

Developing a successful and sustainable agile supply chain in alignment with business strategy for profitability

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Abstract : Supply Chain Management (SCM) is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, at the right time. This article discusses the importance, objectives and principles of supply chain management. It details about supply chain network and the factors influencing the network. It examines the supply chain alignment with the business strategy and its implementation. It explores the supply chain drivers and metrics to improve the supply chain profitability. Finally this article discusses managing supply chain relationships for co-operation and trust.

Keywords: Supply Chain Management, Principles of SCM, Supply chain network, Supply chain alignment, Supply chain implementation, Forecasting, Drivers, Metrics, Profitability, Co-operation and Trust

I. Introduction

Fierce competition in today's global markets, the introduction of products with shorter life cycles, and the heightened expectations of customers have forced business enterprises to invest in, and focus attention on, their supply chains. This, together with continuing advances in communications and transportation technologies (e.g., mobile communication, Internet, and overnight delivery), has motivated the continuous evolution of the supply chain and of the techniques to manage it effectively. The supply chain, which is also referred to as the *logistics network*, consists of suppliers, manufacturing centers, warehouses, distribution centers, and retail outlets, as well as raw materials, work-in-process inventory, and finished products that flow between the facilities.

II. Supply Chain Management (SCM)

A supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves. Within the organization, the supply chain refers to a wide range of functional areas. These include Supply Chain Management related activities such as inbound and outbound transportation, warehousing, and inventory control. Sourcing, procurement, and supply management fall under the supply-chain umbrella, too. Forecasting, production planning and scheduling, order processing, and customer service all are part of the process as well. Importantly, it also embodies the information systems so necessary to monitor all of these activities. Simply stated, "The supply chain encompasses all of those activities associated with moving goods from the raw-materials stage through to the end user."

In addition to the departments within the organization, it includes vendors, carriers, third party companies, and information systems providers. The primary purpose of any supply chain is to satisfy customer needs and, in the process, generate profit for itself. A typical supply chain may involve a variety of stages. These supply chain stages include:

- Customers
- Retailers
- Wholesalers/distributors
- Manufacturers
- Component/raw material suppliers

III. Importance of Supply Chain Management

Managers these days recognize that getting products to customers faster than the competition will improve a company's competitive position. Why is it so important for companies to get products to their customers quickly? Faster product availability is key to increasing sales. There's a substantial profit advantage for the extra time that company are in the market and competitor is not. If the company can be there first, it gets more orders and more market share. The ability to deliver a product faster also can make or break a sale. If two alternatives [products] appear to be equal and one is immediately available and the other will be available in a week, by default, customers will choose the available one.

Clearly, "Supply Chain Management has an important role to play in moving goods more quickly to their destination." The five areas in which supply chain management can have a direct effect on corporate value includes:

- **Profitable growth.** Supply chain management contributes to profitable growth by allowing assembly of "perfect orders," supporting after-sales service, and getting involved in new product development. According to a research, inefficiencies in the supply chain can waste up to 25 percent of a company's operating costs..
- **Working-capital reductions.** Increasing inventory turns, managing receivables and payables, minimizing days of supply in inventory, and accelerating the cash-to-cash cycle all are affected by supply chain execution.
- **Fixed-capital efficiency.** This refers to network optimization, for instance, assuring that the company has the right number of warehouses in the right places, or outsourcing functions where it makes more economic sense.
- **Global tax minimization.** "There's a ton of money here." If companies look at assets and sales locations, transfer pricing, customs duties, and taxes.
- **Cost minimization.** This largely focuses on day-to-day operations, but it also may involve making strategic choices about such issues as outsourcing and process design.

IV. Objectives of the Supply Chain Management

The fundamental objective is to "add value". The objective of every supply chain should be to maximize the overall value generated. The value a supply chain generates is the difference between what the final product is worth to the customer and the costs the supply chain incurs in filling the customer's request. For most commercial supply chains, value will be strongly correlated with supply chain profitability (also known as supply chain surplus), the difference between the revenue generated from the customer and the overall cost across the supply chain.

Supply Chain Management becomes a tool to help accomplish corporate strategic objectives:

- reducing working capital,
- taking assets off the balance sheet,
- accelerating cash-to-cash cycles,
- Increasing inventory turns, and so on.

The objective of supply chain management is to be efficient and cost-effective across the entire system; total system wide costs, from transportation and distribution to inventories of raw materials, work in process, and finished goods, are to be minimized. The emphasis is not on simply minimizing transportation cost or reducing inventories but, rather, on taking a *systems approach* to supply chain management.

V. Principles of Supply Chain Management

Today managers recognize two important things. First, they think about the supply chain as a whole—all the links involved in managing the flow of products, services, and information from their suppliers' suppliers to their customers'. Second, they pursue tangible outcomes—focused on revenue growth, asset utilization, and cost. To help managers, successful manufacturers distilled from their experience and devised seven fundamental principles of supply chain management which are listed below:

- **Principle 1:** Segment customers based on the service needs of distinct groups and adapt the supply chain to serve these segments profitably.
- **Principle 2:** Customize the logistics network to the service requirements and profitability of customer segments.
- **Principle 3:** Listen to market signals and align demand planning accordingly across the supply chain, ensuring consistent forecasts and optimal resource allocation.
- **Principle 4:** Differentiate product closer to the customer and speed conversion across the supply chain.
- **Principle 5:** Manage sources of supply strategically to reduce the total cost of owning materials and services.
- **Principle 6:** Develop a supply chain-wide technology strategy that supports multiple levels of decision making and gives a clear view of the flow of products, services, and information.
- **Principle 7:** Adopt channel-spanning performance measures to gauge collective success in reaching the end-user effectively and efficiently.

