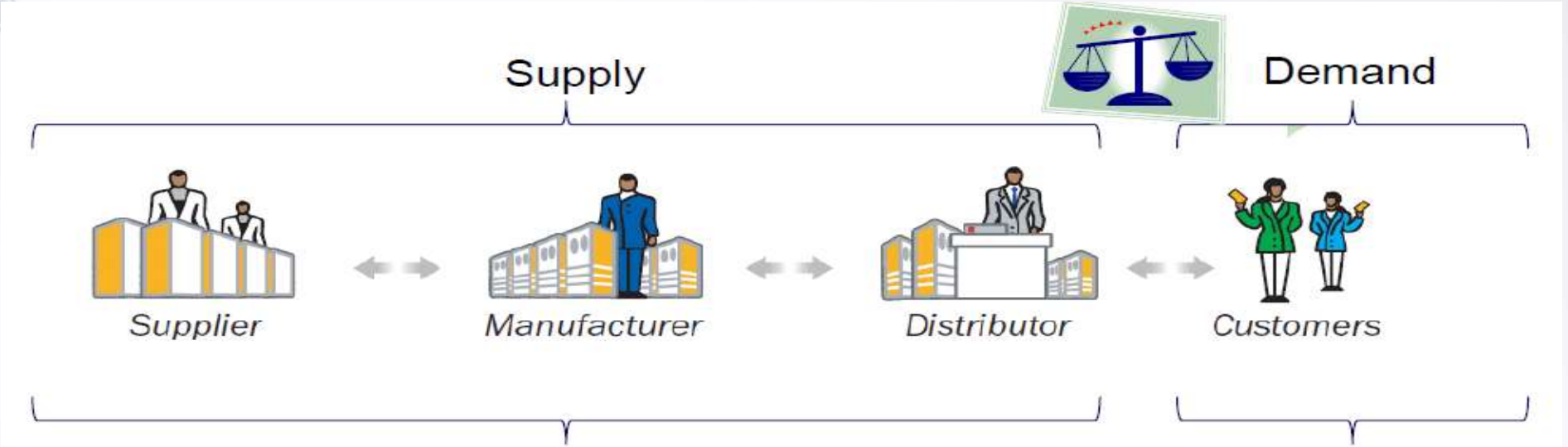
e3melbusiness.com

Supply Chain and Distribution Networks



- Objectives: Minimize costs
  - purchasing costs
  - manufacturing costs
  - inventory holding costs
  - transportation costs
  - duties/tariffs
  - administrative costs
  - Etc

Tradeoff

- Objectives: Maximize revenues/customer value
  - product quality
  - delivery quality
  - responsiveness
  - Flexibility
  - etc

- Within each company, the supply chain includes all functions involved in fulfilling a customer request (sales, customer service, distribution, manufacturing, procurement – perhaps also product development and, to some extent, finance)
- Two perspectives/levels:
- “physical”: a supply chain is a network consisting of geographically dispersed locations (e.g. manufacturing plants, warehouses, customer locations) which are linked through flows of goods
- “institutional”: a network of firms and individuals (suppliers, manufacturers, logistics service providers, customers) which are linked through formal (e.g. contractual, managerial) and informal relationships as well as information flows and flows of funds
- Both levels are interconnected!

- Supply Chain Management Definition
  - Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies
- Logistics Management Definition
  - Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements

