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SCHOOL OF MANAGEMENT STUDIES

UNIT – I – Supply Chain Management – SBAA7026

I. INTRODUCTION TO SUPPLY CHAIN MANAGEMENT

Supply Chain Management - Definition, Nature, Objectives, Importance - Historical Perspective - Value Chain Perspectives - Decision Phases in Supply Chain - Process Views of a Supply Chains

SUPPLY CHAIN MANAGEMENT

A supply chain is a global network used to deliver products and services from raw materials to end customer through information flow, physical distribution and cash.

Supply chain involved all the stages directly or indirectly in fulfilling a customer request which includes manufacturers, suppliers, transporters, warehouses, retailers and customers. It is the integration of demand and supply. Examples of supply chain activities include farming, refining, design, manufacturing, packaging, and transportation.

A supply chain may be defined as an integrated process wherein a number of various business entities like

- Suppliers
- Manufacturers / Producer
- Dealers, Retailers, Customer etc.,

Work together in an effort to

- Acquire raw materials
- Convert these raw materials into specified final products, and
- Deliver these final products to retailers.

Customer is the integral part of supply chain. The main objective of supply chain management is to monitor and relate production, distribution, and shipment of products and services. This can be done by companies with a very good and tight hold over internal inventories, production, distribution, internal productions and sales.

Supply chain management basically merges the supply and demand management. It uses different strategies and approaches to view the entire chain and work efficiently at each and

every step involved in the chain. Every unit that participates in the process must aim to minimize the costs and help the companies to improve their long term performance, while also creating value for its stakeholders and customers. This process can also minimize the rates by eradicating the unnecessary expenses, movements and handling.

DIFFERENT TYPES OF GENETIC SUPPLY CHAINS

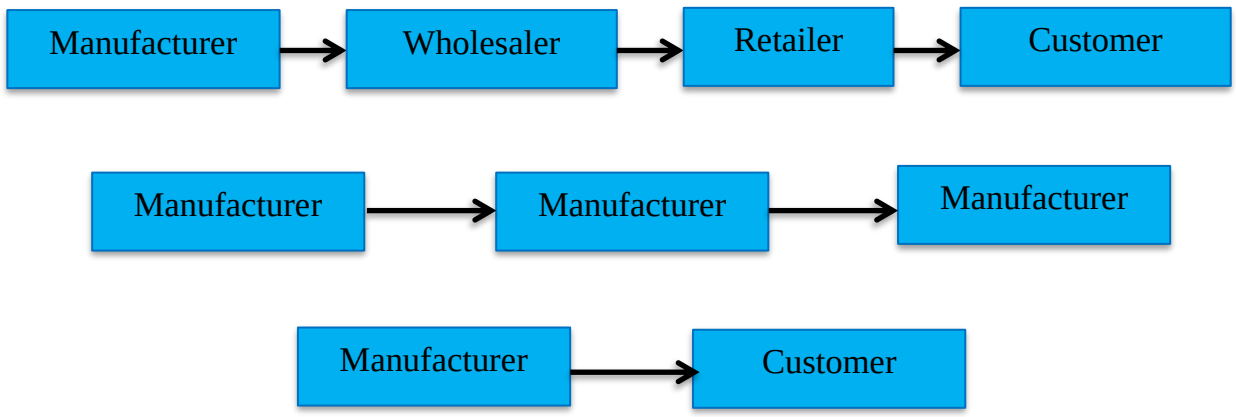

Fig 1 : Types of Genetic Supply Chains

OBJECTIVES OF SUPPLY CHAIN MANAGEMENT

- To maximize overall value generated
- To meet consumer demand for guaranteed delivery of high quality and low cost with minimal lead time
- To fulfill customer demand through efficient resources
- To maximize efficiency of distribution side
- Helps in better decision

IMPORTANCE OF SUPPLY CHAIN MANAGEMENT

- Improves Customer Services
  - ✓ Customers expect to receive the correct product mix and quantity to be delivered on time
  - ✓ Products need to be on hand in the right location
  - ✓ Follow up support after a sale must be done quickly
- Reduce Operating Costs

- ✓ Decreases Purchasing Cost
- ✓ Decrease Production Cost
- ✓ Decrease Total Supply Chain Cost

- Improves Financial Position

FUNCTIONS OF SUPPLY CHAIN MANAGEMENT

- Customer Relationship Management: Consistent focus on end customer demands to meet the increasing customer requirements and ensures a high degree of flexibility.
- Flexibility and demand-oriented production: Continuous cost reduction and resource optimization across all stages of the value chain.
- Synchronization of supply and demand: Increasing the adaptability and development capability of the supply chain.

ADVANTAGES OF SUPPLY CHAIN MANAGEMENT

- Develops better customer relationship and service.
- Creates better delivery mechanisms for products and services in demand with minimum delay.
- Improvises productivity and business functions.
- Minimizes warehouse and transportation costs.
- Minimizes direct and indirect costs.
- Assists in achieving shipping of right products to the right place at the right time.
- Enhances inventory management, supporting the successful execution of just-in-time stock models.
- Assists companies in adapting to the challenges of globalization, economic upheaval, expanding consumer expectations, and related differences.
- Assists companies in minimizing waste, driving out costs, and achieving efficiencies throughout the supply chain process.

CHARACTERISTICS OF SUPPLY CHAIN MANAGEMENT

- Focuses more on the customer
- Sourcing of raw materials or finished goods from anywhere in the world
- Centralized global business
- Ability to manage information not only within a company but across industries and enterprises.
- Responsibility of multiple flow in supply chain network both upward and downward

HISTORY OF SUPPLY CHAIN MANAGEMENT

Creation era

The term "supply chain management" was first coined by Keith Oliver in 1982. However, the concept of a supply chain in management was of great importance long before, in the early 20th century, especially with the creation of the assembly line. The characteristics of this era of supply-chain management include the need for large-scale changes, re-engineering, downsizing driven by cost reduction programs, and widespread attention to Japanese management practices. However, the term became widely adopted after the publication of the seminal book Introduction to Supply Chain Management in 1999 by Robert B. Hand field and Ernest L. Nichols, Jr., which published over 25,000 copies and was translated into Japanese, Korean, Chinese, and Russian.

Integration era

This era of supply-chain-management studies was highlighted with the development of electronic data interchange (EDI) systems in the 1960s, and developed through the 1990s by the introduction of enterprise resource planning (ERP) systems. This era has continued to develop into the 21st century with the expansion of Internet-based collaborative systems. This era of supply-chain evolution is characterized by both increasing value added and reducing costs through integration.

A supply chain can be classified as a stage 1, 2 or 3 networks. In a stage 1–type supply chain, systems such as production, storage, distribution, and material control are not linked and are independent of each other. In a stage 2 supply chain, these are integrated under one plan and enterprise resource planning (ERP) is enabled. A stage 3 supply chain is one that

achieves vertical integration with upstream suppliers and downstream customers. An example of this kind of supply chain is Tesco.

Globalization era

It is the third movement of supply-chain-management development, the globalization era, can be characterized by the attention given to global systems of supplier relationships and the expansion of supply chains beyond national boundaries and into other continents. Although the use of global sources in organizations supply chains can be traced back several decades (e.g., in the oil industry), it was not until the late 1980s that a considerable number of organizations started to integrate global sources into their core business. This era is characterized by the globalization of supply-chain management in organizations with the goal of increasing their competitive advantage, adding value, and reducing costs through global sourcing.

Specialization era (phase I): outsourced manufacturing and distribution

In the 1990s, companies began to focus on "core competencies" and specialization. They abandoned vertical integration, sold off non-core operations, and outsourced those functions to other companies. This changed management requirements, as the supply chain extended beyond the company walls and management was distributed across specialized supply-chain partnerships.

This transition also refocused the fundamental perspectives of each organization. Original equipment manufacturers (OEMs) became brand owners that required visibility deep into their supply base. They had to control the entire supply chain from above, instead of from within. Contract manufacturers had to manage bills of material with different part-numbering schemes from multiple OEMs and support customer requests for work-in-process visibility and vendor-managed inventory (VMI).

The specialization model creates manufacturing and distribution networks composed of several individual supply chains specific to producers, suppliers, and customers that work together to design, manufacture, distribute, market, sell, and service a product. This set of partners may change according to a given market, region, or channel, resulting in a proliferation of trading partner environments, each with its own unique characteristics and demands.

Specialization era (phase II): supply-chain management as a service

Specialization within the supply chain began in the 1980s with the inception of transportation brokerages, warehouse management (storage and inventory), and non-asset-based carriers, and has matured beyond transportation and logistics into aspects of supply planning, collaboration, execution, and performance management.

Market forces sometimes demand rapid changes from suppliers, logistics providers, locations, or customers in their role as components of supply-chain networks. This variability has significant effects on supply-chain infrastructure, from the foundation layers of establishing and managing electronic communication between trading partners, to more complex requirements such as the configuration of processes and work flows that are essential to the management of the network itself.

Supply-chain specialization enables companies to improve their overall competencies in the same way that outsourced manufacturing and distribution has done; it allows them to focus on their core competencies and assemble networks of specific, best-in-class partners to contribute to the overall value chain itself, thereby increasing overall performance and efficiency. The ability to quickly obtain and deploy this domain-specific supply-chain expertise without developing and maintaining an entirely unique and complex competency in house is a leading reason why supply-chain specialization is gaining popularity.

Outsourced technology hosting for supply-chain solutions debuted in the late 1990s and has taken root primarily in transportation and collaboration categories. This has progressed from the application service provider (ASP) model from roughly 1998 through 2003, to the on-demand model from approximately 2003 through 2006, to the software as a service (SaaS) model currently in focus today.

Supply-chain management 2.0 (SCM 2.0)

Building on globalization and specialization, the term "SCM 2.0" has been coined to describe both changes within supply chains themselves as well as the evolution of processes, methods, and tools to manage them in this new "era". The growing popularity of collaborative platforms is highlighted by the rise of TradeCard's supply-chain-collaboration platform, which connects

multiple buyers and suppliers with financial institutions, enabling them to conduct automated supply-chain finance transactions.

Web 2.0 is a trend in the use of the World Wide Web that is meant to increase creativity, information sharing, and collaboration among users. At its core, the common attribute of Web 2.0 is to help navigate the vast information available on the Web in order to find what is being bought. It is the notion of a usable pathway. SCM 2.0 replicates this notion in supply chain operations. It is the pathway to SCM results, a combination of processes, methodologies, tools, and delivery options to guide companies to their results quickly as the complexity and speed of the supply-chain increase due to global competition; rapid price fluctuations; changing oil prices; short product life cycles; expanded specialization; near-, far-, and off-shoring; and talent scarcity.

VALUE CHAIN PERSPECTIVE

Michael E. Porter, of Harvard Business School, introduced the concept of a value chain in his book "Competitive Advantage: Creating and Sustaining Superior Performance" (Free Press, 1998). "Competitive advantage cannot be understood by looking at a firm as a whole," Porter wrote. "It stems from the many discrete activities a firm performs in designing, producing, marketing, delivering, and supporting its product."

PORTER'S VALUE CHAIN

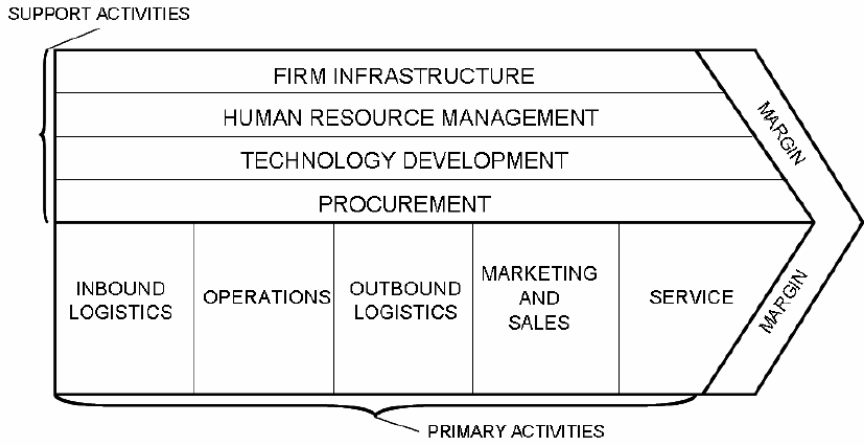

Fig 2 : Porters Value Chain

Primary activities

The first are primary activities which include the five main activities. All five activities are directly involved in the production and selling of the actual product. They cover the physical creation of the product, its sales, transfer to the buyer as well as after sale assistance. The five primary activities are inbound logistics, operations, outbound logistics, marketing & sales and service. Even though the importance of each category may vary from industry to industry, all of these activities will be present to some degree in each organization and play at least some role in competitive advantage.

Inbound Logistics

Inbound logistics is where purchased inputs such as raw materials are often taken care of. Because of this function, it is also in contact with external companies such as suppliers. The activities associated with inbound logistics are receiving, storing and disseminating inputs to the product. Examples: material handling, warehousing, inventory control, vehicle scheduling and returns to suppliers.

Operations

Once the required materials have been collected internally, operations can convert the inputs in the desired product. This phase is typically where the factory conveyor belts are being used. The activities associated with operations are therefore transforming inputs into the final product form. Examples: machining, packaging, assembly, equipment maintenance, testing, printing and facility operations.

Outbound Logistics

After the final product is finished it still needs to finds it way to the customer. Depending on how lean the company is, the product can be shipped right away or has to be stored for a while. The activities associated with outbound logistics are collecting, storing and physically distributing the product to buyers. Examples: finished goods warehousing, material handling, delivery vehicle operations, order processing and scheduling.

Marketing & Sales

The fact that products are produced doesn’t automatically mean that there are people willing to purchase them. This is where marketing and sales come into place. It is the job of marketeers and

sales agents to make sure that potential customers are aware of the product and are seriously considering to purchase them. Activities associated with marketing and sales are therefore to provide a means by which buyers can purchase the product and induce them to do so. Examples: advertising, promotion, sales force, quoting, channel selection, channel relations and pricing. A good tool to structure the entire marketing process is the Marketing Funnel.