Supply chain strategies cannot be determined in isolation. They are directly affected by another chain called the *development chain*. It is challenging to design and operate a supply chain so that total system wide costs are minimized, and system wide service levels are maintained. Supply chains need to be designed and managed to eliminate as much uncertainty and risk as possible as well as deal effectively with the uncertainty and risk that remain.

VI. Supply Chain Management structure

A supply chain is composed of a company and the suppliers and customers of that company. This is the basic group of participants that creates a simple supply chain. The SCM structure includes:

- **Producers:** Producers or manufacturers are organizations that make a product. This includes companies that are producers of raw materials and companies that are producers of finished goods. Producers of raw materials are organizations that mine for minerals, drill for oil and gas, and cut timber. It also includes organizations that farm the land, raise animals, or catch seafood. Producers of finished goods use the raw materials and sub-assemblies made by other producers to create their products.
- **Distributors:** Distributors are companies that take inventory in bulk from producers and deliver a bundle of related product lines to customers. Distributors are also known as wholesalers.
- **Retailers:** Retailers stock inventory and sell in smaller quantities to the general public.
- **Customers:** Customers or consumers are any organization that purchases and uses a product.
- **Service Providers:** These are organizations that provide services to producers, distributors, retailers, and customers. Service providers have developed special expertise and skills that focus on a particular activity needed by a supply chain. Because of this, they are able to perform these services more effectively and at a better price than producers, distributors, retailers, or consumers could do on their own.

VII. Supply chain distribution network design

Supply chain network design includes the assignment of facility role, location of manufacturing, storage, or transportation-related facilities, and the allocation of capacity and markets to each facility. Supply chain network design decisions are classified as follows.

1. **Facility role:** What role should each facility play? What processes are performed at each facility?
2. **Facility location:** Where should facilities be located?
3. **Capacity allocation:** How much capacity should be allocated to each facility?
4. **Market and supply allocation:** What markets should each facility serve? Which supply sources should feed each facility?

Network design decisions have a significant impact on performance because they determine the supply chain configuration and set constraints within which the other supply chain drivers can be used either to decrease supply chain cost or to increase responsiveness. All network design decisions affect each other and must be made taking this fact into consideration. Decisions concerning the role of each facility are significant because they determine the amount of flexibility the supply chain has in changing the way it meets demand.

7.1 Design options for a distribution network

Managers must make two key decisions when designing a distribution network:

1. Will product be delivered to the customer location or picked up from a preordained site?
2. Will product flow through an intermediary (or intermediate location)?

Based on the firm's industry and the answers to these two questions, one of six distinct distribution network designs may be used to move products from factory to customer, which are classified as follows:

1. Manufacturer storage with direct shipping
2. Manufacturer storage with direct shipping and in-transit merge
3. Distributor storage with package carrier delivery
4. Distributor storage with last-mile delivery
5. Manufacturer/distributor storage with customer pickup
6. Retail storage with customer pickup

7.2 Factors influencing network design decisions

7.2.1 Strategic factors

1. **Offshore facility:** low-cost facility for export production.
2. **Source facility:** low-cost facility for global production.
3. **Server facility:** regional production facility.
4. **Contributor facility:** regional production facility with development skills.

5. **Outpost facility:** regional production facility built to gain local skills.
6. **Lead facility:** facility that leads in development and process technologies.

7.2.2 Technological factors

Characteristics of available production technologies have a significant impact on network design decisions. If production technology displays significant economies of scale, a few high-capacity locations are most effective. This is the case in the manufacture of computer chips, for which factories require a very large investment. As a result, most semiconductor companies build few high-capacity facilities.

In contrast, if facilities have lower fixed costs, many local facilities are preferred because this helps lower transportation costs. Flexibility of the production technology affects the degree of consolidation that can be achieved in the network. If the production technology is very inflexible and product requirements vary from one country to another, a firm has to set up local facilities to serve the market in each country. Conversely, if the technology is flexible, it becomes easier to consolidate manufacturing in a few large facilities.

7.2.3 Macroeconomic factors

Macroeconomic factors include taxes, tariffs, exchange rates, and other economic factors that are not internal to an individual firm. As global trade has increased, macroeconomic factors have had a significant influence on the success or failure of supply chain networks. Thus, it is imperative that firms take these factors into account when making network design decisions.

7.2.4 Political factors

The political stability of the country under consideration plays a significant role in location choice. Companies prefer to locate facilities in politically stable countries where the rules of commerce and ownership are well defined. Countries with independent and clear legal systems make it easier for companies to invest in facilities.

7.2.5 Infrastructure factors

The availability of good infrastructure is an important prerequisite to locating a facility in a given area. Poor infrastructure adds to the cost of doing business from a given location. Global companies have located their factories in China near Shanghai, Tianjin, or Guang Zhuo-even though these locations do not have the lowest labor or land costs because there is good infrastructure at these locations. Key infrastructure elements to be considered during network design include availability of sites, labor availability, proximity to transportation terminals, rail service, proximity to airports and seaports, highway access, congestion, and local utilities.

7.2.6 Competitive factors

Companies must consider competitors' strategy, size, and location when designing their supply chain networks. A fundamental decision firms make is whether to locate their facilities close to competitors or far from them. The form of competition and factors such as raw material or labor availability influence this decision.

7.2.7 Logistics and facility costs

Logistics and facility costs incurred within a supply chain change as the number of facilities, their location, and capacity allocation is changed. Companies must consider inventory, transportation, and facility costs when designing their supply chain networks. Inventory and facility costs increase as the number of facilities in a supply chain increase. Transportation costs decrease as the number of facilities is increased. If the number of facilities increases to a point where inbound economies of scale are lost, then transportation cost increases.