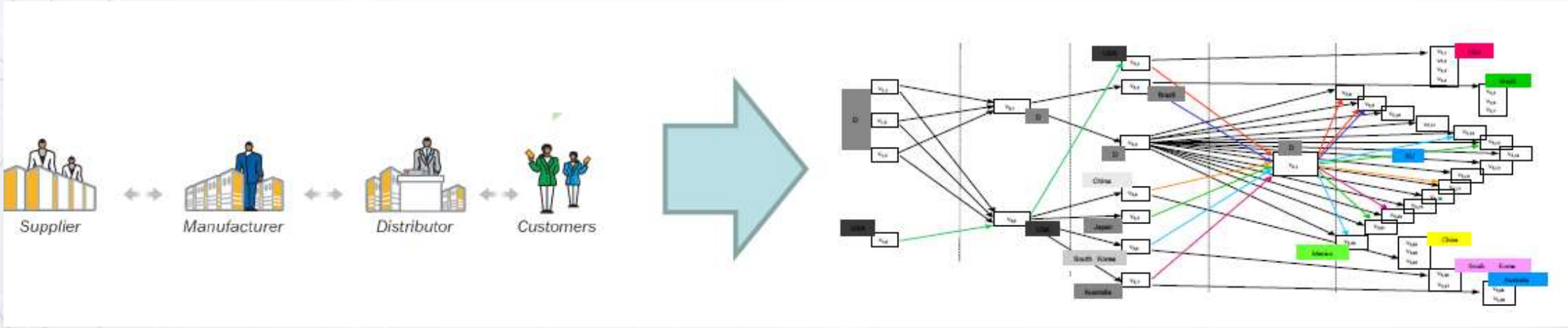
- The Objective of a Supply Chain:
  - Maximize overall value created
  - Supply chain value: difference between what the final product is worth to the customer (i.e., customer's willingness to pay) and the cost the supply chain incurs in filling the customer's request
  - Value is corresponds to supply chain profitability (difference between revenue generated from the customer and the overall cost across the supply chain)
  - Sources of supply chain revenue: the customer
  - Important question: How exactly does the supply chain impact revenue?
  - Sources of supply chain cost: flows of information, products, or funds between stages of the supply chain

- Supply chain strategy or design:
  - Decisions about the structure of the supply chain and what processes each stage will perform
  - Strategic supply chain decisions
  - Locations and capacities of facilities
  - Products to be made or stored at various locations
  - Modes of transportation
  - Information systems
  - Supply chain design must support strategic objectives and must be aligned with business strategy
  - Supply chain design decisions are long-term and expensive to reverse – must take into account market uncertainty

- Supply chain planning:
  - Definition of a set of policies that govern short-term operations
  - Fixed by the supply configuration from previous phase
  - Starts with a forecast of demand in the coming year
  - Planning decisions:
  - Which markets will be supplied from which locations
  - Planned inventories
  - Subcontracting, backup locations
  - Inventory policies
  - Timing and size of market promotions
  - Must consider in planning decisions demand uncertainty, exchange rates, competition over the time horizon

- Supply chain operation/execution:
  - Time horizon is weekly or daily
  - Decisions regarding individual customer orders
  - Supply chain configuration is fixed and operating policies are determined
  - Goal is to implement the operating policies as effectively as possible
  - Allocate orders to inventory or production, set order due dates, generate pick lists at a warehouse, allocate an order to a particular shipment, set delivery schedules, place replenishment orders
  - Much less uncertainty (short time horizon)

