboration Portals

In addition to providing a hub for procurement, modern supply chain monitoring tools also allow companies and their suppliers to collaborate in other ways through a designated portal. [Supply chain portals](#) can eliminate several collaboration challenges including communication issues, bottlenecks in requisition and order, and other issues.

Risk management in global supply chain:

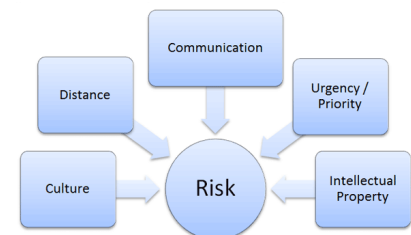
Risk is often defined as

$RISK = f(\text{Probability, Consequences})$.

Hence, risk is the combination of the probability of an event and its consequences/impacts.

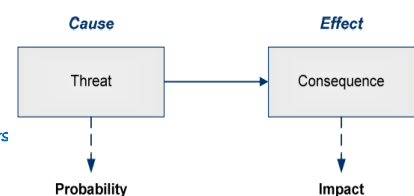
Risk in the context of supply chains may be associated with the [production/procurement processes](#), the [transportation/shipment of the goods](#), and/or the [demand markets](#).

Risk is a fact of life for the supply chain professional due to the long list of forces that drive supply chain risk. These include [quality and safety challenges](#); supply shortages; legal, security, regulatory and environmental compliance; weather and natural disasters; and terrorism. Companies with global supply chains face an addition potential for risk, including, but not limited to, the longer lead times needed in the global environment; supply disruptions due to global customs, foreign regulations and port congestion; political and/or economic instability in a source country; and changes in economics such as exchange rates.



Components of Risk

Risk can be thought of as a **cause-and-effect** pair, where the threat is the cause, and the resulting consequence is the effect. In this context, **threat** is defined as a



circumstance with the potential to produce loss, while a **consequence** is defined as the loss that will occur when a threat is realized.

Three measures are associated with a risk: (1) probability, (2) impact, and (3) risk exposure. The relationships between probability and impact and the components of risk are shown in Figure. In this context, **probability** is defined as a measure of the likelihood that a threat will occur, while **impact** is defined as a measure of the loss that will occur if the threat is realized. **Risk exposure** provides a measure of the magnitude of a risk based on current values of probability and impact.

Supply chain risk management [SCRM]: Is the process of taking **strategic** steps to identify, assess and mitigate the risk in your end-to-end supply chain. A comprehensive approach to SCRM involves the management of all types of risk, for all tiers of supply and for all risk objects (suppliers, locations, ports and more).

Supply Chain Risks:

Supply chain risk management refers to the process by which retailers take strategic steps to identify, assess, and mitigate risks within their end-to-end supply chain. There are both internal and external risks that can disrupt your supply chain, so it's helpful to understand the difference between the two.

External Supply Chain Risks

As their name implies, these global supply chain risks come from outside of your organization. Unfortunately, that means that they are harder to predict and typically require more resources to overcome. Some of the top external supply chain risks include:

- **Demand Risks:** Demand risks occur when you **miscalculate product demand** and are often the product of a lack of insight into year-over-year **purchasing trends or unpredictable demand**.
- **Supply Risks:** Supply risks occur when the raw materials your business relies on **aren't delivered on time** or at all, thereby **causing disruption to the flow of product, material, and/or parts**.
- **Environmental Risks:** Environmental risk in the supply chain is the direct result of social-economic, political, governmental, or environmental issues that affect the timing of any aspect of the supply chain.
- **Business Risks:** Business risks occur whenever unexpected changes take place with one of the entities you depend on to keep your supply chain running smoothly — for example, the purchase or sale of a supplier company.

Internal Supply Chain Risks:

This refers to any supply chain risk factors that are within your control, and that can be identified and monitored using supply chain risk assessment software, robust analytics programs, IoT capabilities, and more. Although internal supply chain risks are more manageable than external ones, they're still — to some degree — unavoidable. Here's what to look for:

- **Manufacturing Risks:** Manufacturing risks refer to the possibility that a key component **or step of your workflow could be disrupted, causing operations to go off schedule**.
- **Business Risks:** Business risks are a product of disruptions to standard personnel, management, reporting, and other essential business processes.
- **Planning and Control Risks:** Planning and control risks are caused by inaccurate forecasting and assessments and poorly planned production and management.
- **Mitigation and Contingency Risks:** Mitigation and contingency risks can occur if your business doesn't have a contingency plan for supply chain disruptions.