7.3 Measuring performance of a distribution network

At the highest level, performance of a distribution network should be evaluated along two dimensions:

1. Customer needs that are met.
2. Cost of meeting customer needs.

Thus, a firm must evaluate the impact on customer service and cost as it compares different distribution network options. The customer needs that are met influence the company's revenues, which along with cost decide the profitability of the delivery network. Although customer service consists of many components, we focus on those measures that are influenced by the structure of the distribution network includes:

- **Response time:** Amount of time taken for a customer to receive an order.
- **Product variety:** Number of different products/configurations that are offered by the distribution network.
- **Product availability:** Probability of having a product in stock when a customer order arrives.

- **Customer experience:** Customer experience includes the ease with which customers can place and receive orders as well as the extent to which this experience is customized. It also includes purely experiential aspects, such as the possibility of getting a cup of coffee and the value that the sales staff provides.
- **Time to market:** Time it takes to bring a new product to the market.
- **Order visibility:** Ability of customers to track their orders from placement to delivery.
- **Returnability:** Ease with which a customer can return unsatisfactory merchandise and the ability of the network to handle such returns.

7.4 Risk management in network design

A global supply chain network is exposed to a variety of risks, including supply disruption, supply delays, demand fluctuations, price fluctuations, and exchange-rate fluctuations as shown in Table 1. If appropriate mitigation plans are not in place, these risks can significantly hurt supply chain performance.

Table 1. Supply chain risks to be considered during network design

Category	Risk Drivers
Disruptions	Natural disaster, war, terrorism, Labor disputes, Supplier bankruptcy
Delays	High capacity utilization at supply source, Inflexibility of supply source, Poor yield at supply source
Systems risk	Information infrastructure breakdown, System integration or extent of systems being networked
Forecast risk	Inaccurate forecasts due to long lead times, seasonality, product variety, short life cycles, small customer base, information distortion
Intellectual property risk	Vertical integration of supply chain, Global outsourcing and markets
Procurement risk	Exchange-rate risk, Fraction purchased from a single source, Industry-wide capacity utilization
Receivables risk	Number of customers, Financial strength of customers
Inventory risk	Rate of product obsolescence, Inventory holding cost, Product value, Demand and supply uncertainty
Capacity risk	Cost of capacity, Capacity flexibility

Good network design can play a significant role in mitigating supply chain risk. Every mitigation strategy, however, comes at a price and may increase other risks. For example, increasing inventory mitigates the risk of delays but increases the risk of obsolescence. Acquiring multiple suppliers mitigates the risk of disruption but increases costs because each supplier may have difficulty achieving economies of scale. Thus, it is very important to develop tailored mitigation strategies during network design as shown in Table 2. This helps to achieve a good balance between the amount of risk mitigated and the increase in cost.

Table 2. Tailored risk mitigation strategies

Risk Mitigation Strategy	Tailored Strategies
Increase capacity	Focus on low cost, decentralized capacity for predictable demand. Build centralized capacity for unpredictable demand. Increase decentralization as cost of capacity drops.
Get redundant suppliers	More redundant supply for high-volume products, less redundancy for low-volume products. Centralize redundancy for low-volume products in a few flexible suppliers.
Increase responsiveness	Favor cost over responsiveness for commodity products. Favor responsiveness over cost for short-life-cycle products.
Increase inventory	Decentralize inventory of predictable, lower-value products. Centralize inventory of less predictable, higher-value products.
Increase flexibility	Favor cost over flexibility for predictable, high-volume products. Favor flexibility for unpredictable, low-volume products. Centralize flexibility in a few locations if it is expensive.
Pool or aggregate	Increase aggregation as unpredictability grows.
Increase source capability	Prefer capability over cost for high-value, high-risk products. Favor cost over capability for low-value commodity products. Centralize high capability in flexible source if possible.

7.5 Planning transportation

Supply chains use a combination of the following modes of transportation: Air, Package carriers, Truck, Rail, Water, Pipeline and Intermodal. The mode of transportation that results in the lowest transportation cost does not necessarily lower total costs for a supply chain. Cheaper modes of transport typically have longer lead times and larger minimum shipment quantities, both of which result in higher levels of inventory in the supply chain. Modes that allow for shipping in small quantities lower inventory levels but tend to be more expensive.

7.6 Risk management in transportation

There are three main types of risk when transporting a shipment between two nodes on the network:

1. The risk that the shipment is delayed.

2. The risk that the shipment does not reach its destination because intermediate nodes or links are disrupted by external forces.
 3. The risk of hazardous material.
- In each case it is important to identify the sources of risk and their consequences and plan suitable mitigation strategies.

VIII. Aligning supply chain with business strategy

A company's supply chain is an integral part of its approach to the markets it serves. The supply chain needs to respond to market requirements and do so in a way that supports the company's business strategy. The business strategy a company employs starts with the needs of the customers that the company serves or will serve. Depending on the needs of its customers, a company's supply chain must deliver the appropriate mix of responsiveness and efficiency. A company whose supply chain allows it to more efficiently meet the needs of its customers will gain market share at the expense of other companies in that market and also will be more profitable. There are three steps to use in aligning the supply chain with the business strategy.

8.1 Understand the markets the company Serves

Begin by asking questions about the customers. What kind of customer does the company serve? What kind of customer does the customer sell to? What kind of supply chain is the company a part of? The answers to these questions will tell what supply chains the company serves and whether the supply chain needs to emphasize responsiveness or efficiency. The following attributes that help to clarify requirements for the customers served. These attributes are:

- The quantity of the product needed in each lot.
- The response time that customers are willing to tolerate.
- The variety of products needed.
- The service level required.
- The price of the product.
- The desired rate of innovation in the product.