Service

In today's economy, after-sales service is just as important as promotional activities. Complaints from unsatisfied customers are easily spread and shared due to the internet and the consequences on your company's reputation might be vast. It is therefore important to have the right customer service practices in place. The activities associated with this part of the value chain are providing service to enhance or maintain the value of the product after it has been sold and delivered. Examples: installation, repair, training, parts supply and product adjustment.

Support Activities

The second category is support activities. They go across the primary activities and aim to coordinate and support their functions as best as possible with each other by providing purchased inputs, technology, human resources and various firm wide managing functions. The support activities can therefore be divided into procurement, technology development (R&D), human resource management and firm infrastructure. The dotted lines reflect the fact that procurement, technology development and human resource management can be associated with specific primary activities as well as support the entire value chain.

Procurement

Procurement refers to the function of purchasing inputs used in the firm's value chain, not the purchased inputs themselves. Purchased inputs are needed for every value activity, including support activities. Purchased inputs include raw materials, supplies and other consumable items as well as assets such as machinery, laboratory equipment, office equipment and buildings. Procurement is therefore needed to assist multiple value chain activities, not just inbound logistics.

Technology Development (R&D)

Every value activity embodies technology, be it know how, procedures or technology embodied in process equipment. The array of technology used in most companies is very broad. Technology development activities can be grouped into efforts to improve the product and the process. Examples are telecommunication technology, accounting automation software, product design research and customer servicing procedures. Typically, Research & Development departments can also be classified here.

Human Resource Management

HRM consists of activities involved in the recruiting, hiring (and firing), training, development and compensation of all types of personnel. HRM affects the competitive advantage in any firm through its role in determining the skills and motivation of employees and the cost of hiring and training them. Some companies (especially in the technological and advisory service industry) rely so much on talented employees, that they have devoted an entire Talent Management department within HRM to recruit and train the best of the best university graduates.

Firm Infrastructure

Firm infrastructure consists of a number of activities including general (strategic) management, planning, finance, accounting, legal, government affairs and quality management. Infrastructure usually supports the entire value chain, and not individual activities. In accounting, many firm infrastructure activities are often collectively indicated as ‘overhead’ costs. However, these activities shouldn’t be underestimated since they could be one of the most powerful sources of competitive advantage. After all, strategic management is often the starting point from which all smaller decisions in the firm are being based on. The wrong strategy will make it extra hard for people on the work floor to perform well.

DECISION PHASES IN SUPPLY CHAIN

Decision phases can be defined as the different stages involved in supply chain management for taking an action or decision related to some product or services. Successful supply chain management requires decisions on the flow of information, product, and funds that fall into

three decision phases. Here we will be discussing the three main decision phases involved in the entire process of supply chain. The three phases are described below –

Supply Chain Strategy

In this phase, decision is taken by the management mostly. The decision to be made considers the sections like long term prediction and involves price of goods that are very expensive if it goes wrong. It is very important to study the market conditions at this stage.

These decisions consider the prevailing and future conditions of the market. They comprise the structural layout of supply chain. After the layout is prepared, the tasks and duties of each is laid out.

All the strategic decisions are taken by the higher authority or the senior management. These decisions include deciding manufacturing the material, factory location, which should be easy for transporters to load material and to dispatch at their mentioned location, location of warehouses for storage of completed product or goods and many more.

Supply Chain Planning

Supply chain planning should be done according to the demand and supply view. In order to understand customers' demands, a market research should be done. The second thing to consider is awareness and updated information about the competitors and strategies used by them to satisfy their customer demands and requirements. As we know, different markets have different demands and should be dealt with a different approach.

This phase includes it all, starting from predicting the market demand to which market will be provided the finished goods to which plant is planned in this stage. All the participants or employees involved with the company should make efforts to make the entire process as flexible as they can. A supply chain design phase is considered successful if it performs well in short-term planning.

Supply Chain Operations

The third and last decision phase consists of the various functional decisions that are to be made instantly within minutes, hours or days. The objective behind this decisional phase is minimizing uncertainty and performance optimization. Starting from handling the customer order to supplying the customer with that product, everything is included in this phase.

For example, imagine a customer demanding an item manufactured by your company. Initially, the marketing department is responsible for taking the order and forwarding it to production department and inventory department. The production department then responds to the customer demand by sending the demanded item to the warehouse through a proper medium and the distributor sends it to the customer within a time frame. All the departments engaged in this process need to work with an aim of improving the performance and minimizing uncertainty.

PROCESS VIEWS OF SUPPLY CHAIN

The supply chain process occurs in two ways, Cycle View and Push/Pull view.

1. **Cycle View**

The processes in a supply chain are divided into a series of cycle, each performed at the interface between two successive stages of a supply chain. Each cycle occurs at the interface between two successive stages

- Customer order cycle (customer-retailer)
- Replenishment cycle (retailer-distributor)
- Manufacturing cycle (distributor-manufacturer)
- Procurement cycle (manufacturer-supplier)

Cycle view clearly defines processes involved and the owners of each process. Specifies the roles and responsibilities of each member and the desired outcome of each process

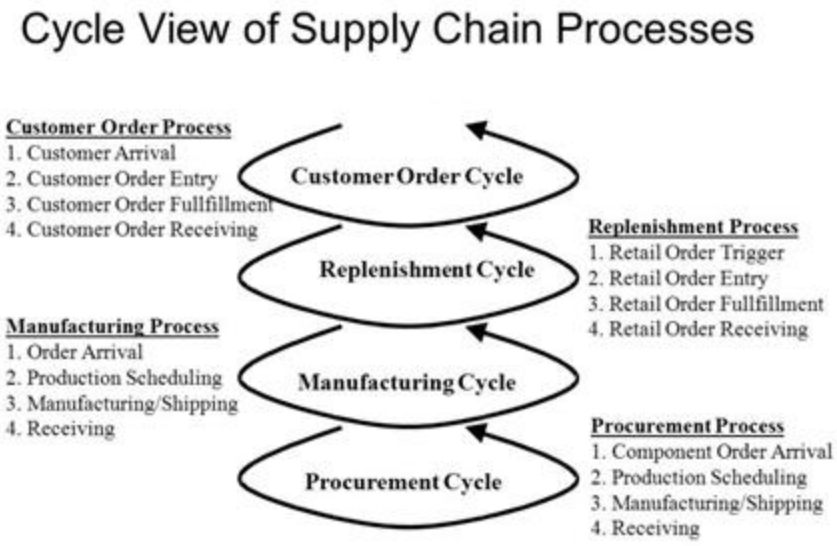

Fig 3 : Cycle View of Supply Chain Processes

2. Push/ Pull view

The processes in a supply chain are dividing into two categories depending on whether they are executed in response to a customer order or in anticipation of customer orders. Pull process are initiated by a customer order, whereas push process are initiated and performed in anticipation of customer orders.

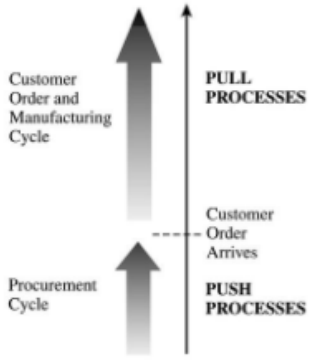

Fig : Push / Pull View

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UNIT – II – Supply Chain Management – SBAA7026

II. SUPPLY CHAIN DRIVERS AND NETWORK DESIGN

Drivers of Supply Chain Performance - Impellers of Supply Chain - Financial Measures of Performance - Framework for Structuring drivers - Framework for Network Design Decisions - Factors Influencing Network design Decisions - Models for Facility Location and for decision making. The making of Network Design Decisions in Practice - The Impact of Uncertainty on Network Design.

DRIVERS OF SUPPLY CHAIN PERFORMANCE

Supply chain capabilities are guided by the decisions you make regarding the five supply chain drivers. Each of these drivers can be developed and managed to emphasize responsiveness or efficiency depending on changing business requirements. As you investigate how a supply chain works, you learn about the demands it faces and the capabilities it needs to be successful. Adjust the supply chain drivers as needed to get those capabilities.

The five drivers provide a useful framework for thinking about supply chain capabilities. Decisions made about how each driver operates will determine the blend of responsiveness and efficiency a supply chain is capable of achieving. The five drivers are illustrated in the diagram below:

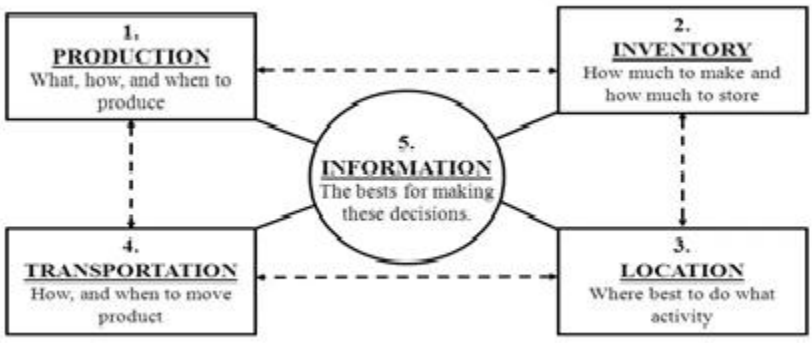

Fig 1 : Divers of Supply Chain Performance

1. **Production** – This driver can be made very responsive by building factories that have a lot of excess capacity and use flexible manufacturing techniques to produce a wide range of items. To be even more responsive, a company could do their production in many smaller plants that are close to major groups of customers so delivery times would be shorter. If

efficiency is desirable, then a company can build factories with very little excess capacity and have those factories optimized for producing a limited range of items. Further efficiency can also be gained by centralizing production in large central plants to get better economies of scale, even though delivery times might be longer.

2. **Inventory** – Responsiveness can be had by stocking high levels of inventory for a wide range of products. Additional responsiveness can be gained by stocking products at many locations so as to have the inventory close to customers and available to them immediately. Efficiency in inventory management would call for reducing inventory levels of all items and especially of items that do not sell as frequently. Also, economies of scale and cost savings can be gotten by stocking inventory in only a few central locations such as regional distribution centers (DCs).
3. **Location** – A location decision that emphasizes responsiveness would be one where a company establishes many locations that are close to its customer base. For example, fast-food chains use location to be very responsive to their customers by opening up lots of stores in high volume markets. Efficiency can be achieved by operating from only a few locations and centralizing activities in common locations. An example of this is the way e-commerce retailers serve large geographical markets from only a few central locations that perform a wide range of activities.
4. **Transportation** – Responsiveness can be achieved by a transportation mode that is fast and flexible such as trucks and airplanes. Many companies that sell products through catalogs or on the Internet are able to provide high levels of responsiveness by using transportation to deliver their products often within 48 hours or less. FedEx and UPS are two companies that can provide very responsive transportation services. And now Amazon is expanding and operating its own transportation services in high volume markets to be more responsive to customer desires. Efficiency can be emphasized by transporting products in larger batches and doing it less often. The use of transportation modes such as ship, railroad, and pipelines can be very efficient. Transportation can also be made more efficient if it is originated out of a central hub facility or distribution center (DC) instead of from many separate branch locations.
5. **Information** – The power of this driver grows stronger every year as the technology for collecting and sharing information becomes more wide spread, easier to use, and less expensive. Information, much like money, is a very useful commodity because it can be

applied directly to enhance the performance of the other four supply chain drivers. High levels of responsiveness can be achieved when companies collect and share accurate and timely data generated by the operations of the other four drivers. An example of this is the supply chains that serve the electronics market; they are some of the most responsive in the world. Companies in these supply chains, the manufacturers, distributors, and the big retailers all collect and share data about customer demand, production schedules, and inventory levels. This enables companies in these supply chains to respond quickly to situations and new market demands in the high-change and unpredictable world of electronic devices (smartphones, sensors, home entertainment and video game equipment, etc.).

IMPELLERS OF SUPPLY CHAIN

- Empowered Customer
- Development in Information Technology
- Globalization

FINANCIAL MEASURES

The measures taken for gauging different fixed and operational costs related to a supply chain are considered the financial measures. Finally, the key objective to be achieved is to maximize the revenue by maintaining low supply chain costs.

There is a hike in prices because of the inventories, transportation, facilities, operations, technology, materials, and labor. Generally, the financial performance of a supply chain is assessed by considering the following items −

- Cost of raw materials.
- Revenue from goods sold.
- Activity-based costs like the material handling, manufacturing, assembling rates etc.
- Inventory holding costs.
- Transportation costs.
- Cost of expired perishable goods.
- Penalties for incorrectly filled or late orders delivered to customers.

- Credits for incorrectly filled or late deliveries from suppliers.
- Cost of goods returned by customers.
- Credits for goods returned to suppliers.

In short, we can say that the financial performance indices can be merged as one by using key modules such as activity-based costing, inventory costing, transportation costing, and inter-company financial transactions.