MITIGATION STRATEGY	Disruptions	Delays	Forecast risk	Procurement risk	Receivables risk	Capacity risk	Inventory risk
Add capacity	↓	↓	↓	↓	↑	↓	↓
Add inventory	↓	↓	↓	↓	↓	↑	↓
Have redundant suppliers	↓	↓	↓	↓	↑	↓	↓
Increase responsiveness	↓	↓	↓	↓	↓	↓	↓
Increase flexibility	↓	↓	↓	↓	↓	↓	↓
Aggregate or pool demand	↓	↓	↓	↓	↓	↓	↓
Increase capability	↓	↓	↓	↓	↓	↓	↓
Have more customer accounts	↓	↓	↓	↓	↓	↓	↓

Greatly Increases Risk ↑ ↓ Decreases Risk
 Increases Risk ↑ ↓ Greatly Decreases Risk

The five steps

The five steps of global supply chain risk management:

1. Risk Identification
2. Risk Assessment and Evaluation
3. Selection of Risk Management Strategies
4. Implementation of Risk Management Strategies
5. Mitigation of Supply Chain Risks

Supply Chain Risk Management- Drivers of Risk

Category of Risk	Drivers of Risk
Disruptions	<ul style="list-style-type: none"> → Natural disaster → Labor disputes → Supplier bankruptcy → War and terrorism → Dependency on a single source of supply as well as the capacity and responsiveness of alternate supplier
Delays	<ul style="list-style-type: none"> → High-capacity utilization at supply source → Inflexibility of supply source → Poor quality or yield at supply source. → Excessive handling due to border crossing or to change in transportation modes
Systems	<ul style="list-style-type: none"> → Information infrastructure breakdown → System integration or extensive system networking → E – Commerce
Forecast	<ul style="list-style-type: none"> → Inaccurate forecast due to long lead times, Seasonality, Productive variety, Short life cycles, Small customer base → “Bullwhip effect” or information distortion due to sales promotion, incentive, lack of Supply-chain visibility and exaggeration of demand in times of product shortage.
Intellectual Property	<ul style="list-style-type: none"> → Vertical integration of supply chain → Global outsourcing and markets
Procurement	<ul style="list-style-type: none"> → Exchange rate risk → Percentage of key component or raw material produced from a single source → Industry wide capacity utilization → Long-term versus short-term contracts
Receivables	<ul style="list-style-type: none"> → Number of Customers → Financial strength of Customers
Inventory	<ul style="list-style-type: none"> → Rate of product obsolescence → Inventory hold cost → Product Value → Demand & supply Uncertainty
Capacity	<ul style="list-style-type: none"> → Cost of Capacity → Cost of flexibility

Risk Management Strategies:

1. Avoidance – Exiting a market (or product) or delay entering a market (or product)
2. Postponement – Delay commitment of resources to maintain utmost flexibility
3. Speculation – Assuming risk to gain competitive advantage
4. Hedging – Globally dispersing your portfolio of suppliers, customers and facilities
5. Control – Vertical and lateral integration of suppliers and business partners
6. Transferring/sharing risk – Outsourcing, offshoring, contracting
7. Security – Identifying unusual movements and protecting against unwanted penetration

Demand forecasting in supply chain

Demand forecasting - process of planning or predicting the demand of materials to ensure you can deliver the right products and in the right quantities to satisfy customer demand without creating a surplus.

Demand forecasting also facilitates critical business activities, like financial planning, production planning, risk assessment, and the purchase of raw materials.

Most importantly, demand forecasting enables retailers to **avoid stock outs and over stocking**, improve production lead times, minimize costs, increase operational efficiencies, and improve the customer experience.

For most retailers, stock-outs are a worst-case scenario. You can't make any money if you run out of inventory to sell, but holding too much inventory can eat away at profitability. You have to strike the right balance between out-of-stock and overstock.

In all forms of retail, **overstocking** is when a company orders too much inventory and **understocking** is when a company orders too little. To minimize the likelihood of overstocking and understocking, retailers utilize a systematic process of sourcing, storing, and selling inventory, known as **inventory management**.

IMPORTANCE OF DEMAND FORECASTING

1. Qualitative methods

- **Jury of executive opinion method:** Method calls for the pooling of views of a group of executives on expected future sales and combining them into a sales estimate.
- **Delphi method:** Method involves converting the views of a group of experts, who do not interact face – to – face, into a forecast through an iterative process.

2. Time series projection methods

these methods generate forecasts on the basis of an analysis of the historical time series.