8.2 Define core competencies of the company

The next step is to define the role that the company plays or wants to play in these supply chains. What kind of supply chain participant is the company? Is the company a producer, a distributor, a retailer, or a service provider? What does the company do to enable the supply chains that it is part of? What are the core competencies of the company? How does the company make money? The answers to these questions will tell what roles in a supply chain will be the best fit for the company.

8.3 Develop needed supply chain capabilities

The last step is to develop the supply chain capabilities needed to support the roles the company plays. This development is guided by the decisions made about the five supply chain drivers. Each of these drivers can be developed and managed to emphasize responsiveness or efficiency depending on the business requirements.

8.4 Achieving strategic fit

There are three basic steps to achieving this strategic fit

1. **Understanding the customer and supply chain uncertainty:** First, a company must understand the customer needs for each targeted segment and the uncertainty the supply chain faces in satisfying these needs. These needs help the company define the desired cost and service requirements. The supply chain uncertainty helps the company identify the extent of the unpredictability of demand, disruption, and delay that the supply chain must be prepared for.
2. **Understanding the supply chain capabilities:** There are many types of supply chains, designed to perform different tasks well. A company must understand what its supply chain is designed to do well.
3. **Achieving strategic fit:** If a mismatch exists between what the supply chain does particularly well and the desired customer needs, the company will either need to restructure the supply chain to support the competitive strategy or alter its competitive strategy.

IX. Supply chain implementation

9.1 Types of firms /organisations Supply Chain Management can be applied

Supply Chain Management could be implemented to all firms (manufacturing firms, retailers, services, etc.) and public organisations that satisfy the following criteria:

- Minimum Number of employees: 20 (at least 4 in management positions).
- Strong management commitment to new ways of working and innovation.

9.2 Process views of a supply chain

A supply chain is a sequence of processes and flows that take place within and between different stages and combine to fill a customer need for a product. There are two different ways to view the processes performed in a supply chain.

- **Cycle View:** The processes in a supply chain are divided into a series of cycles, each performed at the interface between two successive stages of a supply chain.
- **Push/Pull View:** The processes in a supply chain are divided into two categories depending on whether they are executed in response to a customer order or in anticipation of customer orders. Pull processes are initiated by a customer order, whereas push processes are initiated and performed in anticipation of customer orders.

9.3 Supply chain processes

All supply chain processes discussed in the two process views can be classified into the following three macro processes

1. **Customer Relationship Management (CRM):** The CRM macro process aims to generate customer demand and facilitate the placement and tracking of orders. It includes processes such as marketing, pricing, sales, order management, and call center management.
2. **Internal supply chain management (/SCM):** The ISCM macro process aims to fulfill demand generated by the CRM process in a timely manner and at the lowest possible cost. ISCM processes include the planning of internal production and storage capacity, preparation of demand and supply plans, and fulfillment of actual orders.
3. **Supplier Relationship Management (SRM):** The SRM macro process aims to arrange for and manage supply sources for various goods and services. SRM processes include the evaluation and selection of suppliers, negotiation of supply terms, and communication regarding new products and orders with suppliers.

The three macro processes manage the flow of information, product, and funds required to generate, receive, and fulfill a customer request. The framework below outlines the five key dimensions of supply chain management through the implementation procedure that are required to achieve superior performance. These areas must be addressed iteratively and, generally, in a hierarchical fashion:

1. **Strategy**, specifically, the alignment of supply chain strategies with the overall business direction. Key decision points for managers here include:
 - What is required to align the supply chain with the business strategy?
 - What level of customer service must be provided to each customer segment to compete effectively?
 - Which channels of distribution best meet the goals and the customers' needs?
2. **Infrastructure**, which affects cost-service performance and establishes the boundaries within which the supply chain must operate. Pertinent questions include:
 - How must the physical network of plants and distribution be structured?
 - Can the current network be rationalized?
 - Can the third-party logistics capabilities be used?
 - What transportation services can best link together the network of facilities?
 - Which activities should be outsourced?
3. **Process**, the drive to achieve functional excellence and integration across all major processes. Managers must ask themselves the following:
 - What are the core supply chains processes driving the business?
 - How can best-in-class approaches can be adopted to the core processes (e.g., manufacturing, integrated demand planning, procurement, cycle-time compression, dynamic deployment)?
 - How linkages can be build with the suppliers and customers?
4. **Organisation**, providing the critical success factors of cohesion, harmony, and integration across organisation entities. Questions to consider include:
 - What level of cross-functional integration is required to manage core processes effectively?
 - How can the leverage cross-company skills and abilities?
 - What performance-measurement and reporting structure can help to achieve the objectives?

5. **Technology**, which empowers the supply chain to operate on a new level of performance and is creating clear competitive advantages for those companies able to harness it. Companies should address the following points:

- Do the IT platform and core applications software support world-class SCM?
- Where will advanced decision-support capabilities have the greatest impact on business performance?
- What data are required to manage the core business processes outlined above?
- How advanced communications can be capitalized (e.g., intranets and the Internet) in managing the supply chain?
- How enhanced visibility of customer demand and other key operating parameters can be leveraged?

9.4 Decision phases in a supply chain

Successful supply chain management requires many decisions relating to the flow of information, product, and funds. Each decision should be made to raise the supply chain surplus. These decisions fall into three categories or phases, depending on the frequency of each decision and the time frame during which a decision phase has an impact. As a result, each category of decisions must consider uncertainty over the decision horizon.