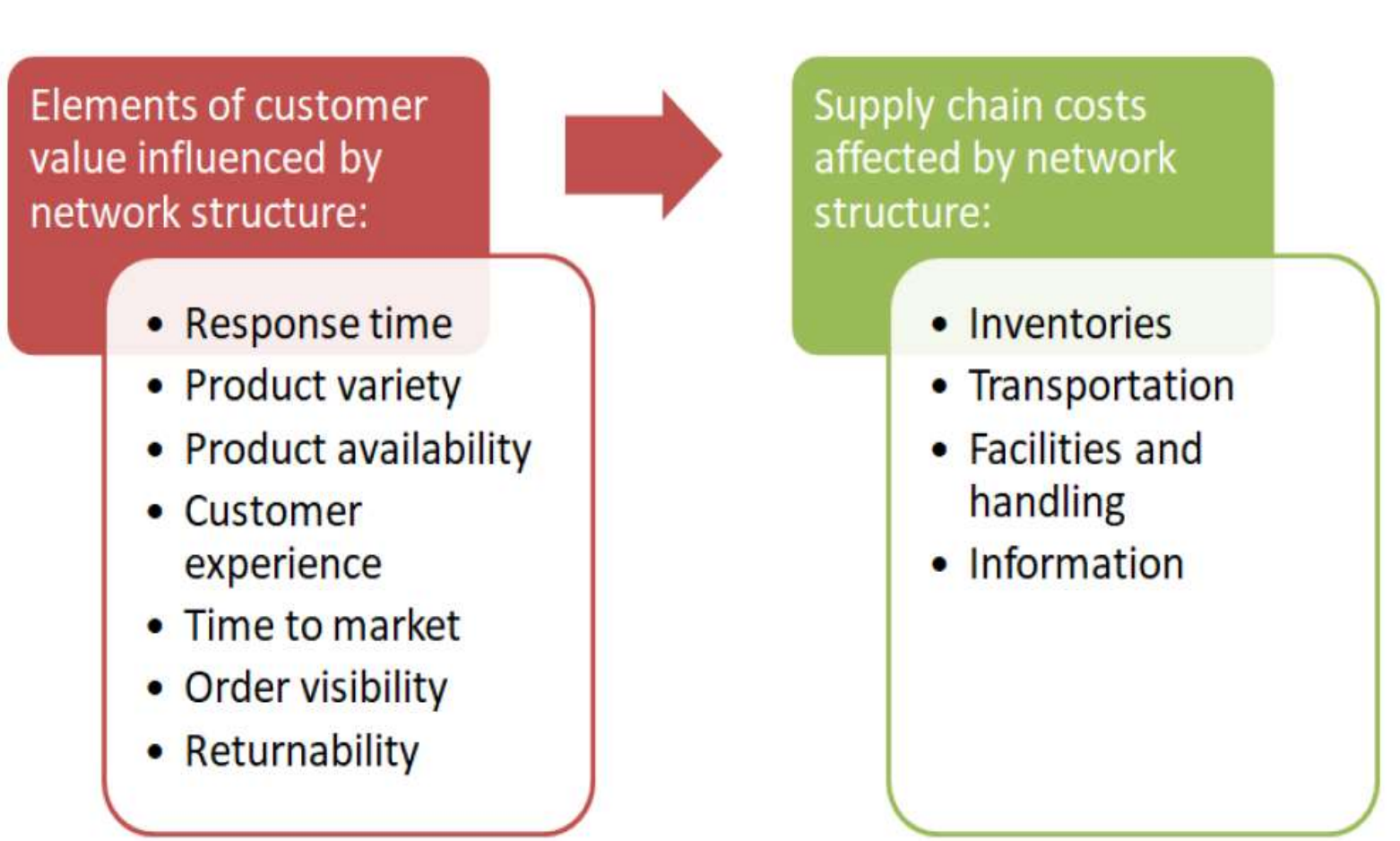
This course is about matching supply with demand in a network (of geographically dispersed facilities, with multiple stages, and multiple firms)