FRAMEWORK OF STRUCTURING DRIVERS

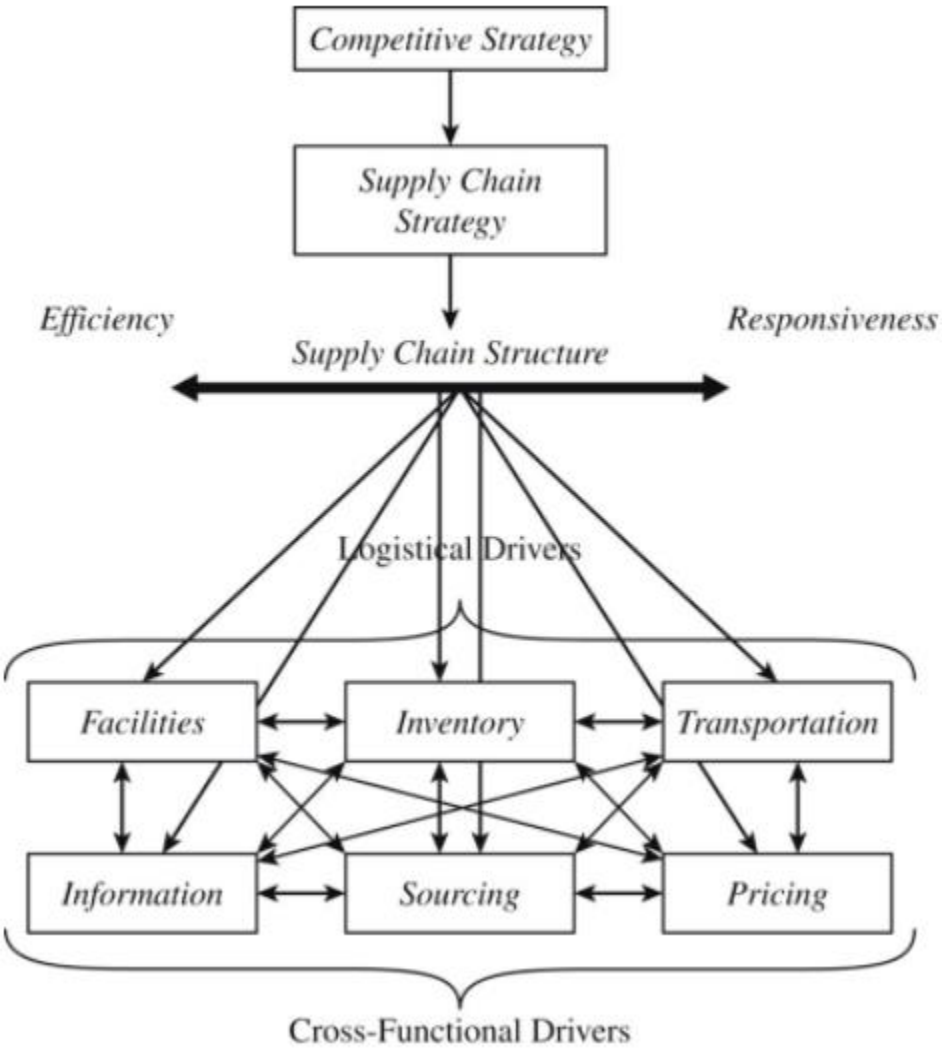

Fig 2 : Framework of Structuring Drivers

- **Facilities**

Places where inventory is stored, assembled or fabricated

Production sites and storage sites

- **Inventory**

All raw materials, work in process, and finished goods within supply chain

- **Transportation**

Moving inventory from one point to another point in the supply chain

- **Information**

Data and analysis concerning facilities, inventory, transportation, cost, prices, and customers throughout the supply chain.

- **Sourcing**

Functions a firm performs and the functions that are outsourced.

- **Pricing**

Price associated with goods and services provided by a firm to the supply chain.

NETWORK DESIGN DECISIONS

Network design is the act of strategizing and making decisions about the role and location of facilities as well as their capacity and the markets they are serving

FACTORS INFLUENCING NETWORK DESIGN DECISIONS

1. Strategic Factors

A company's competitive strategy has a significant impact on decisions in the supply chain network design. Companies that focus on cost leadership will try to find or create the lowest cost for facilities manufacturing. Companies that focus on response rate tends to place a facility that closed in the market and may choose a location to high cost if they meet the company's choice to react quickly to changing market needs. Global supply chain network to support corporate strategic objectives with the role of different facilities in different places.

2. Technological factors

Characteristics contained in production technology have a significant impact on network design decisions. If the production technology displays economies of scale are significant, few high-capacity sites will be more effective. Unlike the case with fixed-cost facilities is lower, many local facilities are prepared because this will help lower transportation costs. Flexibility in production technology have an impact pad level of consolidation that can be achieved by the network.

3. Macroeconomic factors

These factors include taxes, customs duties, exchange rates, and other economic factors that do not exist within the company. This factor has a significant impact on the success or failure of the supply chain network.

- Tariff and tax incentives
- Exchange rate and demand risk
- Freight and fuel cost

4. Political Factors

Political stability in a country is of paramount consideration because it has a significant impact on role in the choice of location. Companies prefer to place the facility at a location or state which has a stability that provide clarity in terms of trade rules and ownership.

5. Infrastructure factors

The existence of good infrastructure is an important prerequisite in allocating facilities in certain areas. Poor infrastructure will further add to business costs.

6. Competitive Factors

Companies must consider the strategy, size, and location of competitors when designing their supply chain network. Making important decisions the company is now set for the company's facilities are not accessible by competitors or in other words away from competitors.

7. Customer response time and local presence

Companies that have targeted customers who can respond in a quick time to put the facilities that are closed to the customer. If the company sends its products to customers, it means that transportation should be slightly built and continue to increase response time is short. This choice resulted in an increase or increase in transportation costs. Furthermore, many situations that require these facilities to customers.

8. The cost of logistics and facilities

Logistics and facilities costs that occur in the supply chain can undergo changes such as the number of facilities, location and capacity allocation. Companies should consider, supplies, transportation and facility costs as the company's supply chain network design. The increasing cost of supplies and facilities, the greater the number of facilities used in the supply chain. The lower the transportation cost, the greater the number of facilities. If the number of facilities increased at a point where the journey economies of scale is lost, then the transportation cost increases. The total number of logistics is the entire inventory, transportation and facility costs

FRAMEWORK FOR NETWORK DESIGN DECISIONS

Phase I: Define a supply chain strategy / design

The objective of the first phase is to define the organization’s high-level supply chain design characteristics, such as determining the stages and whether functions are going to be outsourced or not.

Based on the organization’s business strategy, analysis of global competition (and its likely evolution), and internal constraints, managers must determine a high level supply chain design.

The six major types of distribution networks can come in handy in this phase.

Phase II: Define the regional facility configuration

The second phase aims at defining the regions for facility location, their roles, and approximate capacity.

The second phase starts with aggregated demand forecasting (the topic of the next lesson). Such a prediction should include the demand's characteristics in demand variability and stability of customer's requirement.

Then the manager can identify opportunities for cost reduction using economies of scale or scope. Such information should be used to determine capacity allocation decisions.

Managers should also consider macroeconomic, political, and competitive factors (as we previously saw).

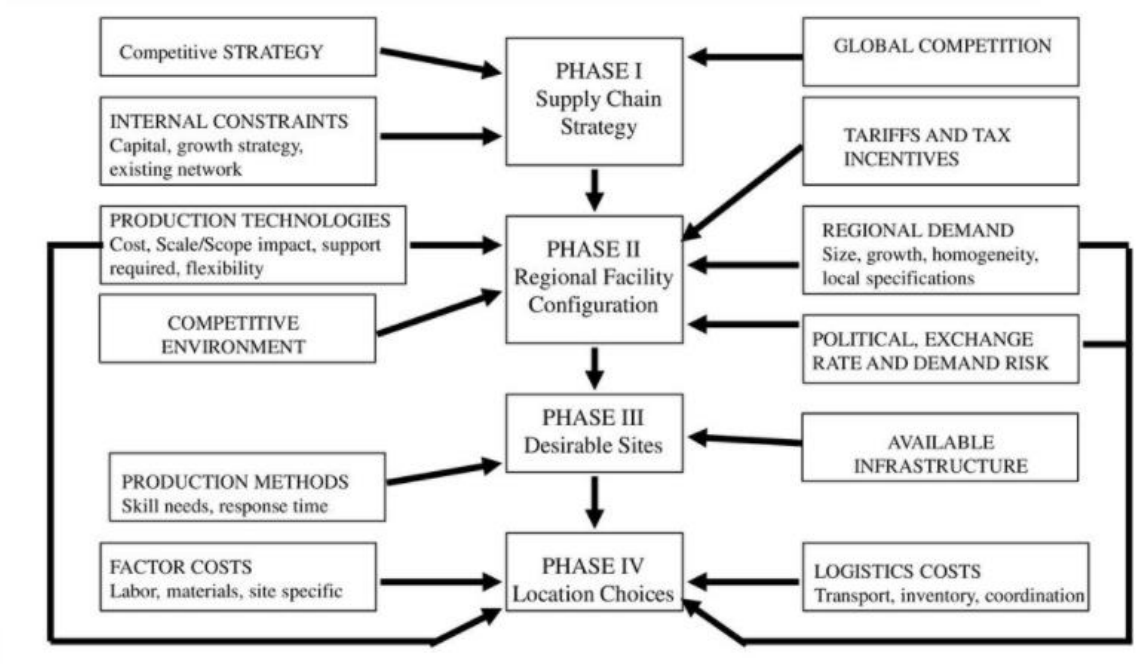

Fig 3 : Network design decisions

Phase III: Select a set of potentially desirable sites

In Phase III, we identify some potentially desirable sites within each region defined in Phase II.

For each region defined in Phase II, we define a list of potential sites based on the infrastructure availability and other "soft" factors:

– Available infrastructure: accessibility to suppliers, transportation services, communication, utilities, and warehouse facilities.

– "Soft" factors: availability of skilled workforce, community receptivity.

Phase IV: Choose the locations

Finally, we select the precise location and capacity allocation for each facility.

– From the preliminary list of potential sites defined in Phase III, we pick those that are more suitable to the organization's needs and define the capacity of each one.

– Here we add in the cost components into our decision model, such as labor, materials, site-specifics, transport, inventory, and coordination costs.

FACILITY LOCATION

Facility location may be defined as a place where the facility will be set up for producing goods or services. The need for location selection may arise under any of the following conditions:

- When a business is newly started.
- When the existing business unit has outgrown its original facilities and expansion is not possible; hence a new location has to be found.
- When the volume of business or the extent of market necessitates the establishment of branches.
- When the lease expires and the landlord does not renew the lease.

FACTORS AFFECTING LOCATION DECISION

- **Availability of raw materials**

  Availability of raw materials is the most important factor in plant location decisions. Usually, manufacturing units where there is the conversion of raw materials into finished goods is the main task then such organizations should be located in a place where the raw materials availability is maximum and cheap.

- **Nearness to the market**

  Nearness of market for the finished goods not only reduces the transportation costs, but it can render quick services to the customers. If the plant is located far away from the markets then the chances of spoiling and breakage become high during transport. If the industry is nearer to the market then it can grasp the market share by offering quick services.

- **Availability of labour**

  Another most important factor which influences the plant location decisions is the availability of labour. The combination of the adequate number of labour with suitable skills and reasonable labour wages can highly benefit the firm. However, labor- intensive firms should select the plant location which is nearer to the source of manpower.

- **Transport facilities**

  In order to bring the raw materials to the firm or to carrying the finished goods to the market, transport facilities are very important. Depending on the size of the finished goods or raw materials a suitable transportation is necessary such as roads, water, rail, and air. Here the transportation costs highly increase the cost of production, such organizations can not complete with the rival firms. Here the point considered is transportation costs must be kept low.

- **Availability of fuel and power**

  Unavailability of fuel and power is the major drawback in selecting a location for firms. Fuel and power are necessary for all most all the manufacturing units, so locating firms nearer to the coal beds and power industries can highly reduce the wastage of efforts, money and time due to the unavailability of fuel and power.

- **Availability of water**

  Depending on the nature of the plant firms should give importance to the locations where water is available.

MODELS FOR FACILITY LOCATION AND FOR DECISION MAKING

- **Location rating factor technique**

In this technique, first of all an organization needs to identify the factors that influence its location decision. Next, each factor is provided a weight between ‘0’ to ‘1’ according to the level of importance, where ‘0’ denotes least important and ‘1’ denotes most important.

Sl. No.	Location factor	Factor rating (1)	Location 1		Location 2	
			(Rating) (2)	Total= (1) . (2)	(Rating) (3)	Total = (1) . (3)
1.	Facility utilization	8	3	24	5	40
2.	Total patient per month	5	4	20	3	15
3.	Average time per emergency trip	6	4	24	5	30
4.	Land and construction costs	3	1	3	2	6
5.	Employee preferences	5	5	25	3	15
			Total	96	Total	106

Table 1 : Location rating factor technique

- **Centre-of-gravity technique**

This technique emphasizes on transportation cost in the determination of facility location. Transportation cost mainly depends on distance, weight of merchandise and the time required for transportation.

The centre-of-gravity technique can be used when multiple suppliers or customers exist at different geographic locations and it is economically sensible to locate centrally to service all of them

- **Transportation technique**

In simple words, the transportation technique evaluates multiple transportation routes of shipping goods from multiple origins to multiple destinations and finds or develops the least cost route. The technique is often used in determining facility locations for evaluating transportation costs of routes by selecting different facility locations. In the transportation technique, multiple facility locations fits are identified and their relative transportation costs are calculated. Finally, the location that is related to the lowest cost routes is selected.

THE MAKING OF NETWORK DESIGN DECISIONS IN PRACTICE

Managers should keep the following issues in mind when making network design decisions for a supply chain.

Do not underestimate the life span of facilities. It is important to think through the long-term consequences of facility decisions because facilities last a long time and have an enduring impact on a firm's performance. Managers must consider not only future demand and costs but also scenarios in which technology may change. Otherwise, facilities may become useless within a few years.

Do not gloss over the cultural implications. Network design decisions regarding facility location and facility role have a significant impact on the culture of each facility and the firm. The culture at a facility will be influenced by other facilities in its vicinity. Network designers can use this fact to influence the role of the new facility and the focus of people working there.

Do not ignore quality-of-life issues. The quality of life at selected facility locations has a significant impact on performance because it influences the workforce available and its morale. In many instances, a firm may be better off selecting a higher cost location if it provides a much better quality of life. Failure to do so can have dire consequences.

Focus on tariffs and tax incentives when locating facilities. Managers making facility location decisions should consider tariffs and tax incentives carefully. When considering international locations, it is astounding how often tax incentives drive the choice of location, often overcoming all of the other cost factors combined.