1. **Supply Chain Strategy or Design:** During this phase, given the marketing and pricing plans for a product, a company decides how to structure the supply chain over the next several years. It decides what the chain's configuration will be, how resources will be allocated, and what processes each stage will perform.
2. **Supply Chain Planning:** Companies start the planning phase with a forecast for the coming year (or a comparable time frame) of demand in different markets. Planning includes making decisions regarding which markets will be supplied from which locations, the subcontracting of manufacturing, the inventory policies to be followed, and the timing and size of marketing and price promotions. Planning establishes parameters within which a supply chain will function over a specified period of time. In the planning phase, companies must include uncertainty in demand, exchange rates, and competition over this time horizon in their decisions.
3. **Supply Chain Operation:** The goal of supply chain operations is to handle incoming customer orders in the best possible manner. During this phase, firms allocate inventory or production to individual orders, set a date that an order is to be filled, generate pick lists at a warehouse, allocate an order to a particular shipping mode and shipment, set delivery schedules of trucks, and place replenishment orders.

9.5 Supply Chain Drivers

Each supply chain has its own unique set of market demands and operating challenges but the issues remain essentially the same in every case. Companies in any supply chain must make decisions individually and collectively regarding their actions in five areas:

1. **Production:** What products does the market want? How much of which products should be produced and by when? This activity includes the creation of master production schedules that take into account plant capacities, workload balancing, quality control, and equipment maintenance.
2. **Inventory:** What inventory should be stocked at each stage in a supply chain? How much inventory should be held as raw materials, semi finished, or finished goods? The primary purpose of inventory is to act as a buffer against uncertainty in the supply chain. However, holding inventory can be expensive, so what are the optimal inventory levels and reorder points?
3. **Location:** Where should facilities for production and inventory storage be located? Where are the most cost efficient locations for production and for storage of inventory? Should existing facilities be used or new ones built? Once these decisions are made they determine the possible paths available for product to flow through for delivery to the final consumer.
4. **Transportation:** How should inventory be moved from one supply chain location to another? Air freight and truck delivery are generally fast and reliable but they are expensive. Shipping by sea or rail is much less expensive but usually involves longer transit times and more uncertainty. This uncertainty must be compensated for by stocking higher levels of inventory. When is it better to use which mode of transportation?
5. **Information:** How much data should be collected and how much information should be shared? Timely and accurate information holds the promise of better coordination and better decision making. With good information, people can make effective decisions about what to produce and how much, about where to locate inventory and how best to transport it.

The capabilities and effectiveness of a company's supply chain as shown in Table 3.

Table 3. Comparison between efficient and responsive supply chains

	Efficient Supply Chains	Responsive Supply Chains
Primary goal	Supply demand at the lowest cost	Respond quickly to demand
Product design strategy	Maximize performance at a minimum	Create modularity for product differentiation
Pricing strategy	Lower margins since price is key customer driver	Higher margins since price is not key customer driver
Manufacturing	Lower costs through high utilization	Maintain capacity flexibility to balance demand
Inventory strategy	Minimize inventory to lower cost	Maintain buffer inventory to deal with demand/supply
Lead time strategy	Reduce, but not at the expense of costs	Reduce aggressively, even if the costs are significant
Supplier strategy	Select based on cost and quality	Select based on speed, flexibility, reliability, and quality

X. Supply Chain Metrics

To understand how a company can improve supply chain performance in terms of responsiveness and efficiency it is necessary to examine the logistical and cross-functional metrics of supply chain performance: facilities, inventory, transportation, information, sourcing, and pricing. These metrics interact with each other to determine the supply chain's performance in terms of responsiveness and efficiency. As a result, the structure of these metrics determines if and how strategic fit is achieved across the supply chain. The supply chain metrics are listed in Table 4.

1. **Facilities** are the actual physical locations in the supply chain network where product is assembled, or fabricated. The two major types of facilities are production sites and storage sites. Decisions regarding the role, location, capacity and flexibility of facilities have a significant impact on the supply chain's performance.
2. **Inventory** encompasses all raw materials, work in process, and finished goods within a supply chain.
3. **Transportation** entails moving inventory from point to point in the supply chain. Transportation can take the form of many combinations of modes and routes, each with its own performance characteristics. Transportation choices have a large impact on supply chain responsiveness and efficiency.
4. **Information** consists of data and analysis concerning facilities, inventory, transportation, costs, prices, and customers throughout the supply chain. Information is potentially the biggest driver of performance in the supply chain because it directly affects each of the other drivers. Information presents management with the opportunity to make supply chains more responsive and more efficient.
5. **Sourcing** is the choice of who will perform a particular supply chain activity such as production, storage, transportation, or the management of information.
6. **Pricing** determines how much a firm will charge for goods and services Pricing affects the behavior of the buyer of the good or service, thus affecting supply chain performance.

Table 4. Supply chain metrics

Facility related metrics	Inventory related metrics	Transportation related metrics	Information related metrics	Sourcing related metrics	Pricing related metrics
Capacity	Average inventory	Average inbound transportation cost	Forecast horizon	Days payable outstanding	Profit margin
Utilization	Average batch size	Average incoming shipment size	Frequency of update	Average purchase price	Days sales outstanding
Cycle time of production	Average safety inventory	Average inbound transportation cost per shipment	Forecast error	Range of purchase price	Incremental fixed cost per order
Actual average cycle time	Seasonal inventory	Average outbound transportation cost	Seasonal factors	Average purchase quantity	variable cost per unit
Flow time efficiency	Fill rate	Average outbound shipment size	Variance from plan	Fraction on-time deliveries	Average sale price
Product variety	Fraction of time out of stock	Average outbound transportation cost per shipment	Ratio of demand variability to order variability	Supply quality	Average order size
Volume contribution of top 20 % SKUs and customers		Fraction transported by mode		Supply lead time	Range of sale price
Processing/setup/down/idle time					Range of periodic sales
Average production batch size					
Production service level					

XI. Supply chain forecasting

A company must be knowledgeable about numerous factors related to the demand forecast listed below:

- Past demand
- Lead time of product
- Planned advertising or marketing efforts
- State of the economy
- Planned price discounts
- Actions that competitors have taken

Forecasting methods are classified according to the following four types.