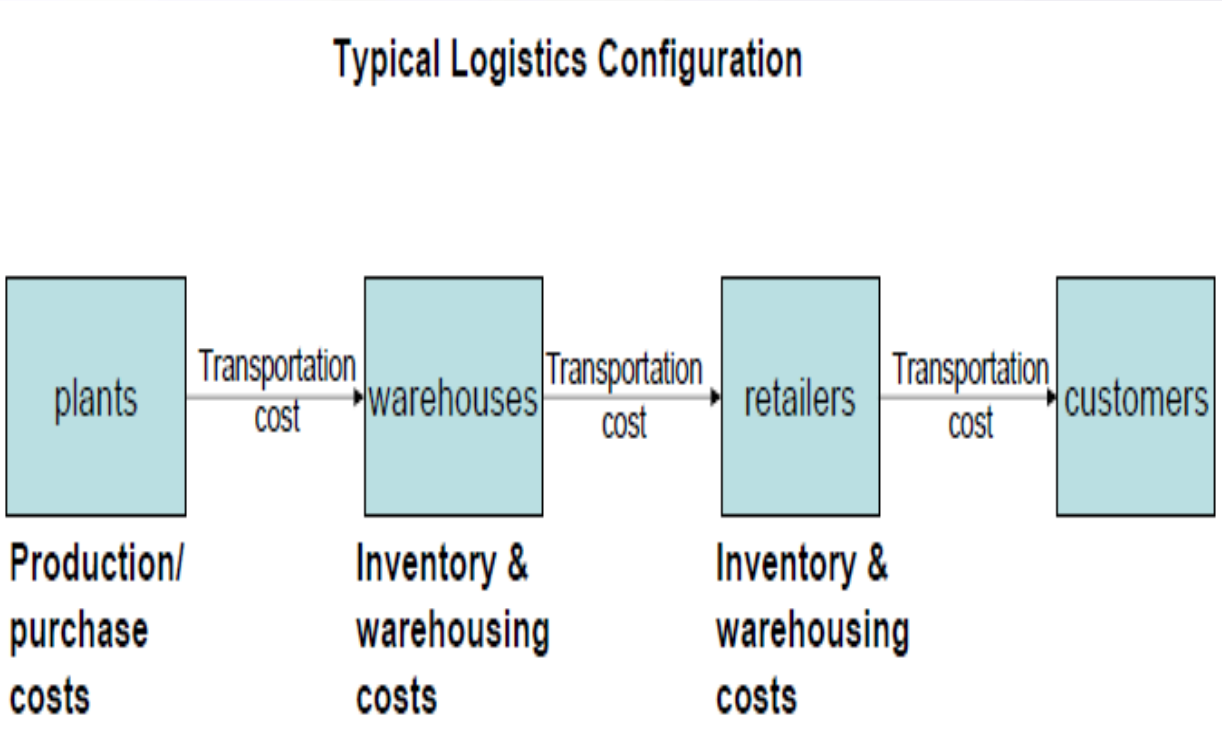
	Efficient	Responsive
Primary goal	Lowest cost	Quick response
Product design strategy	Min product cost	Modularity to allow postponement
Pricing strategy	Lower margins	Higher margins
Manufacturing strategy	High utilization	Capacity flexibility
Inventory strategy	Minimize inventory	Buffer inventory
Lead time strategy	Reduce but not at expense of greater cost	Aggressively reduce even if costs are significant
Supplier selection strategy	Cost and low quality	Speed, flexibility, quality
Transportation strategy	Greater reliance on low cost modes	Greater reliance on responsive (fast) modes

- The Role of Distribution in the Supply Chain
  - Distribution: the steps taken to move and store a finished product from the manufacturer/supplier stage to the customer stage in a supply chain
  - Distribution directly affects cost and the customer experience and therefore drives
  - Choice of distribution network can achieve supply chain objectives from low cost to high responsiveness

- Factors Influencing Distribution Network Design
- Distribution network performance evaluated along two dimensions at the highest level:
- Customer needs that are met
- Cost of meeting customer needs