- **Trend projection method:** Method involves extrapolating (extend the application of (a method or conclusion) to an unknown situation by assuming that existing trends will continue or similar methods will be applicable.) the past trend onto the future.
- **Exponential smoothing method:**
 - Forecasts are modified in the light of observed errors.
 - Is a time series forecasting method for univariate data.
 - Prediction is a weighted sum of past observations, but the model explicitly uses an exponentially decreasing weight for past observations.
- **Moving average method:** forecast for the next period represents a simple arithmetic average or a weighted arithmetic average of the last few observations.

3. Casual methods:

More analytical than the preceding methods, causal methods seek to develop forecasts on the basis of cause – effect relationships specified in an explicit, quantitative manner. The important methods under this category are as follows:

- **Chain ratio method:** A simple analytical approach, this method calls for applying a series of factors for developing a demand forecast.
- **Consumption level method:** Useful for a product that is directly consumed; this method estimates consumption level on the basis of elasticity coefficients, the important ones being the income elasticity of demand and the price elasticity of demand.
- **End use method:** Suitable for intermediate products, the end use method develops demand forecasts on the basis of the consumptions coefficient of the product for various uses.
- **Leading indicator method:** According to this method, observed changes in leading indicators are used to predict the changes in lagging variables.
- **Econometric method:** Perhaps the most sophisticated forecasting tool, the econometric method involves estimating quantitative relationship derived from economic theory.

Quantitative Approaches of Forecasting

Most of the quantitative techniques calculate demand forecast as an average from the past demand. The following are the important demand forecasting techniques.

- **Simple average method:** A simple average of demands occurring in all previous time periods is taken as the demand forecast for the next time period in this method.
- **Simple moving average method:** In this method, the average of the demands from several of the most recent periods is taken as the demand forecast for the next time period. The number of past periods to be used in calculations is selected in the beginning and is kept constant (such as 3-period moving average).

- **Weighted moving average method:** In this method, unequal weights are assigned to the past demand data while calculating simple moving average as the demand forecast for next time period. Usually most recent data is assigned the highest weight factor.
- **Exponential smoothing method:** In this method, weights are assigned in exponential order. The weights decrease exponentially from most recent demand data to older demand data.
- **Regression analysis method:** In this method, past demand data is used to establish a functional relationship between two variables. One variable is known or assumed to be known; and used to forecast the value of other unknown variable (i.e. demand).

Error in Forecasting

Error in forecasting is nothing but the numeric difference in the forecasted demand and actual demand. **MAD** (Mean Absolute Deviation) and **Bias** are two measures that are used to assess the accuracy of the forecasted demand. It may be noted that MAD expresses the magnitude but not the direction of the error.

Example 1

Simple Average:

A XYZ television supplier found a demand of 200 sets in July, 225 sets in August & 245 sets in September. Find the demand forecast for the month of October using simple average method.

The average demand for the month of October is

$$\begin{aligned}
 SA &= \left(\frac{D1 + D2 + D3}{3} \right) \\
 &= \left(\frac{200 + 225 + 245}{3} \right) \\
 &= 223.33 \\
 &\approx 224 \text{ units}
 \end{aligned}$$

Example 2

Simple Moving Average:

A XYZ refrigerator supplier has experienced the following demand for refrigerator during past five months.

Month	Demand
February	20
March	30
April	40
May	60
June	45

Find out the demand forecast for the month of July using five-period moving average & three-period moving average using simple moving average method.

$$MA_n = \frac{\sum_{i=1}^n D_i}{n}$$

For five period average (i.e. $n=5$)

$$\begin{aligned}
 MA_5 &= \frac{20 + 30 + 40 + 60 + 45}{5} \\
 &= 29 \text{ units}
 \end{aligned}$$

For three period average (i.e. $n=3$)

$$\begin{aligned}
 MA_3 &= \frac{40 + 60 + 45}{3} \\
 &= 48.33 \\
 &\approx 49 \text{ units}
 \end{aligned}$$

Example 3

Weighted Moving Average Method:

The manager of a restaurant wants to make decision on inventory and overall cost. He wants to forecast demand for some of the items based on weighted moving average method. For the past three months he experienced a demand for pizzas as follows:

Month	Demand
October	400
November	480
December	550

Find the demand for the month of January by assuming suitable weights to demand data.

$$WMA = \sum_{i=1}^n C_i D_i$$

C_i = Weights for Periods
 D_i = Demand for Periods
 Let $C_1 = 0.25, C_2 = 0.3, C_3 = 0.5$
 $\therefore WMA = C_1 D_1 + C_2 D_2 + C_3 D_3$
 $= 0.25 * 400 + 0.3 * 480 + 0.5 * 550$
 $= 100 + 144 + 275$
 $= 519 \text{ units}$