THE IMPACT OF UNCERTAINTY ON NETWORK DESIGN

Supply chain design decisions cannot be easily changed in the short-term. There will be a good deal of uncertainty in demand, prices, exchange rates, and the competitive market over the lifetime of a supply chain network. Therefore, building flexibility into supply chain operations allows the supply chain to deal with uncertainty in a manner that will maximize profits

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SCHOOL OF MANAGEMENT STUDIES

UNIT – III – Supply Chain Management – SBAA7026

III. SUPPLY CHAIN INVENTORIES AND SOURCING DECISIONS

Supply Chain Inventory Management: EOQ Models - Reorder Point Models - Multi Channel Inventory Systems - Supply Chain Facilities Layout - Capacity Planning - Inventory Optimization - The role of Sourcing in Supply Chain - In House or Outsource - Supplier Selection: Auctions and Negotiations - Contracts, Risk Sharing and Supply Chain Performance - Design Collaboration - The Procurement Process - Designing a Sourcing Portfolio: Tailored Sourcing - Risk Management in Sourcing.

INVENTORY MANAGEMENT

Inventory management is a systematic approach to sourcing, storing, and selling inventory—both raw materials (components) and finished goods (products). In business terms, inventory management means the right stock, at the right levels, in the right place, at the right time, and at the right cost as well as price.

OBJECTIVES OF INVENTORY MANAGEMENT

- To ensure a continuous supply of materials to facilitate uninterrupted production
- To maintain sufficient stocks of raw materials during short-supply
- To maintain sufficient finished goods for efficient customer service
- To minimize the carrying cost
- To maintain the optimum level of investment in inventories

INVENTORY TERMINOLOGIES

- **Set-up cost:** This is the cost associated with the setting up of machinery before starting production. The set-up cost is generally assumed to be independent of the quantity ordered for.
- **Ordering cost:** This is the cost incurred each time an order is placed. This cost includes the administrative costs (paper work, telephone calls, postage), transportation, receiving and inspection of goods, etc.

- **Purchase (or production) cost**: It is the actual price at which an item is purchased (or produced). It may be constant or variable. It becomes variable when quantity discounts are allowed for purchases above a certain quantity.
- **Carrying (or holding) cost:** The cost includes the following costs for maintaining the inventory: i) Rent for the space; ii) cost of equipment or any other special arrangement for storage; iii) interest of the money blocked; iv) the expenses on stationery; v) wages of the staff required for the purpose; vi) insurance and depreciation; and vii) deterioration and obsolescence, etc.
- **Shortage (or Stock-out) cost:** This is the penalty cost for running out of stock, i.e., when an item cannot be supplied on the customer's demand. These costs include the loss of potential profit through sales of items demanded and loss of goodwill in terms of permanent loss of the customer
- **Demand:** Demand is the number of units required per period and may either be known exactly or known in terms of probabilities. Problems in which demand is known and fixed are called deterministic problems whereas problems in which demand is known in terms of probabilities are called probabilistic problems
- **Order Cycle**: The period between placement of two successive orders is referred to as an order cycle.
- **Lead Time:** The time gap between placing an order for an item and actually receiving the item into the inventory is referred to as lead time
- **Reorder Level**: The lower limit for the stock is fixed at which the purchasing activities must be started for replenishment. With this replenishment, the stock reached at a level is known as maximum stock. The level between maximum and minimum stock is known as the reorder level.
- **Economic Order Quantity (EOQ):** The order in quantity that balances the costs of holding too much stock or the costs of ordering in small quantities too frequently is called Economic Order Quantity (or Economic lot size).
- **Reorder Quantity:** The quantity ordered at the level of minimum stock is known as the reorder quantity.

EOQ MODELS – DETERMINISTIC

- Model I: Purchasing model without shortages
- Model II: Production model without shortages
- Model III: Purchasing model with shortages
- Model IV: Production model with shortages

(Note: For Problems kindly refer PPT)

MULTI-CHANNEL INVENTORY MANAGEMENT

Multi-channel inventory management (also known as multi-source inventory) is the process by which businesses account for and track orders from various sales sources on inventory that is stored at multiple locations, such as marketplaces, ecommerce, retail, and wholesale.

Managing inventory across multiple sources and channels is an expected challenge these days. An important component of this process is how the information is shared across the business - since many different departments need inventory data for different reasons.

Most merchants would agree that inventory is the heart of their commerce operations, and being able to seamlessly manage it across multiple channels has become essential to maintaining a competitive edge internally that translates into a strong customer experience externally

For example

- Order placed on ecommerce website, picked up in-store.
- Customer finds a product they want on yourwebsite.com
- They see they can order it online, and get it shipped to their house, which will take 5 business days, or they can pay for it now, and pick it up in store tomorrow morning (the store is 15 minutes away). They choose to pick it up in store.
- The order is placed, paid for.
- The customer picks up their order the next day.

Let's look at what's going on behind the scenes to make that happen.

1. The ecommerce website's inventory levels are updated while the customer is browsing. It doesn't go out of stock, so they don't see any change.
2. After entering a zip code, the customer sees how shipping would take from the closest warehouse to get to their house. They also see the closest store that has the product they want in stock, and how many of them they have.

3. Upon confirming their purchase, the total inventory and the store inventory are updated, and an employee at the store gets a notification to set the product aside.
4. The employee verifies that the customer picked up their purchased product.

MULTI CHANNEL INVENTORY - FACTORS

- Number of sales channels
- Number of distribution options
- Number of systems being used
- Interfaces between those systems

SUPPLY CHAIN FACILITY LAYOUT

According to James Lundy, “Layout identically involves the allocation of space and the arrangement of equipment in such a manner that overall operating costs are minimized.”

OBJECTIVES OF LAYOUT

- Proper and efficient utilization of available floor space
- Giving good and improved working conditions
- To ensure that work proceeds from one point to another point without any delay
- Provide enough production capacity
- Minimizing delays in production
- Reduce material handling costs
- Reduce hazards to personnel
- Utilize labour efficiently
- Increase employee morale
- Reduce accidents
- Provide for volume and product flexibility
- Provide ease of supervision and control
- Provide for employee safety and health
- Allow ease of maintenance
- Allow high machine or equipment utilization
- Improve productivity

PRINCIPLES OF GOOD FACILITY LAYOUT

- A good plant layout is the one which is able to integrate its workmen, materials, machines in the best possible way.
- A good plant layout is the one which sees very little or minimum possible movement of the materials during the operations.
- A good layout is the one that is able to make effective and proper use of the space that is available for use.
- A good layout is the one which involves unidirectional flow of the materials during operations without involving any back tracking.
- A good plant layout is the one which ensures proper security with maximum flexibility.
- Maximum visibility, minimum handling and maximum accessibility, all form other important features of a good plant layout.

TYPES OF FACILITY LAYOUT

- Product layout
- Process layout
- Fixed Position/ Stationary layout
- Cellular or group layout
- Service Facility Layout
- Combined Layout

Product layout

A product layout groups different workstations together according to the products they work on. Workstations in a product layout can quickly transfer small batches of semi-finished goods directly to the next station in a production line. Product layouts can be ideal for smaller manufacturing businesses with lower volume than their large corporate competitors.

Layout that uses standardized processing operations to achieve smooth, rapid, high-volume flow. Here machines are arranged according to the needs of product & in the same sequence as the operations are necessary for manufacture. E.g. _back office‘ of services such as banks and insurance companies.

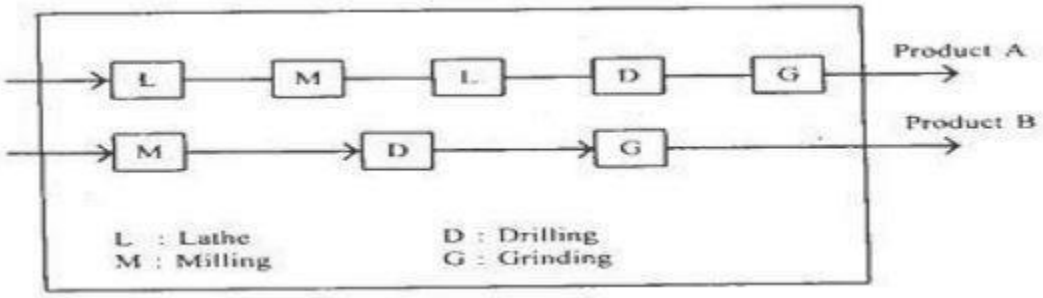

Fig 1 : Product Layout

Advantages of Product Layout

- Low unit cost
- Labor specialization
- Low material handling cost
- High utilization of labor and equipment
- Established routing and scheduling
- Short processing time

Disadvantages of Product Layout

- Creates dull, repetitive jobs
- Poorly skilled workers may not maintain equipment or quality of output
- Fairly inflexible to changes in volume
- Highly susceptible to shutdowns
- Needs preventive maintenance
- Require large capital investment

Process layout

A process layout groups workstations together according to the activities being performed, regardless of which products each workstation is working on. Workstations produce higher volumes of output at a time before sending semi-finished goods in bulk to the next area, which may be located as close as the other end of a building or as far as another facility on the other side of the globe.

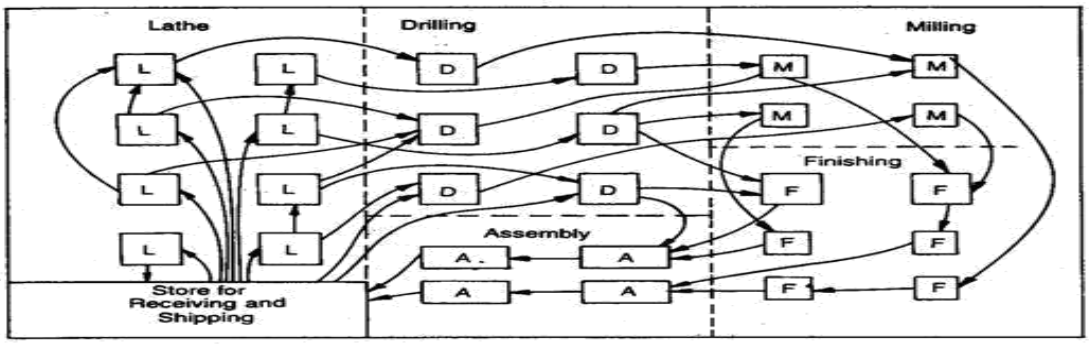

Fig 2 : Process Layout

Layout that can handle varied processing requirements. Here all machines performing similar types of operations are grouped together at one location in the process layout. Thus here facilities are grouped together acc. to their functions. E.g. all drilling machines are located at one place known as the drilling section.

Advantages of Process Layouts

- Can handle a variety of processing requirements
- Machines breakdown doesn‘t result in shutdown.
- Equipment used is less costly
- Wide flexibility in production facilities.
- Each production unit of system works independently.
- High utilization of facilities
- Variety makes the job interesting.

Disadvantages of Process Layouts

- In-process inventory costs can be high
- Challenging routing and scheduling
- Equipment utilization rates are low
- Material handling is slow and inefficient & is more.
- More space is required
- Longer processing time
- Backtracking may occur.

Stationary layout:

Stationary Layout in which the product or project remains stationary, and workers, materials and equipment are moved as needed. Eg. Construction of DAMS. The product, because of its size and/or weight, remains in one location and processes are brought to it.

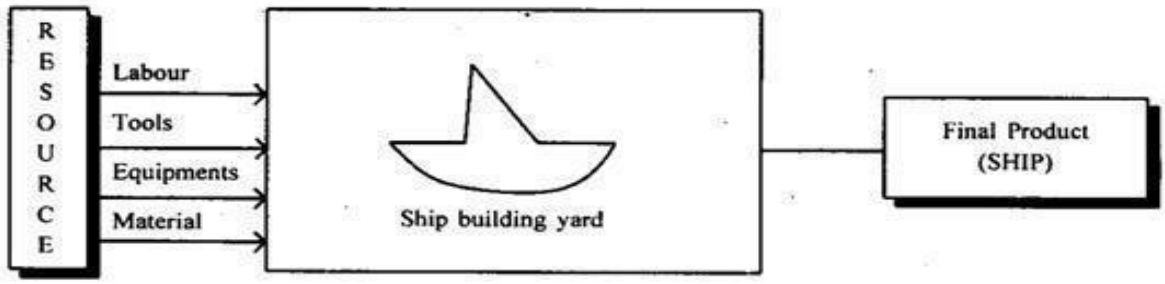

Fig 3 : Stationary Layout

4. **Cellular or group layout**

Cellular layout is based on the group technology (GT) principle. Therefore, it is also called as group layout. This layout is suitable for a manufacturing environment in which large variety of products are needed in small volumes (or batches). The group technology principle suggests that parts, which are similar in design or manufacturing operations, are grouped into one family, called part-family.

For each part-family a dedicated Cluster of machines (called machine cell) are identified. Generally, all the processing requirements of a particular part-family are completed in its corresponding machine ceil. In other words, the intercell transfer UT part should ideally be zero."