1. **Qualitative:** Qualitative forecasting methods are primarily subjective and rely on human judgment. They are most appropriate when little historical data is available or when experts have market intelligence that may affect the forecast. Such methods may also be necessary to forecast demand several years into the future in a new industry.
2. **Time series:** Time-series forecasting methods use historical demand to make a forecast. They are based on the assumption that past demand history is a good indicator of future demand. These methods are most appropriate when the basic demand pattern does not vary significantly from one year to the next. These are the simplest methods to implement and can serve as a good starting point for a demand forecast.
3. **Causal:** Causal forecasting methods assume that the demand forecast is highly correlated with certain factors in the environment (the state of the economy, interest rates, etc.). Causal forecasting methods find this correlation between demand and environmental factors and use estimates of what environmental factors will be to forecast future demand. For example, product pricing is strongly correlated with demand. Companies can thus use causal methods to determine the impact of price promotions on demand.
4. **Simulation:** Simulation forecasting methods imitate the consumer choices that give rise to demand to arrive at a forecast.

11.1 Basic approach to demand forecasting

The following basic, six step approach helps an organization perform effective forecasting.

1. Understand the objective of forecasting.
2. Integrate demand planning and forecasting throughout the supply chain.
3. Understand and identify customer segments.
4. Identify the major factors that influence the demand forecast.
5. Determine the appropriate forecasting technique.
6. Establish performance and error measures for the forecast.

11.2 Aggregate planning in a supply chain

Aggregate planning is a process by which a company determines ideal levels of capacity, production, subcontracting, inventory, stock outs, and even pricing over a specified time horizon. The goal of aggregate planning is to satisfy demand while maximizing profit. Aggregate planning, as the name suggests, solves problems involving aggregate decisions rather than stock-keeping unit (SKU)-level decisions. For example, aggregate planning determines the total production level in a plant for a given month, but it does so without determining the quantity of each individual SKU that will be produced. This level of detail makes aggregate planning a useful tool for thinking about decisions with an intermediate time frame of between roughly 3 and 18 months. In this time frame, it is too early to determine production levels by SKU, but it is also generally too late to arrange for additional capacity. Therefore, aggregate planning answers the question, "How should a firm best utilize the facilities that it currently has?"

The aggregate planner's main objective is to identify the following operational parameters over the specified time horizon:

- **Production Rate:** the number of units to be completed per unit time (such as per week or per month)
- **Workforce:** the number of workers/units of capacity needed for production
- **Overtime:** the amount of overtime production planned
- **Machine Capacity Level:** the number of units of machine capacity needed for production
- **Subcontracting:** the subcontracted capacity required over the planning horizon
- **Backlog:** demand not satisfied in the period in which it arises but carried over to future periods
- **Inventory on Hand:** the planned inventory carried over the various periods in the planning horizon

An aggregate planner requires the following information:

1. Demand forecast (Fr) for each Period (t) in a planning horizon that extends over T periods
2. Production costs
 - Labor costs, regular time and overtime costs
 - Cost of subcontracting production
 - Cost of changing capacity; specifically, cost of hiring/laying off workforce and cost of adding or reducing machine capacity
3. Labor/machine hours required per unit
4. Inventory holding cost
5. Stock out or backlog cost
6. Constraints
 - Limits on overtime
 - Limits on layoffs
 - Limits on capital available
 - Limits on stockouts and backlogs
 - Constraints from suppliers to the enterprise

Using this information, a company makes the following determinations through aggregate planning:

- **Production quantity from regular time, overtime, and subcontracted time:** used to determine number of workers and supplier purchase levels
- **Inventory held:** used to determine the warehouse space and working capital required
- **Backlog/stockout quantity:** used to determine customer service levels
- **Workforce hired/Laid off** used to determine any labor issues likely to be encountered
- **Machine capacity increase/decrease:** used to determine if new production equipment should be purchased or idled

The quality of an aggregate plan has a significant impact on the profitability of a firm. A poor aggregate plan can result in lost sales and lost profits if the available inventory and capacity are unable to meet demand. A poor aggregate plan may also result in a large amount of excess inventory and capacity, thereby raising costs. Therefore, aggregate planning is a very important tool in helping a supply chain maximize profitability.

XII. Improving supply chain profitability

Two obvious managerial levers to increase profitability are:

1. Increase the salvage value of each unit increases profitability (as well as the optimal cycle service level).
2. Decrease the margin lost from a stock out increases profitability (as well as the optimal cycle service level).

Strategies to increase the salvage value include selling to outlet stores so that leftover units are not merely discarded. Strategies to decrease the margin lost in a stock out include arranging for backup sourcing (which may be more expensive) so customers are not lost forever. The practice of purchasing product from a competitor on the open market to satisfy customer demand is observed.

Another significant managerial lever to improve supply chain profitability is the reduction of demand uncertainty. With reduced demand uncertainty, a supply chain manager can better match supply and demand by reducing both over- and under stacking.

A manager can reduce demand uncertainty via the following means:

1. **Improved forecasting:** Use better market intelligence and collaboration to reduce demand uncertainty.
2. **Quick response:** Reduce replenishment lead time so that multiple orders may be placed in the selling season.
3. **Postponement:** In a multiproduct setting, postpone product differentiation until closer to the point of sale.
4. **Tailored sourcing:** Use a low lead time, but perhaps an expensive supplier as a backup for a low-cost, but perhaps long-lead-time supplier.