Example 4

Exponential Smoothing:

One of the two-wheeler manufacturing company experienced irregular but usually increasing demand for three products. The demand was found to be 420 bikes for June and 440 bikes for July. They use a forecasting method which takes average of past year to forecast future demand. Using the simple average method demand forecast for June is found as 320 bikes (Use a smoothing coefficient 0.7 to weight the recent demand most heavily) and find the demand forecast for August.

$$F_t = \alpha D_{t-1} + (1 - \alpha) F_{t-1}$$

where α = Smoothing Coefficient
 D_{t-1} = Actual Demand for Recent Period
 F_{t-1} = Demand Forecast for Recent Period
 F_t = Forecast of Next Period Demand
 for July :
 $= 0.7(420) + (1 - 0.7)320$
 $= 294 + 96$
 $= 390 \text{ units}$
 for August :
 $= 0.7(440) + (1 - 0.7) 390$
 $= 308 + 117$
 $= 425 \text{ units}$

Example 5

Regression Analysis :

Farewell Corporation manufactures Integrated Circuit boards(I.C board) for electronics devices. The planning department knows that the sales of their client goods depends on how much they spend on advertising, on account of which they receive in advance of expenditure. The planning department wish to find out the relationship between their clients advertising and sales, so as to find demand for I.C board.

The money spend by the client on advertising and sales (in dollar) is given for different periods in following table :

Period(t)	Advertising (X_t) \$(1,00,000)	Sales (D_t) \$(1,000,000)	D_t^2	X_t^2	$X_t D_t$
1	20	6	36	400	120
2	25	8	64	625	200
3	15	7	49	225	105
4	18	7	49	324	126
5	22	8	64	484	176
6	25	9	81	625	225
7	27	10	100	729	270
8	23	7	49	529	161
9	16	6	36	256	96
10	20	8	64	400	120
Σ	211	76	592	4597	1599

$$\begin{aligned}
 b &= \frac{n(\sum X_t D_t) - (\sum X_t)(\sum D_t)}{n(\sum X_t^2) - (\sum X_t)^2} \\
 &= \frac{10(1599) - (211)(76)}{10(4597) - (211)^2} \\
 &= \frac{15990 - 16036}{45970 - 44521} \\
 &= \frac{-46}{1449} = -0.0317 \\
 a &= \sum D_t - b \sum X_t \\
 &= \frac{76 - (-0.0317)(211)}{10} \\
 &= 8.268
 \end{aligned}$$

Relationship between future sales F_t and advertising cost X_t is

$$\begin{aligned}
 F_t &= a + bX_t \\
 &= 8.268 - 0.0317X_t
 \end{aligned}$$

\$

Role of Information Technology in Forecasting:

A supply chain is a network of companies, people, functions, information, and resources who are involved in moving the product from the supplier to the customer.

Data is pivotal to the execution of the supply chain, primarily because it provides the base on which the supply chain managers can take decisions.

Information technology provides the tools which can pick up relevant information, break it down for proper analysis and execute on it for optimum performance of the supply chain.

1. Integrated & Coordinated Supply Chain - A supply chain can only work efficiently when it is properly integrated and well-coordinated. IT performs this crucial task by bringing in multiple technologies and combining them in the best possible manner to optimise all possible scenarios of the supply chain. These technologies make the collection of even the most basic data possible. In turn, this allows precise and detailed data analysis possible on the Business Intelligence (BI) side.

2. Increased Productivity - Smooth flow of information, new technologies and effective communication increases the productivity of all entities in the supply chain. It is like a trigger action which starts at one end and continues down the line until the action is (in this case the product movement) complete. Instead of going back and forth, IT provides the link that passes the requisite information continuously.

3. Cost Reduction - IT permits optimum utilisation of resources and assets. Old data is used to study the trends and technology is used to analyse it for improving performance. When resources are used optimally they result in cost reduction. In a supply chain, the role of IT becomes more prominent because it has to make all the parties use their respective resources in the most cost-efficient manner. When IT is used as it should be there is a dramatic fall in overall expenses.

4. Product Improvement - IT consists of tools and applications which can be used to gain early awareness. In a market where the customer wants something new regularly, the product will either have to evolve or it will go out of demand. To stay in business, you will have to introduce product improvement at all levels. The kind and extent of product improvement can be validated with the help of IT.

5. Supply Chain Visibility - Information makes the entire supply chain visible to the managers. The manner in which the information flows from one collaborator to the other and the impact it has on others is used by the managers in making strategic decisions.