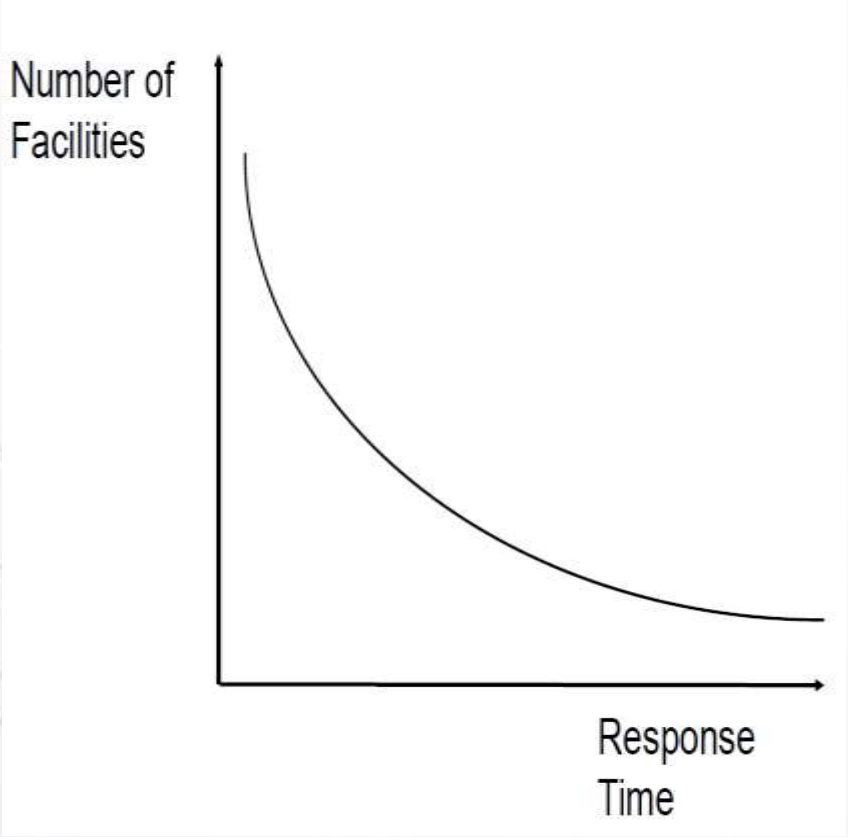
- Factors Influencing Distribution Network Design
- In designing a distribution network, the organization should focus on:
- Where customers should pickup their goods?
- At designated locations
- Directly to customer's location
- Should goods go through
- Middleman
- Intermediate location



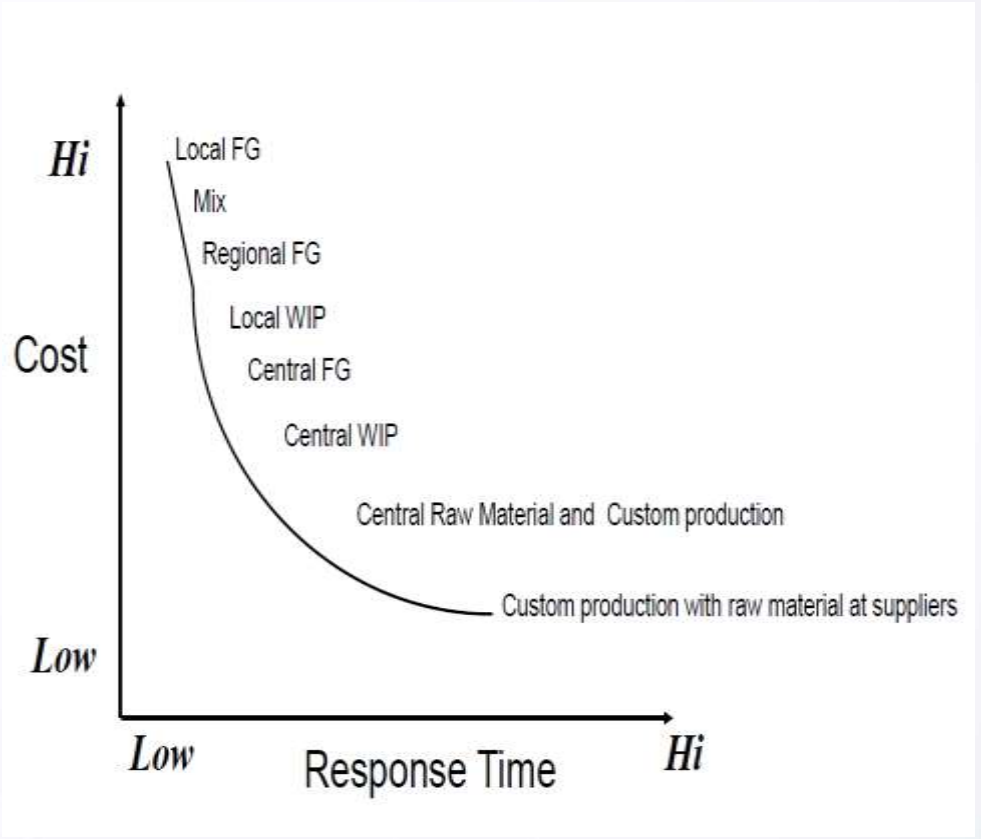
Higher Number of Facilities → Higher facilities cost → Higher Inventory cost → Shorter response time for customers → Lower Transportation cost