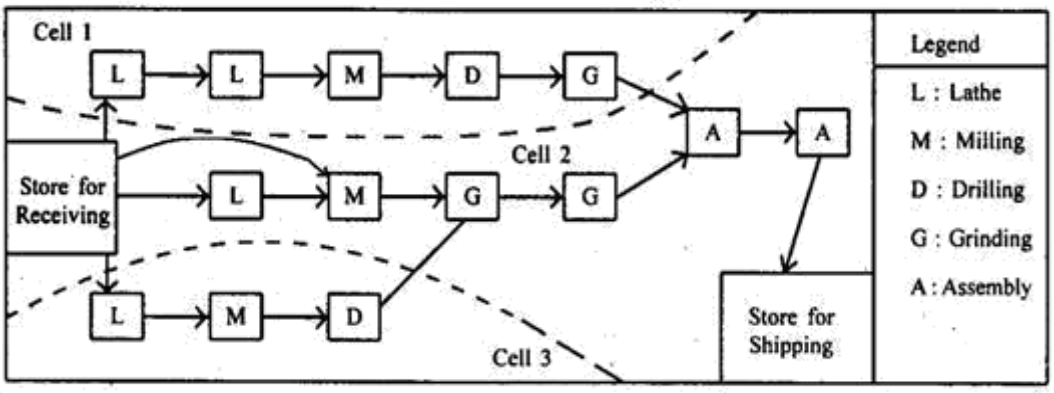

Fig 4 : Cellular or group layout

The cellular layout is thus a combination of process and product layout. Therefore, it possesses the features of both. Cellular manufacturing system (CMS) involves decomposition of manufacturing system into subsystems of similar parts/machines. CMS allows batch production to give economic advantages similar to those of mass production with additional advantages of flexibility, normally associated with job shop production systems

Service facility Layout

The fundamental difference between service facility and manufacturing facility layouts is that many service facilities exist to bring together customers and services. Service facility layouts should provide for easy entrance to these facilities from freeways and busy thoroughfares. large, well organized and amply lighted parking areas and well-designed walkways to and from parking areas are some of the requirements of service facility layouts.

Combined Layout

The application of the principles of product layout or fixed location layout in their strict meanings is difficult to come across. A combination of the product and process layouts, with an emphasis on either, is noticed in most industrial establishments. Plants are never laid out in either pure form. It is possible to have both types of layout in an efficiently combined form if the products manufactured are somewhat similar and not complex.

CAPACITY PLANNING

Capacity planning is the process of determining the production capacity needed by an organization to meet changing demands for its products.

IMPORTANCE OF CAPACITY DECISIONS

- Impacts ability to meet future demands
- Affects operating costs
- Major determinant of initial costs
- Involves long-term commitment
- Affects competitiveness

CAPACITY UTILIZATION

It measures how much of the available capacity is actually being used:

Utilization = Actual Output rate (100%) / Capacity

DETERMINANTS OF EFFECTIVE CAPACITY

- ✓ Facilities (size, location, layout, heating, lighting, ventilations)
- ✓ Product and service factors (similarity of products)
- ✓ Process factors (productivity, quality)
- ✓ Human factors (training, skills, experience, motivations, absentation, turnover)
- ✓ Policy factors (overtime system, no. of shifts)
- ✓ Operational factors (scheduling problems, purchasing requirements, inventory shortages)
- ✓ Supply chain factors (warehousing, transportation, distribution)
- ✓ External factors (product standards, government agencies, pollution standard)

TYPES OF CAPACITY PLANNING

Design Capacity

Design capacity is the maximum output of a structure, facility, process, machine, tool or component based on its design. It is the capacity that can be achieved under ideal conditions with unlimited resources such as labor, power, materials and parts.

Actual Capacity

The actual capacity of an air or gas compressor is the quantity of air or gas compressed and delivered. It is usually expressed in cubic feet per minute (CFM) at intake pressure and temperature.

Effective Capacity

Effective capacity is the maximum amount of work that an organization is capable of completing in a given period due to constraints such as quality problems, delays, material handling, etc

INVENTORY OPTIMIZATION

Inventory optimization is the provision of the right inventory, in the right quantities and at the right locations, to meet the supply and demand of parts and materials in the enterprise.

Benefits of Optimizing Inventory

- ✓ Reduction in on-hand stock levels

- ✓ Reduction in out-of-stock instances
- ✓ Reduction in inventory holding costs
- ✓ Increased focus on other business critical functions due to automation.

ROLE OF SOURCING IN SUPPLY CHAIN

- Sourcing is the set of business processes required to purchase goods and services
- Sourcing processes include:
    - **Supplier scoring and assessment**

      It is the process used to rate supplier performance. Suppliers should be compared based on their impact on the supply chain surplus and total cost. Unfortunately, sourcing decisions are often driven based solely on the price charged by a supplier. Many other supplier characteristics, such as lead time, reliability, quality, and design capability also affect the total cost of doing business with a supplier. A good supplier scoring and assessment process must identify and track performance along all dimensions and evaluate the impact on the total cost of using a supplier.
    - **Supplier selection and contract negotiation**

      Supplier selection uses the output from supplier scoring and assessment to identify the appropriate suppliers. A supply contract is then negotiated with the supplier. A good contract should account for all factors that affect supply chain performance and should be designed to increase supply chain profits in a way that benefits both the supplier and the buyer.
    - **Design collaboration**

      Design collaboration allows the supplier and the manufacturer to work together when designing components for the final product. Design collaboration also ensures that any design changes are communicated effectively to all parties involved with designing and manufacturing the product.
    - **Procurement**

      Once the product has been designed, *procurement* is the process whereby the supplier sends product in response to orders placed by the buyer. The

goal of procurement is to enable orders to be placed and delivered on schedule at the lowest possible overall cost.

- **Sourcing planning and analysis**

  The role of sourcing planning and analysis is to analyze spending across various suppliers and component categories to identify opportunities for decreasing the total cost.

BENEFITS OF EFFECTIVE SOURCING DECISIONS

- Better economies of scale can be achieved if orders within a firm are aggregated.
- More efficient procurement transactions can significantly reduce the overall cost of
- purchasing. This is most important for items for which a large number of low-value
- transactions occur.
- Design collaboration can result in products that are easier to manufacture and distribute,
- resulting in lower overall costs. This factor is most important for components that
- contribute a significant amount to product cost and value.
- Good procurement processes can facilitate coordination with the supplier and improve
- forecasting and planning. Better coordination lowers inventories and improves the matching
- of supply and demand.
- Appropriate supplier contracts can allow for the sharing of risk, resulting in higher profits
- for both the supplier and the buyer.
- Firms can achieve a lower purchase price by increasing competition through the use of auctions.

IN-HOUSE OR OUTSOURCE

The decision to outsource is based on the growth in supply chain surplus provided by the third party and the increase in risk incurred by using a third party. A firm should consider outsourcing if the growth in surplus is large with a small increase in risk. Performing the function in-house is preferable if the growth in surplus is small or the increase in risk is large.

Increase supply chain surplus through

- ✓ Capacity aggregation
- ✓ Inventory aggregation
- ✓ Transportation aggregation by transportation intermediaries

- ✓ Transportation aggregation by storage intermediaries
- ✓ Warehousing aggregation
- ✓ Procurement aggregation
- ✓ Information aggregation
- ✓ Receivables aggregation
- ✓ Relationship aggregation
- ✓ Lower costs and higher quality

Capacity aggregation. A third party can increase the supply chain surplus by aggregating demand across multiple firms and gaining production economies of scale that no single firm can on its own. This is the most common reason for outsourcing production in a
supply chain.

Inventory aggregation. A third party can increase the supply chain surplus by aggregating inventories across a large number of customers.

Transportation aggregation by transportation intermediaries. A third party may increase the surplus by aggregating the transportation function to a higher level than any shipper can on its own. UPS, FedEx, and a host of LTL carriers are examples of transportation intermediaries that increase the supply chain surplus by aggregating transportation across a variety of shippers.

Transportation aggregation by storage intermediaries. A third party that stores inventory can also increase the supply chain surplus by aggregating inbound and outbound transportation. On the inbound side, they are able to aggregate shipments from several manufacturers onto a single truck. This results in a lower transportation cost than could be achieved by each manufacturer independently. On the outbound side, they aggregate packages for customers at a common destination, resulting in a significantly lower transportation cost than can be achieved by each customer separately.

Warehousing aggregation. A third party may increase the supply chain surplus by aggregating warehousing needs over several customers. The growth in surplus is achieved in terms of lower real estate costs and lower processing costs within the warehouse. Savings through warehousing aggregation arise if a supplier's warehousing needs are small or if its needs fluctuate over time. In either case, the intermediary with the warehouse can exploit economies of scale in warehouse

construction and operation by aggregating across multiple customers. An example is Safexpress, a third-party logistics provider in India.

Procurement aggregation. A third party increases the supply chain surplus if it aggregates procurement for many small players and facilitates economies of scale in ordering, production, and inbound transportation. Procurement aggregation is most effective across many small buyers. A good example is Fleet Xchange, a firm that offers small truck fleets lower prices for truck equipment and services through aggregate buying.

Information aggregation. A third party may increase the surplus by aggregating information to a higher level than can be achieved by a firm performing the function in-house. All retailer's aggregate information on products from many manufacturers in a single location. This information aggregation reduces search costs for customers. eBags is an example of a retailer that primarily provides information aggregation. eBags holds little inventory but is a single point of display for information on bags from many manufacturers.

Receivables aggregation. A third party may increase the supply chain surplus if it can aggregate the receivables risk to a higher level than the firm or it has a lower collection cost than the firm. Brightstar is a distributor for Motorola in most Latin American countries other than Brazil.

Relationship aggregation. An intermediary can increase the supply chain surplus by decreasing the number of relationships required between multiple buyers and sellers. Without an intermediary, connecting a thousand sellers to a million buyers requires a billion relationships. The presence of an intermediary lowers the number of relationships required to just over a million.

Lower costs and higher quality. A third party can increase the supply chain surplus if it provides lower cost or higher quality relative to the firm. If these benefits come from specialization and learning, they are likely to be sustainable over the longer term. A specialized third party that is further along the learning curve for some supply chain activity is likely to maintain its advantage over the long term.

STEPS IN SUPPLIER SELECTION

- Recognize the need for supplier selection
- Identify key sourcing requirement
    - Quality
    - Cost
    - Delivery Performance
    - Technological Capabilities
- Determining Sourcing Strategies
    - Single Source vs Multiple Source
    - Short term vs Long term
    - Domestic vs Foreign Supplier
- Identify potential Supply sources

SUPPLIER SELECTION : AUCTIONS AND NEGOTIATIONS

Supplier selection can be performed through competitive bids, reverse auctions and direct negotiations. Supplier evaluation is based on total cost of using a supplier Auctions :

- Sealed bid first price auctions
- English Auctions
- Dutch Auctions
- Second price auctions

- Sealed-bid first-price auctions require each potential supplier to submit a sealed bid for the contract by a specified time. These bids are then opened and the contract is assigned to the lowest bidder.
- English auctions, the auctioneer starts with a price and suppliers can make bids as long as each successive bid is lower than the previous bid. The supplier with the last (lowest) bid receives the contract. The difference in this case is that all suppliers get to see the current lowest bid as the auction unfolds.
- In Dutch auctions, the auctioneer starts with a low price and then raises it slowly until one of the suppliers agrees to the contract at that price.
- In second-price (Vickrey) auctions, each potential supplier submits a bid. The contract is assigned to the lowest bidder but at the price quoted by the second-lowest bidder.

BASIC PRINCIPLES OF NEGOTIATION

The difference between the values of the buyer and seller is the bargaining surplus. The goal of each negotiating party is to capture as much of the bargaining surplus as possible

- Have a clear idea of your own value and as good an estimate of the third party's value as possible
- Look for a fair outcome based on equally or equitably dividing the bargaining surplus
- A win-win outcome

CONTRACTS, RISK SHARING, AND SUPPLY CHAIN PERFORMANCE

A supply contract specifies parameters governing the buyer-supplier relationship. In addition to making the terms of the buyer-supplier relationship explicit, contracts have significant impact on the behavior and performance of all stages in a supply chain. Contracts should be designed to facilitate desirable supply chain outcomes by growing the supply chain surplus and minimizing actions that hurt performance. A manager should ask the following three questions when designing a supply chain contract:

1. How will the contract affect the firm's profits and total supply chain profits?

2. Will the incentives in the contract introduce any information distortion?

3. How will the contract influence supplier performance along key performance measures?

Ideally, a contract should be structured to increase the firm's profits and supply chain profits, discourage information distortion, and offer incentives to the supplier to improve performance along key dimensions. Many shortcomings in supply chain performance occur because the buyer and supplier are different entities, each trying to optimize its own profits.

DESIGN COLLABORATION

Two statistics highlight the importance of design collaboration between a manufacturer and suppliers. Today, typically between 50 and 70 percent of the spending at a manufacturer comes from procurement, compared to only about 20 percent several decades ago. Second, it is generally accepted that about 80 percent of the cost of a purchased part is fixed during the design stage.

Thus, it is crucial for a manufacturer to collaborate with suppliers during the design stage if product costs are to be kept low. Design collaboration can lower the cost of purchased material and also lower logistics and manufacturing costs. Design collaboration is also important for a company

trying to provide variety and customization, because failure to do so can significantly raise the cost of variety.

Working with suppliers can speed up product development time significantly. This is crucial in an era when product life cycles are shrinking and bringing a product to market before the competition offers a significant advantage. Finally, integrating the supplier into the design phase allows the manufacturer to focus on system integration, resulting in a higher quality product at lower cost. For example, auto manufacturers are increasingly playing the role of system integrators rather than component designers. This is an approach that has been used even more extensively in the high-tech industry.

THE PROCUREMENT PROCESS

- The process in which the supplier sends product in response to orders placed by the buyer
- Main categories of purchased goods
  - Direct materials
  - Indirect materials

	Direct Materials	Indirect Materials
Use	Production	Maintenance, repair, and support operations
Accounting	Cost of goods sold	Selling, general, and administrative expenses (SG&A)
Impact on production	Any delay will delay production	Less direct impact
Processing cost relative to value of transaction	Low	High
Number of transactions	Low	High

Table 1 : Direct and Indirect Material

- Procurement process for direct materials should be designed to ensure that components are available in the right place, in the right quantity, and at the right time
- Focus for indirect materials should be on reducing transaction cost
- A good example of a procurement process that focuses on these objectives is the eHub initiative at Cisco. eHub is designed to provide synchronized planning and end-to-end supply chain visibility. Another example is the relationship between Johnson Controls and

Chrysler for the 2002 Jeep Liberty. Johnson Controls integrated components from 35 suppliers and delivered the assembly to Chrysler as a cockpit module. As soon as Chrysler notified it of an order for a Jeep, Johnson Controls had 204 minutes in which to build and deliver the module. This was done 900 times every day for about 200 color and interior combinations. The focus of the procurement process was to completely synchronize production at Chrysler and Johnson Controls. The result was a significant reduction in inventory and a better matching of product supply with end customer demand.