12.1 Sourcing decisions in a supply chain

Effective sourcing processes within a firm can improve profits for the firm and total supply chain surplus in a variety of ways. It is important that the drivers of improved profits be clearly identified when making sourcing decisions.

When scoring and assessing suppliers, the following factors other than quoted price must be considered: Replenishment lead time, On-time performance, Supply flexibility, Delivery frequency/minimum lot size, Supply quality, Inbound transportation cost, Pricing terms, Information coordination capability, Design collaboration capability, Exchange rates, taxes, and duties and Supplier viability. Supplier performance must be rated on each of these factors because they affect total supply chain cost.

12.2 Pricing and revenue management in a supply chain

Revenue management adjusts the pricing and available supply of assets to maximize profits. Revenue management has a significant impact on supply chain profitability when one or more of the following four conditions exist:

1. The value of the product varies in different market segments.
2. The product is highly perishable or product wastage occurs.
3. Demand has seasonal and other peaks.
4. The product is sold both in bulk and on the spot market.

12.3 Information technology in a supply chain

Information must have the following characteristics to be useful when making supply chain decisions:

1. **Information must be accurate.** Without information that gives a true picture of the state of the supply chain, it is very difficult to make good decisions. That is not to say that all information must be 100 percent correct, but rather that the data available paint a picture that is at least directionally correct.
2. **Information must be accessible in a timely manner.** Often, accurate information exists, but by the time it is available, it is either out of date or, if it is current, it is not in an accessible form. To make good decisions, a manager needs to have up-to-date information that is easily accessible.
3. **Information must be of the right kind.** Decision makers need information that they can use. Often companies have large amounts of data that is not helpful in making a decision. Companies must think about what information should be recorded so that valuable resources are not wasted collecting meaningless data while important data goes unrecorded.

XIII. Building coordination, co-operation and trust in a supply chain

13.1 Lack of supply chain coordination

Supply chain coordination improves, if all stages of the chain take actions that together increase total supply chain profits. A lack of coordination occurs either because different stages of the supply chain have objectives that conflict or because information moving between stages is delayed and distorted. Different stages of a supply chain may have conflicting objectives if each stage has a different owner. As a result, each stage tries to maximize its own profits, resulting in actions that often diminish total supply chain profits. Fundamental challenge today for supply chains is to achieve coordination in spite of multiple ownership.

13.2 Effect on performance of lack of coordination

A supply chain lacks coordination if each stage optimizes only its local objective, without considering the impact on the complete chain. Total supply chain profits are thus less than what could be achieved through coordination. Each stage of the supply chain, in trying to optimize its local objective, takes actions that end up hurting the performance of the entire supply chain. Lack of coordination also results if information distortion occurs within the supply chain.

13.3 Obstacles to coordination in a supply chain

Any factor that leads to either local optimization by different stages of the supply chain, or an increase in information delay, distortion, and variability within the supply chain, is an obstacle to coordination. If managers in a supply chain are able to identify the key obstacles, they can then take suitable actions to help achieve coordination. The major obstacles are divided into five categories:

- **Incentive obstacles:** Incentive obstacles occur in situations when incentives offered to different stages or participants in a supply chain lead to actions that increase variability and reduce total supply chain profits.
- **Information-processing obstacles:** Information-processing obstacles occur in situations when demand information is distorted as it moves between different stages of the supply chain, leading to increased variability in orders within the supply chain.
- **Operational obstacles:** Operational obstacles occur when actions taken in the course of placing and filling orders lead to an increase in variability.
- **Pricing obstacles:** Pricing obstacles arise when the pricing policies for a product lead to an increase in variability of orders placed.
- **Behavioral obstacles:** Behavioral obstacles are problems in learning within organizations that contribute to the bullwhip effect.

13.4 Managerial levers to achieve coordination

The following managerial actions increase total supply chain profits and helps to overcome the obstacles and achieve coordination in the supply chain.

- Aligning of goals and incentives

- Improving information accuracy
- Improving operational performance
- Designing pricing strategies to stabilize orders
- Building partnerships and trust

13.5 Building strategic partnerships and trust within a supply chain

Cooperation and trust within the supply chain help improve performance for the following reasons.

1. When stages trust each other, they are more likely to take the other party's objectives into consideration when making decisions.
2. Action-oriented managerial levers to achieve coordination become easier to implement. Sharing of information is natural between parties that trust each other. Similarly, operational improvements are easier to implement and appropriate pricing schemes are easier to design if both parties are aiming for the common good.
3. An increase in supply chain productivity results, either by elimination of duplicated effort or by allocating effort to the appropriate stage. For example, a manufacturer receives material from a supplier without inspecting it if the supplier shares process control charts. Another example might be a situation in which a distributor aids the postponement strategy of a manufacturer by performing customization just before the point of sale.
4. A greater sharing of detailed sales and production information results. This sharing allows the supply chain to coordinate production and distribution decisions. As a result, the supply chain is better able to match supply and demand, resulting in better coordination.

13.6 Designing a relationship with cooperation and trust

The key steps in designing effective supply chain partnerships are as follows:

1. Assessing the value of the relationship
2. Identifying operational roles and decision rights for each party
3. Creating effective contracts
4. Designing effective conflict resolution mechanisms

13.7 Managing supply chain relationships for cooperation and trust

Effectively managed supply chain relationships foster cooperation and trust, thus increasing supply chain coordination. In contrast, poorly managed relationships lead to each party being opportunistic, resulting in a loss of total supply chain profits. The management of a relationship is often seen as a tedious and routine task. Top management, in particular, is often very involved in the design of a new partnership but rarely involved in its management. This has led to a mixed record in running successful supply chain alliances and partnerships.