- The trade-of between finding a minimal annual cost configuration of the distribution network that satisfies product demands at specified customer service levels.
- Increasing the number of warehouses yields
- An improvement in service level due to the reduction in average travel time to the customers.
- An increase in inventory costs due to increased safety stocks required to protect each warehouse against uncertainties in customer demands.
- An increase in overhead and setup costs
- A reduction in outbound transportation costs (transportation costs from the warehouse to the customers).
- An increase in inbound transportation costs (transportation costs from the suppliers and/or manufacturers to the warehouse).
- In essence, the firm must balance the costs of opening new warehouses with the advantages of being close to the customer.

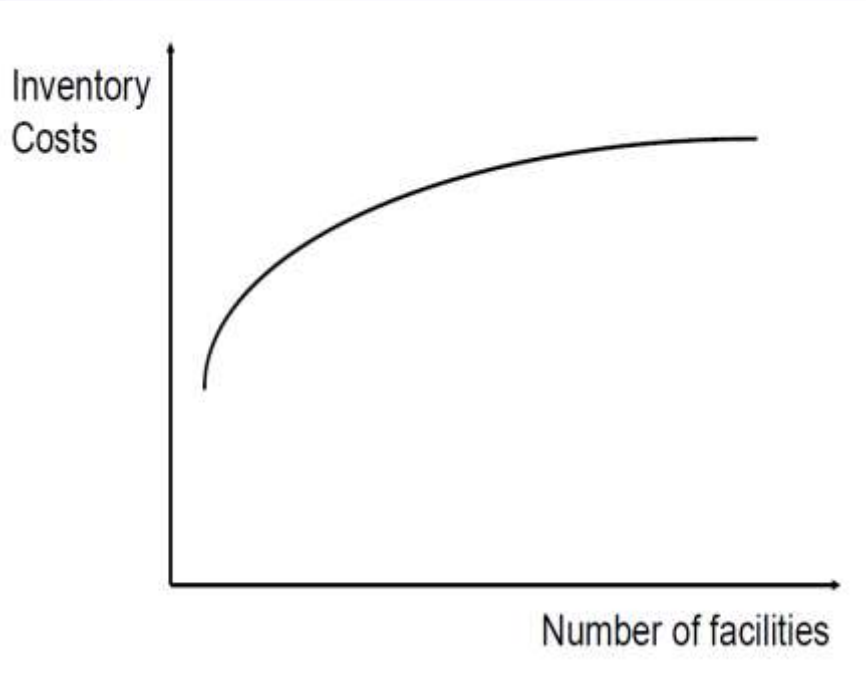
Service and Number of Facilities



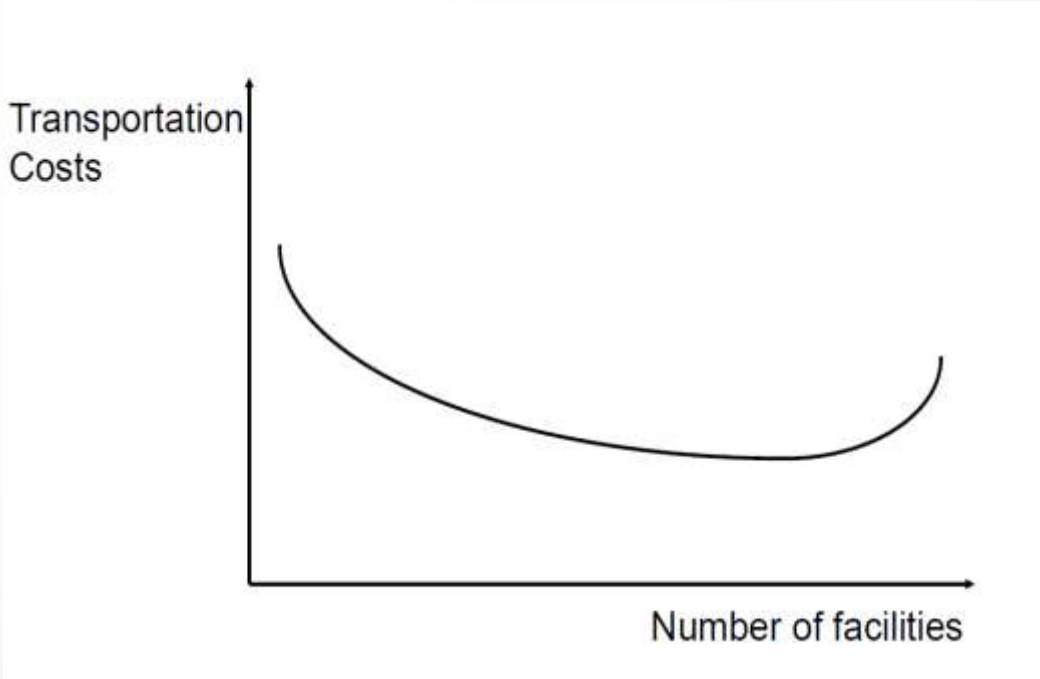
The Cost-Response Time Frontier



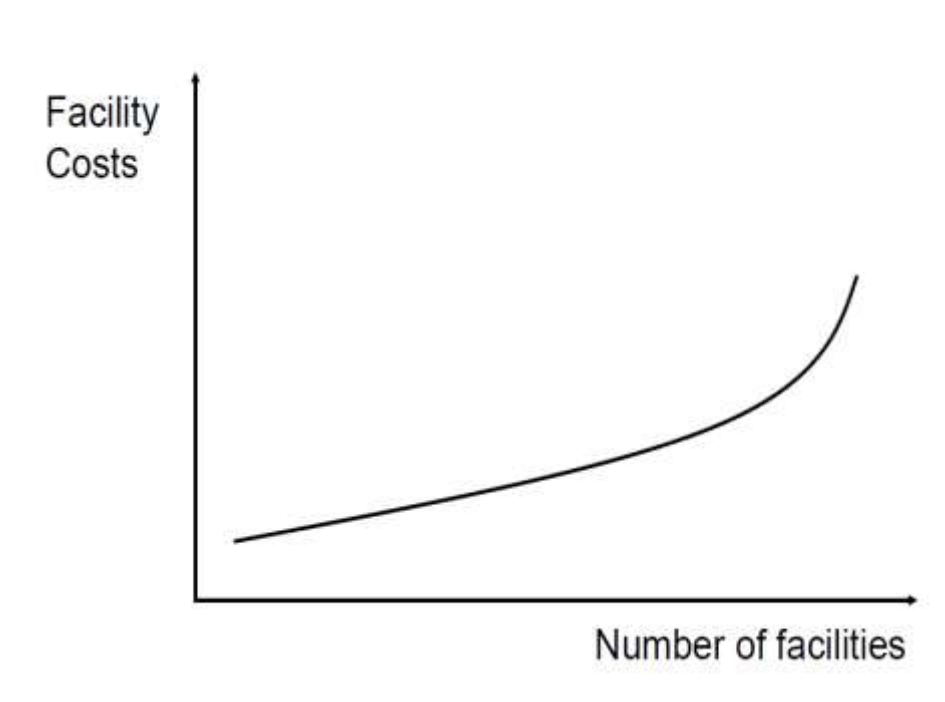
Inventory Costs and Number of Facilities