DESIGNING A SOURCING PORTFOLIO

- Tailored Sourcing
  - Options with regard to whom and where to source from
  - Produce in-house or outsource to a third party
  - Will the source be cost efficient or responsive?
  - Onshoring, near-shoring, and offshoring
- Tailor supplier portfolio based on a variety of product and market characteristics

DESIGNING A SOURCING PORTFOLIO: TAILORED SOURCING

When structuring a supplier portfolio, firms have many options with regard to whom to source from and where to source from. With regard to the "whom," a company must decide on whether to produce in-house or outsource to a third party. The company must also decide whether the supply source will be cost efficient or responsive. With regard to the "where," a company can choose between onshoring, near-shoring, and offshoring. Onshoring refers to producing the product in the market where it is sold, even when it is a high-cost location. Near-shoring refers to producing the product at a lower cost location near the market. For the U.S. market, producing in Mexico is near shoring. For the market in Europe, producing in Eastern Europe is near-shoring. Offshoring refers to producing the product at a low-cost location that may be far from the market. In this section, we discuss a variety of factors that influence the design of the sourcing portfolio. Most companies need to tailor their supplier portfolio based on a variety of product and market characteristics. For example, Zara uses responsive sources out of Europe to produce trendy products that must be in stores quickly to meet customer demand. In contrast, basics such as a white t-shirt are sourced out of lower-cost facilities in Asia. The table identifies factors that favor the selection of a responsive or low-cost source.

	Responsive Source	Low-Cost Source
Product life cycle	Early phase	Mature phase
Demand volatility	High	Low
Demand volume	Low	High
Product value	High	Low
Rate of product obsolescence	High	Low
Desired quality	High	Low to medium
Engineering/design support	High	Low

Table 2 : Responsive Source and Low-cost source

In general, responsive sources will tend to be located onshore or near-shore to facilitate a quick response. Low-cost sources could be located anywhere but low cost is often the main reason for going offshore or near-shore. In Table, we identify some factors that influence the sourcing location decision.

	Onshore	Near-shore	Offshore
Rate of innovation/product variety	High	Medium to High	Low
Demand volatility	High	Medium to High	Low
Labor content	Low	Medium to High	High
Volume or weight-to-value ratio	High	High	Low
Impact of supply chain disruption	High	Medium to High	Low
Inventory costs	High	Medium to High	Low
Engineering/management support	High	High	Low

Table 3 : Onshore, Near shore and Off shore

Large, bulky items such as washing machines and refrigerators are best onshored or nearshored because they have high transportation costs relative to value. In contrast, small items like consumer electronics, especially those that sell in large amounts (say the iPad), can be offshored. As transportation costs increase, the onshore and near-shore options become more attractive relative to offshoring. High-value routers with high demand volatility, high inventory costs, and the need for significant management support are outsourced by Cisco to an onshore supplier. Low value routers with stable designs and low demand volatility, in contrast, are offshored to low-cost countries.

RISK MANAGEMENT IN SOURCING

Sourcing risks may result in an inability to meet demand on time, an increase in procurement costs, or the loss of intellectual property. It is important to develop mitigation strategies that help mitigate a significant part of the risk. An inability to meet demand on time arises because of disruption or delay from the supply source. The risk of supply disruption may be serious, especially with a single or few sources. Supply chains with a single source based in the tsunami-affected region faced significant disruption. Disruption risk can be mitigated by developing multiple sources. Given the high cost of developing multiple sources and the resulting loss of economies of scale, it is best to do so for products with relatively high demand. Developing multiple sources is expensive for products with low demand. Carrying inventory or developing a backup source that is more responsive can mitigate delays from a supply source.

Carrying inventory is best for low-value products that do not become obsolete quickly, whereas developing a responsive backup source is preferred for high-value, short life cycle products. The risk of higher procurement costs can be significant when industry-wide demand for the product exceeds available supply, exchange rates are unfavorable, or there is a single supply source. For example, commodity prices for steel and crude oil were very high in 2004–2005 because of high global demand in the face of limited supply capacity. A portfolio of long- and

short-term contracts can help mitigate the risk of higher procurement costs. For example, a significant contributor to the profits at Southwest Airlines in 2004–2005 was the long-term contracts it had in place for the purchase of fuel. Exchange-rate risk can be mitigated using financial hedges or by developing a global supply network that is flexible enough to be reconfigured based on exchange-rate fluctuations. The risk of holdup because of a single source can be countered by developing alternative sources or bringing part of the supply capability in-house.

MAKING SOURCING DECISIONS IN PRACTICE

1. Use multifunctional teams. Effective strategies for sourcing result from multifunctional collaboration within the firm. A sourcing strategy from the purchasing group is likely to be relatively narrow and focus on purchase price. A strategy developed with the collaboration of purchasing, manufacturing, engineering, and planning is much more likely to identify the correct drivers of total cost. The collaboration must be continued beyond strategy formulation to the

procurement phase, because that is where manufacturing and engineering are most likely to realize the full benefits of good sourcing strategy.

2. Ensure appropriate coordination across regions and business units. Coordination of purchasing across all regions and business units allows a firm to maximize economies of scale in purchasing and also to reduce transaction costs. Other opportunities from improved sourcing, such as better supply chain coordination and design collaboration, however, may require strong involvement at the business-unit level to be effective. Mandating global coordination across all business units may complicate these efforts. Items such as MRO supplies, for which transaction costs and total purchase volume have a significant impact on total cost, benefit most from coordinated purchasing across geography and business units. On the other hand, items for which most of the value is extracted from better design collaboration and coordinated supply chain forecasting and fulfillment are better served with somewhat more decentralized sourcing.

3. Always evaluate the total cost of ownership. An effective sourcing strategy should not make price reduction its sole objective. All factors that influence the total cost of ownership should be identified and used in selecting suppliers. Supplier performance along all relevant dimensions should be measured, and its impact on total cost should be quantified. Focusing on the total cost of ownership also allows a buyer to better identify opportunities for better collaboration in design, planning, and fulfillment.

4. Build long-term relationships with key suppliers. A basic principle of good sourcing is that a buyer and supplier working together can generate more opportunities for savings than the two parties working independently. Solid cooperation is likely to result only when the two parties have a long-term relationship and a degree of trust. A long-term relationship encourages the supplier to expend greater effort on issues that are important to a particular buyer. This includes investment in buyer-specific technology and design collaboration. A long-term relationship also improves communication and coordination between the two parties. These capabilities are very important when sourcing direct materials. Thus, long-term relationships should be nurtured with suppliers of critical and strategic direct materials.

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SCHOOL OF MANAGEMENT STUDIES

UNIT – IV – Supply Chain Management – SBAA7026

IV. SUPPLY CHAIN TRANSPORTATION

Role of Transportation in Supply Chain - Modes of Transportation and Their Performance Characteristics - Transportation Infrastructure and policies - Design Options for a Transportation Network - Trade-offs in Transportation Design - Tailored Transportation- Risk Management in Transportation - IT Solutions - e-procurement - Bar coding and RFID Technology - Supply Chain IT in Practice

TRANSPORTATION

Transport or transportation is the movement of goods from one location to another. As an example, one location might be the place where you source raw materials or where you source goods from a manufacturing facility. We call such a location a node in the supply chain. There is then a series of such nodes or locations to finally get to the end customer.

ROLE OF TRANSPORTATION IN SUPPLY CHAIN

- ✓ Movement of product from one location to another
- ✓ Products rarely produced and consumed in the same location
- ✓ Significant cost component
- ✓ Shipper requires the movement of the product
- ✓ Carrier moves or transports the product

MODES OF TRANSPORTATION AND THEIR PERFORMANCE CHARACTERISTICS

- Air
- Package carriers
- Road
- Rail
- Water
- Pipeline
- Intermodal

Air Transportation

Air freighting is commonly used by companies who work with short lead times, or advanced service levels. Air transportation is best suited for small, high- value items or time sensitive emergency shipments that have to travel a long distance. Air carriers normally move shipments that have high value but light weight.

- Advantages of Air transportation:

- ✓ It is the fastest mode of transport.
- ✓ It is very useful in transporting goods to the area, which are not accessible by any other means.
- ✓ Reduces lead time
- ✓ Improved service level

- Disadvantages:
  - ✓ It is relatively more expensive mode of transport.
  - ✓ It is not suitable for transporting heavy and bulky goods.
  - ✓ It is not suitable for short distance travel.

Road Transportation

Truck Load shipping suited for transportation between manufacturing facilities and warehouses.

- Road Transport Advantages:
  - ✓ It is a relatively cheaper mode of transport as compared to other modes.
  - ✓ It is a flexible mode of transport as loading and unloading is possible at any destination.
  - ✓ It provides door-to-door service.
  - ✓ It helps to carry goods from one place to another, in places which are not connected by other means of transport like hilly areas.
- Limitations of Road transport:
  - ✓ Due to limited carrying capacity road transport is not economical for long distance transportation of goods.
  - ✓ Transportation of heavy goods or goods in bulk by road involves high cost.

Package Carriers

Package carriers are transportation companies which carry small packages. Examples: FedEx, UPS, DHL. Etc. Package carrier use air, truck and rail to transport the goods. Packages carriers also provide other value-added services that allow shippers to inventory flow and track order status, shipper can proactively inform the customer about their packages. Package carrier is suited for e- business.

Rail Transportation

Rail transport uses freight trains for the delivery of merchandise Freight trains are usually powered by diesel, electricity and steam. Rail is suited for bulk shipment of products like fertilizer, cement, food grains and coal etc. from the production plant to the warehouses.

- Advantages of Rail transportation:
  - ✓ It is relatively faster than road transport.
  - ✓ It is suitable for carrying heavy goods in large quantities over long distances.
  - ✓ Cost effective
- Limitations of Rail transportation:
  - ✓ It is relatively expensive for carrying goods over short distances.
  - ✓ It is not available in remote parts of the country.
  - ✓ It provides service according to fixed time schedule and is not flexible for loading or unloading of goods at any place.

Water Transportation

Water transport uses ships and large commercial vessels that carry billions of tons of cargo. water transport is used primarily for the movement of large bulk commodity shipments and it is the cheapest mode for carrying such load. Water transport is particularly effective for significantly large quantities of goods that are non-perishable in nature and for cities or states that have water access.

- Advantages of water transportation:
  - ✓ It is a relatively economical mode of transport for bulky and heavy goods.
  - ✓ The cost of maintaining and constructing routes is very low most of them are naturally made.
  - ✓ It promotes international trade.
- Disadvantages:
  - ✓ The depth and navigability of rivers and canals vary and thus, affect operations of different transport vessels.
  - ✓ It is a slow-moving mode of transport and therefore not suitable for transport of perishable goods.
  - ✓ It is adversely affected by weather conditions.
  - ✓ Sea transport requires large investment on ships and their maintenance.

Pipeline

Pipeline is used primarily for the transport of crude petroleum, refined petroleum products and natural gas. It includes a significant initial fixed cost in setting up the pipeline and related infrastructure. Pipelines are not flexible and this scope is limited with respect to commodities.

Intermodal

Intermodal Transportation is use of more than one mode of transport for the movement of shipment from origin to its destination. Intermodal operation is used two or more mode of transport to take the advantage of inherent economies of each and thus provide the integrated service at lower cost. Unable to transport a variety of materials. For example: truck/water/rail.

TRANSPORTATION INFRASTRUCTURE AND POLICIES

Roads, seaports, airports, rail, and canals are some of the major infrastructural elements that exist along nodes and links of a transportation network. In almost all countries, the government has either taken full responsibility or played a significant role in building and managing these infrastructure elements. Improved infrastructure has played a significant role in the development of transportation and the resulting growth of trade.

The role of the railroads and canals in the economic development of the United States is well documented. More recently, the impact of improved road, air, and port infrastructure on the development in China is very visible.

Transportation infrastructures often require government ownership or regulation because of their inherently monopolistic nature. In the absence of a monopoly, deregulation and market forces help create an effective industry structure.

When the infrastructure is publicly owned, it is important to price usage to reflect the marginal impact on the cost to society. If this is not done, overuse and congestion result because the cost borne by a user is less than his or her marginal impact on total cost.

DESIGN OPTIONS FOR A TRANSPORTATION NETWORK

The design of a transportation network affects the performance of a supply chain by establishing the infrastructure within which operational transportation decisions regarding scheduling and routing are made. A well-designed transportation network allows a supply chain to achieve the desired degree of responsiveness at a low cost.

Direct Shipment Network to Single Destination

With the direct shipment network to a single destination option, the buyer structures the transportation network so that all shipments come directly from each supplier to each buyer location, as shown in the below diagram. With a direct shipment network, the routing of each shipment is specified, and the supply chain manager needs to decide only the quantity to ship and the mode of transportation to use. direct shipment network to single destination is justified only if demand at buyer locations is large enough that optimal replenishment lot sizes are close to a truckload from each supplier to each location.

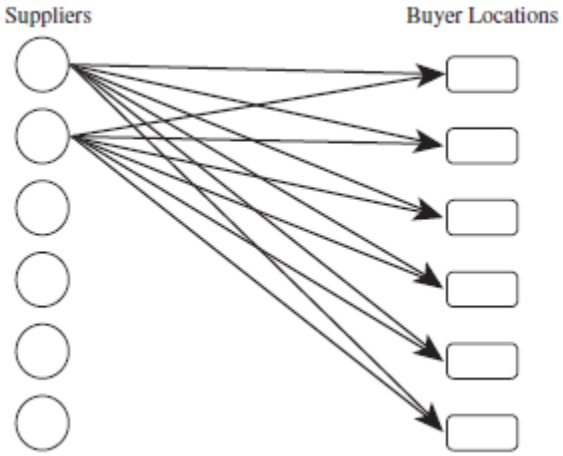

Fig 1: Direct Shipment Network

Direct Shipping with Milk Runs

A milk run is a route on which a truck either delivers product from a single supplier to multiple retailers or goes from multiple suppliers to a single buyer location, as shown in the below figure. In direct shipping with milk runs, a supplier delivers directly to multiple buyer locations on a truck or a truck picks up deliveries destined for the same buyer location from many suppliers. When using this option, a supply chain manager has to decide on the routing of each milk run.