When managing a supply chain relationship, managers should focus on the following factors to improve the chances of success of a supply chain partnership:

1. The presence of flexibility, trust, and commitment in both parties helps a supply chain relationship succeed. In particular, commitment of top management on both sides is crucial for success.
2. Good organizational arrangements, especially for information sharing and conflict resolution, improve chances of success. Lack of information sharing and the inability to resolve conflicts are the two major factors that lead to the breakdown of supply chain partnerships.
3. Mechanisms that make the actions of each party and resulting outcomes visible help avoid conflicts and resolve disputes. Such mechanisms make it harder for either party to be opportunistic and help identify defective processes, increasing the value of the relationship for both parties.
4. The more fairly the stronger partner treats the weaker, vulnerable partner, the stronger the supply chain relationship tends to be.

XIV. Discussion

Two decades before Supply Chain Management department included the following Inventory management, Transportation service procurement, Materials handling, Inbound transportation, Transportation operations management and warehousing management. The Supply Chain Management department is expected to increase its range of responsibilities, most often in line with the thinking that sees the order fulfillment process as one co-ordinated set of activities. Thus the functions most often cited as planning to formally include in the Supply Chain Management department are Customer service performance monitoring, Order processing/customer service and Supply Chain Management budget forecasting.

Today Supply Chain Management includes services such as Operational Analysis and Design Materials Handling, Distribution Strategy, Operational Improvements, Distribution Management, Computer Systems, Warehouse Design Project Management, Operational Commissioning, Computer Simulation, Technical

seminars. Today’s Supply Chain Challenges includes Global supply chain with long lead times, Rising and shifting customer expectations, Increase in labor costs in developing countries, Increase in logistics costs, Rising energy prices, Rail capacity pressure, Truck driver shortage and Security requirements.

These key issues in supply chain management span a large spectrum of a firm’s activities, from the strategic through the tactical to the operational level:

- The strategic level deals with decisions that have a long-lasting effect on the firm. This includes decisions regarding product design, what to make internally and what to outsource, supplier selection, and strategic partnering as well as decisions on the number, location, and capacity of warehouses and manufacturing plants and the flow of material through the logistics network.
- The tactical level includes decisions that are typically updated anywhere between once every quarter and once every year. These include purchasing and production decisions, inventory policies, and transportation strategies, including the frequency with which customers are visited.
- The operational level refers to day-to-day decisions such as scheduling, lead time quotations, routing, and truck loading.

XV. Recommendation

The future for Supply Chain Management looks very bright. Currently two major trends are benefiting Supply Chain Management operations. These are Customer service focus and Information technology. Successful organisations must be excellent in both of these areas, so the importance of Supply Chain Management and the tools available to do the job right will continue to expand. Today’s fast-moving markets require more flexible and responsive supply chains. Integrating Lean, Agile, Resilience and Green Paradigms in Supply Chain Management helps to add value to supply chain. Table 5 explains the importance of integration.

Table 5. Importance of integrating Lean, Agile, Resilience and Green Paradigms

	Lean	Agile	Resilient	Green
Purpose	Focus on cost reduction and flexibility, for already available products, through continuous elimination of waste or non-value added activities across the chain	Understands customer requirements by interfacing with customers and market and being adaptable to future changes	Ability to return to its original state or to a new one, more desirable, after experiencing a disturbance, avoiding the occurrence of failures modes	Focus on sustainable development and on reduction of ecological impact of industrial activity
Manufacturing focus	Maintain high average utilization rate (a). It uses just in time practices, “pulling” the goods through the system based on demand	Has the ability to respond quickly to varying customer needs (mass customization), it deploys excess buffer capacity to respond to market requirements	The emphasis is on flexibility (minimal batch sizes and capacity redundancies) improving supply chain responsiveness. The schedule planning is based on shared information	Focus on efficiency and waste reduction for environmental benefit and developing of remanufacturing capabilities to integrate reusable/ remanufactured components
Alliances (with Suppliers and customers)	May participate in traditional alliances such as partnerships and joint ventures at the operating level The demand information is spread along the supply chain	Exploits a dynamic type of alliance known as a “virtual organization” for product design (a). It promotes the market place visibility	Supply chain partners join an alliance network to develop security practices, share knowledge and increasing demand visibility	Inter-organizational collaboration involving transferring or/and disseminating green knowledge to partners and customer cooperation
Lead time focus	Shorten lead-time as long as it does not increase cost	Invest aggressively in ways to reduce lead times	Reduce lead time and use flexible transportation systems	Reduce transportation lead time as long it does not increase carbon dioxide emissions

XVI. Conclusion

A supply chain is composed of all the companies involved in the design, production, and delivery of a product to market. Supply chain management is the coordination of production, inventory, location, and transportation among the participants in a supply chain to achieve the best mix of responsiveness and efficiency for the market being served. The goal of supply chain management is to increase sales of goods and services to the final, end use customer while at the same time reducing both inventory and operating expenses.

With the right technology, people, and processes, inevitable supply chain problems can be prevented from blossoming into full-blown disruptions to continuity of supply, allowing the company to reap a number of benefits, including:

1. Improving the ability to serve the customers by building and delivering the products on time and in the right quantities.
2. Lowering costs by avoiding expedited shipping, and alternative, costlier sources of supply, as well as reducing the need for “just-in-case” inventory, and the tied-up working capital it represents.
3. Becoming a more dependable partner for the customers.

By enabling the people with a business network and developing a core competency in collaborative planning and execution, the complex challenge of ensuring continuity of supply can be successfully met. This will give the business a significant competitive advantage by empowering it to meet demand effectively, thereby protecting its most valuable asset: customer satisfaction. To conclude in today competitive markets that make up today's economy; companies must learn to align their supply chains with the demands of the markets they serve to excel in supply chain performance

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