Functional Roles of IT in Supply Chain Management

Apart from the above-mentioned basic roles, there are three functional roles of IT in SCM. These are:

1. Transaction Execution - When information flows efficiently between the participants of the SC, the number of transactions between them is reduced. IT increases the efficiency of repetitive data exchanges. This data usually is appropriate for delivery verification, order processing, billing, and dispatch advice.

2. Collaboration & Coordination - IT renders the flow of information. This makes for easier planning, coordination and improved collaboration between all participants. Demand forecasts make it possible to plan for the future and order tracking makes knowing the physical location of each order a reality. Neither of these activities are possible without IT.

3. Decision Support - Good decisions cannot be pulled out of thin air, they are and should be based on data. IT is a huge benefit in decision support. It can collect even the most complicated set of data and convert it to easy to understand charts and reports. In this context, IT extends decision support to all managers.

Software in Supply Chain Management

There are many software systems which are used in SCM. These are primarily categorised as:

1. Enterprise Resource Planning - Materials requirement planning, which was earlier used to distribute resources for a manufacturing operation, resulted in enterprise resource planning (or ERP). Electronic Resource Planning is a system that links individual IT applications into a single one. This results in the integration of the data and the processes of the complete business. When all operations are consolidated, information relating to cash flow and material flow starts making more sense. ERP has now become the backbone of the supply chain and provides an integrated view of the organisation as a whole. Today, ERP has also led to the automation of many functions so that there is minimal human intervention.

2. Electronic Data Interchange - EDI is the exchange of business data from one computer to another. It is usually done in a standard format so that all concerned parties can use it according to their need without having to constantly ask for it. The benefit of using EDI is that it allows companies, across the industry, to communicate with each other. Everyone who uses EDI follows the same rules and methods. This makes for efficient inventory management, better business relationships, and improved customer service.

3. Supply Chain Management Systems - An ideal supply chain management system will help in planning, selecting the vendor, manufacturing, logistics, and building the customer relationship. To provide the necessary assistance Supply Chain Planning (SCP) software and Supply Chain Execution (SCE) software are used.

4. Customer Relationship Management - CRM or e-CRM uses IT to assist an e-business in managing its customer base. It matches customer needs with the product plans to increase sales.

Most Promising Demand and Forecasting Technology Solution Providers:

Company Name	Company Description
Blue Ridge	Blue Ridge unique forecasting solution helps retailers and distributors capitalize on richer, customer transaction data to generate precise supply chain planning recommendations
Causometrix	Provides cloud-based SaaS applications for demand planning and inventory replenishment and the necessary tools for the associated collaborative planning
Demand Foresight	Helps optimize inventory, increase customer satisfaction, reduce capital investment, and increase profits by using their own forecasting technology
Demand Management	Delivers the powerful demand planning and inventory planning functionality that an organization needs to increase their visibility into their supply chain processes
DemandLink	Provides next-generation demand planning and high accuracy forecasting systems for retailers
E2open	Enables supply chains to better plan, execute and collaborate
GMDH LLC	Creates advanced software solutions by bringing the power of the GMDH modeling and forecasting algorithms, providing accurate, flexible forecasting for businesses
John Galt Solutions	Delivers world-class supply chain, inventory, and forecast solutions to companies who depend on the importance of accurate prediction tools to establish a world-class planning process
JustEnough	Just Enough Demand Forecasting automates the production of an organizations' forecasts, accommodating everything from erratic products to seasonal variations and trends
Keption	Provides a rapid development approach towards leveraging financial planning and reporting applications on the Microsoft BI platform

Company Name	Company Description
Logility	Offers a complete supply chain management and that features a performance monitoring architecture and provides supply chain visibility; demand, inventory and replenishment planning
Manhattan Associates [NASDAQ: MANH]	Manages the delicate balancing act between supply and demand, between minimizing inventory investment and optimizing revenue opportunities
NeoGrid	Provider of end-to-end supply chain management solutions that enables companies to access action-oriented collaboration tools in a high-scale
One Network	Provides an advanced Cloud PaaS platform and a wide array of SaaS business applications deployed onto a large business network
ORTEC	Provider of optimization and analytics solution for making businesses efficient
Outperform Solutions	A solution provider for the demand forecasting which inspects and enhances the sales and operations
RELEX Solutions	Provides an integrated retail and supply chain planning system
StatWizards	Provides an inclusive software suite for demand forecasting, by utilizing the commonly available data within the enterprise
Vanguard Software Corporation	Vanguard automates manual processes to reduce planning-cycle time, and it integrates with core systems to ensure that the organization is working with the latest data
Zimit	Forecasting, quoting, and scheduling for the professional services industry