Direct shipping provides the benefit of eliminating intermediate warehouses, whereas milk runs lower transportation cost by consolidating shipments to multiple locations on a single truck. Milk runs make sense when the quantity destined for each location is too small to fill a truck but multiple locations are close enough to each other such that their combined quantity fills the truck.

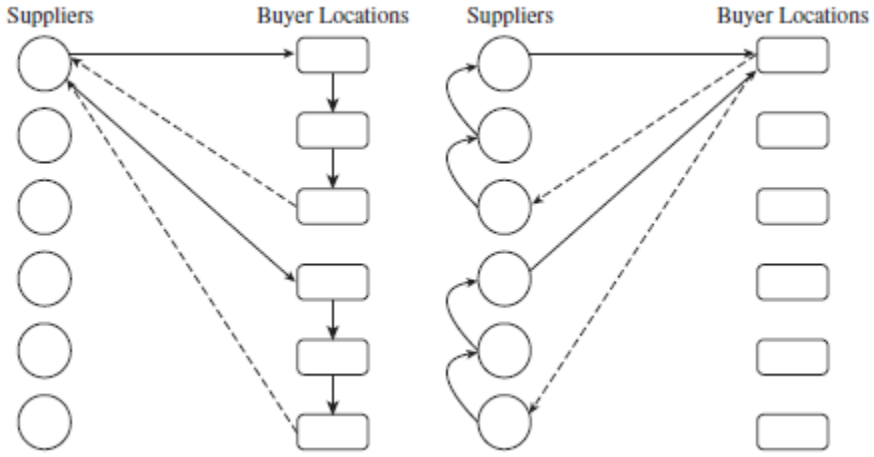

Fig 2 : Milk Runs from Multiple Suppliers or to Multiple Buyer Locations

All Shipments via Intermediate Distribution Centre with Storage

Under this option, product is shipped from suppliers to a central distribution centre where it is stored until needed by buyers when it is shipped to each buyer location, as shown in below figure. Storing product at an intermediate location is justified if transportation economies require large shipments on the inbound side or shipments on the outbound side cannot be coordinated. In such a situation, product comes into a DC in large quantities where it is held in inventory and sent to buyer locations in smaller replenishment lots when needed.

The presence of a DC allows a supply chain to achieve economies of scale for inbound transportation to a point close to the final destination, because each supplier sends a large shipment to the DC that contains product for all locations the DC serves. Because DCs serve locations nearby, the outbound transportation cost is not very large.

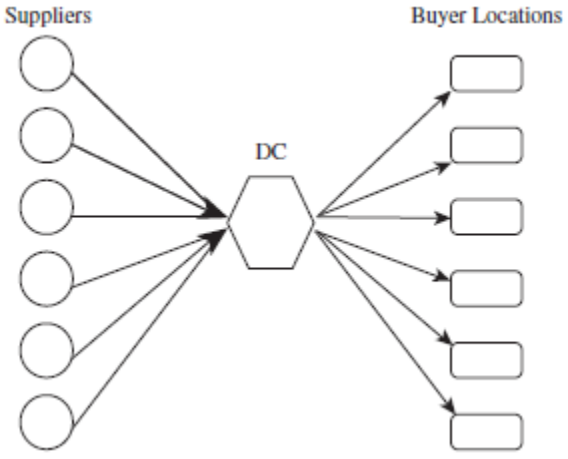

Fig 3: All Shipments via DC

All Shipments via Intermediate Transit Point with Cross-Docking

Under this option, suppliers send their shipments to an intermediate transit point (could be a DC) where they are cross-docked and sent to buyer locations without storing them. The product flow is similar to that shown in above figure except that there is no storage at the intermediate facility. When a DC cross-docks product, each inbound truck contains product from suppliers for several buyer locations, whereas each outbound truck contains product for a buyer location from several suppliers. Major benefits of cross docking are that little inventory needs to be held and product flows faster in the supply chain. Cross-docking also saves on handling cost because product does not have to be moved into and out of storage. Cross-docking is appropriate when economies of scale in transportation can be achieved on both the inbound and outbound sides and both inbound and outbound shipments can be coordinated. Wal-Mart has used cross-docking successfully to decrease inventories in the supply chain without incurring excessive transportation costs.

Shipping via DC Using Milk Runs

As shown in below figure, milk runs can be used from a DC if lot sizes to be delivered to each buyer location are small. Milk runs reduce outbound transportation costs by consolidating small shipments.

For example, Seven-Eleven Japan cross-docks deliveries from its fresh-food suppliers at its DCs and sends out milk runs to the retail outlets because the total shipment to a store from all suppliers does not fill a truck. The use of cross-docking and milk runs allows Seven-Eleven Japan to lower its transportation cost while sending small replenishment lots to each store. The use of cross-docking with milk runs requires a significant degree of coordination and suitable routing and scheduling.

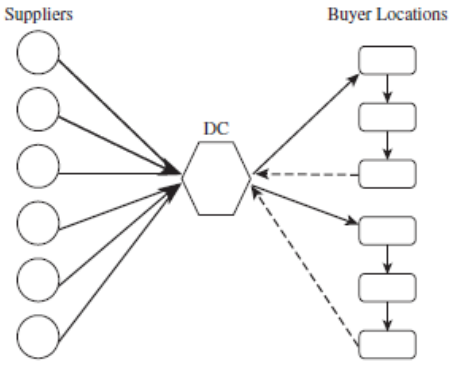

Fig 4: Milk Runs from DC

TAILORED NETWORK

The tailored network option is a suitable combination of previous options that reduces the cost and improves responsiveness of the supply chain. Here transportation uses a combination of cross-docking, milk runs, and TL and LTL carriers, along with package carriers in some cases. The goal is to use the appropriate option in each situation. High-demand products to high demand retail outlets may be shipped directly, whereas low-demand products or shipments to low-demand retail outlets are consolidated to and from the DC. The complexity of managing this transportation network is high because different shipping procedures are used for each product and retail outlet. Operating a tailored network requires significant investment in information infrastructure to facilitate the coordination. Such a network, however, allows for the selective use of a shipment method to minimize the transportation as well as inventory costs.

Network Structure	Pros	Cons
Direct shipping	No intermediate warehouse Simple to coordinate	High inventories (due to large lot size) Significant receiving expense
Direct shipping with milk runs	Lower transportation costs for small lots Lower inventories	Increased coordination complexity
All shipments via central DC with inventory storage	Lower inbound transportation cost through consolidation	Increased inventory cost Increased handling at DC
All shipments via central DC with cross-dock	Low inventory requirement Lower transportation cost through consolidation	Increased coordination complexity
Shipping via DC using milk runs	Lower outbound transportation cost for small lots	Further increase in coordination complexity
Tailored network	Transportation choice best matches needs of individual product and store	Highest coordination complexity

Table 1 : Pros and Cons of Different Transportation Networks

TRADE-OFFS IN TRANSPORTATION DESIGN

All transportation decisions made by shippers in a supply chain network need to take into account their impact on inventory costs, facility and processing costs, the cost of coordinating operations, and the level of responsiveness provided to customers. For example, Amazon's use of package carriers to deliver products to customers increases transportation cost but allows Amazon to centralize its facilities and reduce inventory costs. If Amazon wants to reduce its transportation costs, the company must either sacrifice responsiveness to customers or increase the number of facilities and resulting inventories to move closer to customers.

The cost of coordinating operations is generally hard to quantify. Shippers should evaluate different transportation options in terms of various costs and revenues and then rank them according to coordination complexity. A manager can then make the appropriate transportation decision. Managers must consider the following trade-offs when making transportation decisions:

• Transportation and inventory cost trade-off

• Transportation cost and customer responsiveness trade-off

Transportation and Inventory Cost Trade-Off

The trade-off between transportation and inventory costs is significant when designing a supply chain network. Two fundamental supply chain decisions involving this trade-off are

• Choice of transportation mode

• Inventory aggregation

Choice of Transportation Mode

Selecting a transportation mode is both a planning and an operational decision in a supply chain. The decision regarding carriers with which a company contracts is a planning decision, whereas the choice of transportation mode for a particular shipment is an operational decision. For both decisions, a shipper must balance transportation and inventory costs. 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.

Inventory Aggregation

Firms can significantly reduce the safety inventory they require by physically aggregating inventories in one location. Most online businesses use this technique to gain advantage over firms with facilities in many locations. For example, Amazon has focused on decreasing its facility and inventory costs by holding inventory in a few warehouses, whereas booksellers such as Barnes & Noble have to hold inventory in many retail stores.

TAILORED TRANSPORTATION

Tailored transportation is the use of different transportation networks and modes based on customer and product characteristics. Most firms sell a variety of products and serve many different customer segments. For example, W.W. Grainger sells more than 200,000 MRO supply products to both small contractors and large firms.

Products vary in size and value, and customers vary in the quantity purchased, responsiveness required, uncertainty of the orders, and distance from W.W. Grainger branches and DCs. Given these differences, a firm such as W.W. Grainger should not design a common transportation network to meet all needs. A firm can meet customer needs at a lower cost by using tailored transportation to provide the appropriate transportation choice based on customer and product characteristics.

Tailored Transportation by Customer Density and Distance

Firms must consider customer density and distance from warehouse when designing transportation networks. When a firm serves a high density of customers close to the DC, it is often best for the firm to own a fleet of trucks that are used with milk runs originating at the DC to supply customers, because this scenario makes good use of the vehicles and provides customer contact. If customer density is high but distance from the warehouse is large, it does not pay to send milk runs from the warehouse because empty trucks will travel a long distance on the return trip. In such a situation, it is better to use a public carrier with large trucks to haul the shipments to a cross-dock centre close to the customer area, where the shipments are loaded onto smaller trucks that deliver product to customers using milk runs. In this situation, it may not be ideal for a firm to own its own fleet. As customer density decreases, use of an LTL carrier or a third party doing milk runs is more economical because the third-party carrier can aggregate shipments across many firms

Tailored Transportation by Size of Customer

Firms must consider customer size and location when designing transportation networks. Large customers can be supplied using a TL carrier, whereas smaller customers will require an LTL carrier or milk runs. When using milk runs, a shipper incurs two types of costs:

• Transportation cost based on total route distance

• Delivery cost based on number of deliveries

The transportation cost is the same whether going to a large or small customer. If a delivery is to be made to a large customer, including other small customers on the same truck can save on transportation cost. For each small customer, however, the delivery cost per unit is higher than for large customers. Thus, it is not optimal to deliver to small and large customers with the same frequency at the same price. One option firm have is to charge a higher delivery cost for smaller customers.

Tailored Transportation by Product Demand and Value

The degree of inventory aggregation and the modes of transportation used in a supply chain network should vary with the demand and value of a product. The cycle inventory for high-value products with high demand is disaggregated to save on transportation costs because this allows replenishment orders to be transported less expensively.

RISK MANAGEMENT IN TRANSPORTATION

There are three main types of risk to consider 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

ROLE OF IT IN TRASPORTATION

The complexity and scale of transportation makes it an excellent area within the supply chain for the use of IT systems. The use of software to determine transportation routes has been the most common IT application in transportation. This software takes the location of customers, shipment size, desired delivery times, information on the transportation infrastructure (such as distances between points), and vehicle capacity as inputs. These inputs are formulated into an optimization problem whose solution is a set of routings and a packing list for each vehicle that minimize costs while meeting delivery constraints.

Along with routing, vehicle load optimization software helps improve fleet utilization. By accounting for the size of the container and the size and sequence of each delivery, this software develops a plan to pack the vehicle efficiently while allowing for the greatest ease of unloading and/or loading along the route. Synchronization between the packing and routing software is important because how much is packed on a truck affects the routing, while the routing obviously affects what is packed on a truck.

IT also comes into play in the use of global positioning systems (GPS) for tracking real time location of vehicles and electronic notification of impending arrivals. The availability of current information also allows for real-time dynamic optimization of transportation routes and deliveries. Electronic notifications and tracking improve customer service and preparedness throughout the supply chain

e-PROCUREMENT

e-Procurement involves the online conduct of business-to-business procurement processes using web-based applications. The significance of e-Procurement is that it enables buyers to locate potential suppliers, review product choices, select products and make purchasing transactions directly over the Internet.

BAR CODING

A barcode or bar code is a method of representing data in a visual, machine-readable form. Initially, barcodes represented data by varying the widths and spacings of parallel lines. These barcodes, now commonly referred to as linear or one-dimensional (1D), can be scanned by special optical scanners, called barcode readers They also come in patterns of squares, dots, hexagons and other geometric patterns within images termed 2D (2 dimensional) matrix codes or symbology.

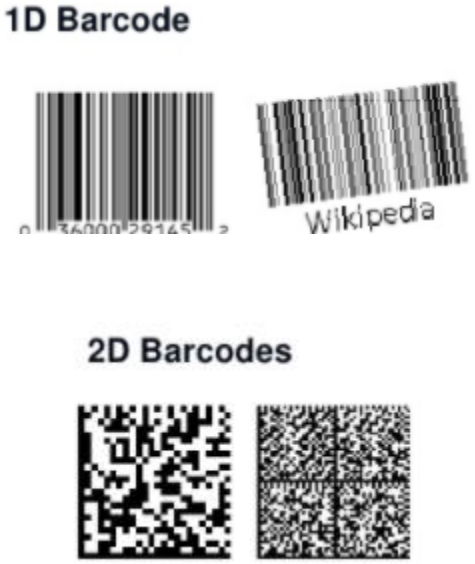

Fig 5: 1D and 2D barcodes

RFID TECHNOLOGY

Radio frequency identification (RFID) consists of an active or passive radio frequency (RF) tag applied to the item being tracked and an RF reader/emitter. A passive tag draws energy from the reader, whereas an active tag has its own battery and draws power from it. RFID has many potential uses. It can be used in manufacturing to check availability of the entire bill of materials. The technology can make the receiving of a truck much faster and cheaper. Full implementation of RFID could eliminate the need for manual counting and bar-code scanning at the receiving dock.

It can also be used to get an exact count of incoming items and items in storage. RFID technology, however, has yet to reach 100 percent accuracy, and its cost per unit is still high enough to make global acceptance difficult, even at the case level.

Fig 6 : RFID

SUPPLY CHAIN IT IN PRACTICE

1. Select an IT system that addresses the company's key success factors. Every industry and even companies within an industry can have different key success factors. By key success factors, we mean the two or three elements that really determine whether or not a company is going to be successful. It is important to select supply chain IT systems that are able to give a company an advantage in the areas most crucial to its success.

2. Take incremental steps and measure value. Some of the worst IT disasters result when companies try to implement IT systems in a wide variety of processes at the same time and end up with their projects being failures (often called the "big bang" approach). The impact of these failures is amplified by the fact that many of a company's processes are tied up in the same debugging cycle all at once, causing productivity to come to a standstill. One way to help ensure success of IT projects is to design them so that they have incremental steps.

3. Align the level of sophistication with the need for sophistication. Management must consider the depth to which an IT system deals with the firm's key success factors. There is a trade-off between the ease of implementing a system and the system's level of complexity. Therefore, it is important to consider just how much sophistication a company needs to achieve its goals and then ensure that the system chosen matches that level

4. Use IT systems to support decision making, not to make decisions. Although the software available today can make many supply chain decisions for management, this does not mean that IT applications can make all of the decisions. A mistake companies can make is installing a supply chain system and then reducing the amount of managerial effort it spends on supply chain issues.

Management must keep its focus on the supply chain because as the competitive and customer landscape changes, there needs to be a corresponding change in the supply chain.

5. Think about the future. Although it is more difficult to make a decision about an IT system with the future rather than the present in mind, managers need to include the future state of the business in the decision process. If trends in a company's industry indicate that insignificant characteristics will become crucial in the future, managers need to make sure their IT choices take these trends into account. As IT systems often last for many more years than was originally planned, managers need to spend time exploring how flexible the systems will be if, or rather when, changes are required in the future.

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SCHOOL OF MANAGEMENT STUDIES

UNIT – V – Supply Chain Management – SBAA7026

V. SUPPLY CHAIN INTEGRATION AND SUSTAINABILITY

Supply Chain Integration - Internal and External integrations - Ethical Supply Chains - Emerging Technologies in Supply Chain Integration - The Role of Sustainability in Supply Chain - The Tragedy of the commons - Key Metrics for Sustainability - Sustainability and Supply Chain Drivers - Closed-loop Supply Chains

SUPPLY CHAIN INTEGRATION

Supply chain integration is a process where the all the parties involved with the fulfillment of a product are integrated into a single system. An integrated supply chain drives top-line business growth and profit margins and enables the business and marketing plans of the organization. Additional benefits of an integrated supply chain include increased efficiencies, sufficient supply, reduced waste and happier customers. This requires significant coordination and alignment in order to ensure everyone is effectively working toward the same goal at all times.

- **Baseline** - This is the first stage, and it is when every department or system within a company is managing their own supply chain, and related issues. Companies also refer to this as a siloed approach, and while it can have some benefits, it is quite inefficient.

- **Functional Integration** - In this next stage, all the different departments within a company will work together to help to improve efficiency and reduce cost. This could be done by combining orders, scheduling jobs together, or other important steps.

- **Internal Supply Chain Integration** - All the departments within a company are connected using the same systems. This will almost always involve using some type of IT infrastructure solution that allows the departments to work efficiently together, share their needs, and identify collaboration opportunities.

- **External Supply Chain Integration** - The final stage involves external vendors as well as all of the internal departments. Providing a vendor with system access, and encouraging them to function almost as another department helps to generate the best possible results.

When it comes to integrating supply chains within a company, there are quite a few things that need to come together. The following are some of the key steps that most companies will need to take during this process:

- **Choosing Vendors** - Choosing vendors is more than just finding one that can provide the necessary parts. In addition to that, the vendor must be able to supply their piece at the needed time and place based on the overall supply chain.
- **Internal Teams** - Working with the internal teams of a company to work based on the needs of the overall system rather than just their department. Having set procedures based on the big picture can help to eliminate waste, and improve efficiency.
- **Waste Elimination** - While often overlooked, waste elimination should be an important part of an effective supply chain integration. This can happen when either a vendor or an internal team will physically relocate in order to more efficiently complete the work that needs to be done.

There are many other things involved with effective supply chain integration. This can seem like a very complex process, and in many ways, it really is. Once the initial integration is completed, the system should run very smoothly for years to come.

In most cases, the initial integration of the supply chain will require that all parties get together to discuss their abilities, as well as their needs. Going over all the logistics in an open environment will help provide everyone the opportunity to make suggestions, express concerns, and overcome obstacles, before it is ever implemented into a production environment.

ETHICS IN SCM

An ethical supply chain focuses on the need for corporate social responsibility, working to produce products and services in a way that treats its workers and the environment ethically.

Supporting an ethical supply chain means that companies will incorporate social and human rights and environmental considerations into how they do business across the world.

Ethical principles & standards are

- Used by individuals to make choices about how to behave
- Define acceptable conduct in business
- Should underpin decision making

- An ethical decision is one that is both legal and meets the shared ethical standards of the community

A business cannot claim to be ethical firm if it

- ✓ Ignores unethical practices by its suppliers
  e.g. – Use of child labour and forced labour
- ✓ Violation of the basic rights of workers
- ✓ Ignoring health, safety and environmental standards

An ethical business has to be concerned with the behaviour of all businesses that operate in the supply chain – i.e.

- ✓ Suppliers
- ✓ Contractors
- ✓ Distributors
- ✓ Sales agent

EMERGING TECHNOLOGIES IN SUPPLY CHAIN INTEGRATION

- **Robotics in Supply chain**

  The first robot in the supply chain was capable of moving material about a dozen feet. For several years, robots were used only in industrial manufacturing because it was not safe for people to be around them. However, over the last few decades, innovative logistic robotic companies have worked hard to mesh AI and machine learning, better sensors and response capabilities, warehouse management software or logistics management software. Recently, warehouse robotics in the supply chain has picked up pace exponentially. There has been huge funding and investment in the industry.

- **Big data in Supply Chain**

  Big supply chain analytics uses data and quantitative methods to improve decision making for all activities across the supply chain. In particular, it does two new things. First, it expands the dataset for analysis beyond the traditional internal data held on Enterprise Resource Planning (ERP) and supply chain management (SCM) systems. Second, it applies powerful statistical methods to both new and existing data sources. This creates new insights that help improve supply chain decision-making, all the way from the improvement of front-line operations, to strategic choices, such as the selection of the right supply chain operating models.

- **Industry 4.0 in Supply Chain**

  Industry 4.0 is essentially a blueprint for digitalizing the value chain from factory to customer. It combines logistics, production, IT, engineering, production to digitize business operations. Technologies included are the Internet of Things (IoT) and the Internet of Services, which in turn create the Smart Factory.

- **IOT in Supply Chain**

  The Internet of Things (IoT), refers to a network of connected devices, objects, and sensors, that collect and communicate information. When applied to the global supply chain, IoT technology can help businesses serve their customers better, while also saving the business money and improving overall efficiency.

- **Agile Supply Chain**

  The agile supply chain basically refers to the use of responsiveness, competency, flexibility, and quickness to manage how well a supply chain entity operates on a daily basis.

ROLE OF SUSTAINABILITY IN SUPPLY CHAIN

It is an ability of a supply chain to balance its economic, environmental and social performance. The health and survival of every supply chain and every individual depends on the health of the surrounding world. Expand the goal of a supply chain to others that may be affected by supply chain decision. The importance of sustainability in a supply chain extends beyond going green. A supply chain built on a sustainable platform creates more partnership opportunities because environmental responsibility is a crucial focal point in today's industry. Practicing eco-awareness in every aspect of your business improves your reputation and further legitimizes your organization.

A sustainable supply chain also helps improve productivity while saving money at the same time. By using sustainable techniques and resources, you increase the efficiency of buildings, vehicles and machinery at a significant cost savings. Nike is a prime example of sustainability at work. The world's number one shoe manufacturer changed how it makes some of its shoes and reduced labor costs by up to 50 percent and material use by 20 percent. The result was a 0.25 percent increase in margins.

- Factors driving focus on sustainability
    - ✓ Reducing risk and improving the financial performance of the supply chain
    - ✓ Attracting customers who value sustainability
    - ✓ Making the world more sustainable

Steps to implement a sustainable supply chain

- Identify your sustainability goals and objectives, and then create a plan for how to achieve them. Be sure to include your supply chain because it plays a big role in your company's environmental, social and economic impact.
- Create a sustainability policy for your suppliers and customers. What you prescribe is up to you, but it should have requirements for waste disposal, energy use, transportation and more. Once you make a policy, stick to it.
- Evaluate your supply chain from top to bottom. Is it as sustainable as you want it to be, or should you make adjustments?
- Take the appropriate action to make your supply chain more sustainable. This may mean changing vendors or transportation options, or it could result in your current partners adopting more sustainable practices in order to maintain your business.

Fig 1 : Role of Sustainability in Supply Chain

THE TRAGEDY OF THE COMMONS

- Dilemma arising when the common good does not align perfectly with the good of individual entities
- Getting any agreement on action is difficult because the optimal joint action is not individually optimal
- Need for intervention but considerable disagreement on the required form of intervention

KEY METRICS FOR SUSTAINABILITY

- **Energy consumption**

  Energy consumption refers to all the energy used to perform an action, manufacture something or simply inhabit a building. Examples: In a factory, total energy consumption can be measured by looking at how much energy a production process consumes, for example, by making car parts.

- **Water consumption**

  Water consumption is defined as the freshwater taken from ground or surface water sources, either permanently or temporarily, and conveyed to the place of use. If the water is returned to a surface water source, abstraction of the same water by the downstream user is counted again in compiling total abstractions.

- **Greenhouse gas emissions**

  Greenhouse gases (GHGs) are so called because they contribute towards the greenhouse effect. The greenhouse effect describes the natural phenomenon where certain gases in the atmosphere increase the Earth's surface temperature due to an ability to trap heat, similar to the way in which glass traps heat in a greenhouse.

- **Waste generation**

  Waste generation is closely linked to the level of economic activity in a country and reflects society's production and consumption patterns. A reduction in the volume of waste generated per unit of GDP is an indication of the economy's move towards less material-intensive production patterns.

SUSTAINABILITY AND SUPPLY CHAIN DRIVERS

- **Transportation**
  - Lower transportation costs also tend to reduce emissions and waste
  - Product design a significant role in reducing transportation cost and emissions
  - Reducing packaging and allowing greater density during transportation
- **Sourcing**
  - Majority of energy and water use and waste and emissions occurs in extended supply chain outside the enterprise
  - Extended supply chain and work with their suppliers to improve performance
  - Verifying and tracking supplier performance on sustainability is a major challenge

- **Information**
  - Good information is a big challenge
  - Absence of standards leads to claims of improvement that are not verifiable
  - Leads to company-specific standards and an explosion of certifications and certifying agencies
  - Use of consistent measures within a supply chain
- **Pricing**
  - Consumption visibility and differential pricing by load or time of day may make a significant difference in the usage of energy
  - Change customer's willingness to pay for a product that is produced and distributed in a more sustainable manner but costs more
  - Sustainability cannot be improved simply by focusing on reducing costs or the use of incentives

CLOSED LOOP SUPPLY CHAIN

Closed-loop supply chains (CLSC) are supply chain networks that "include the returns processes and the manufacturer has the intent of capturing additional value and further integrating all supply chain activities"

A closed-loop supply chain essentially combines the traditional supply chain (forward logistics) with reverse logistics, considering the item after it's served its original purpose. Once the item has been manufactured, shipped, and distributed through a reseller, the manufacturer works to encourage the item's return once it's no longer functional or needed. Reverse logistics then kick in, and the items can either be repaired and resold, or they can be broken down for reuse in future products. The "closed-loop" term refers to the fact that the chain is intended to maintain and recover value from unused products, while helping to create as little waste as possible.

Closed-loop supply chains can substantially help cut back on these wastes. For example, most products require raw materials to make, but some recycled material is useable for creating new consumer products. Even if raw materials are used, the goal of the closed-loop supply chain is to reduce the number of raw materials needed, through reclaiming and reusing post-consumer materials.

Once the original product is made, it is sent along the supply chain as usual, going to a distributor and retailer, eventually reaching the customer. But that's where new reverse logistics come in—the product must be recyclable or manufacturers must offer take-back programs and returns to close the supply chain.

Customers who find that their product doesn't work properly, or simply doesn't meet their needs return items all the time. The manufacturer then has to determine if the item can be fixed and resold, or if it should continue on to another step in the reverse logistics path. If it does, the item might be recycled—along with the products that other consumers submit to the manufacturer via take-back programs. These programs allow customers to recycle potentially hazardous items like electronics, whether they're broken or out-of-date, so they can be disposed of and recycled in an environmentally friendly way.

A Win-Win

It's a win-win when sustainable initiatives can actually save a business money, and a closed-loop supply chain can do just that when managed properly. Companies that create products of any kind should tune into this new trend—and see if a closed-loop supply chain could save money and gain the public's goodwill. It's our responsibility to preserve our natural resources—and businesses need to be leading that fight.

The main advantages of a closed-loop supply chain are:

- Reduced Waste
- Improved Public Perception
- Enhanced Customer Loyalty
- Being Ahead of the Regulatory Curve

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