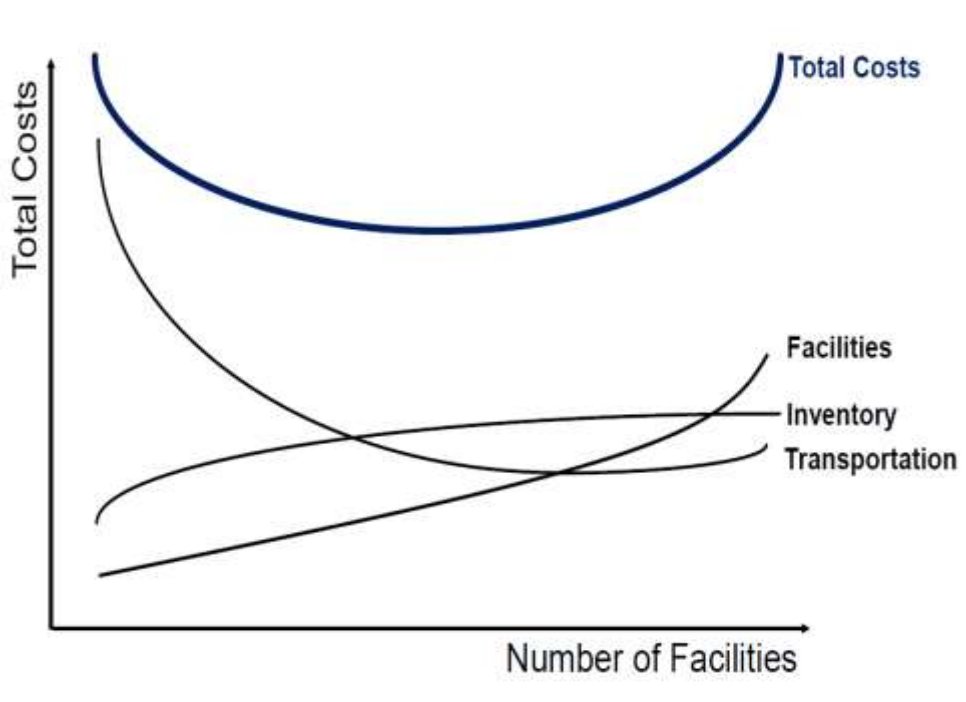
Transportation Costs and Number of Facilities



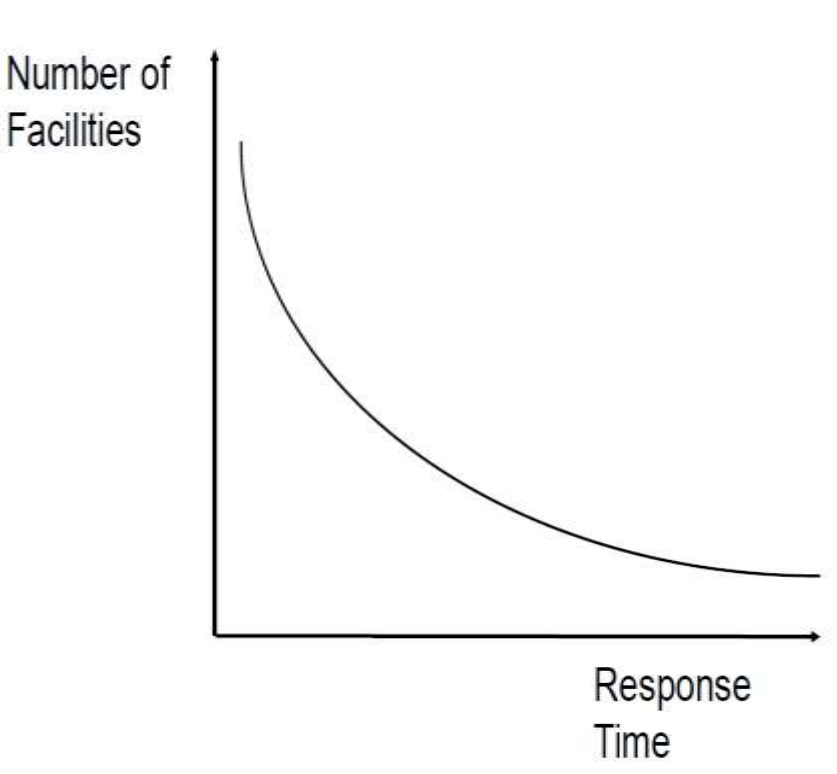
Facility Costs and Number of Facilities



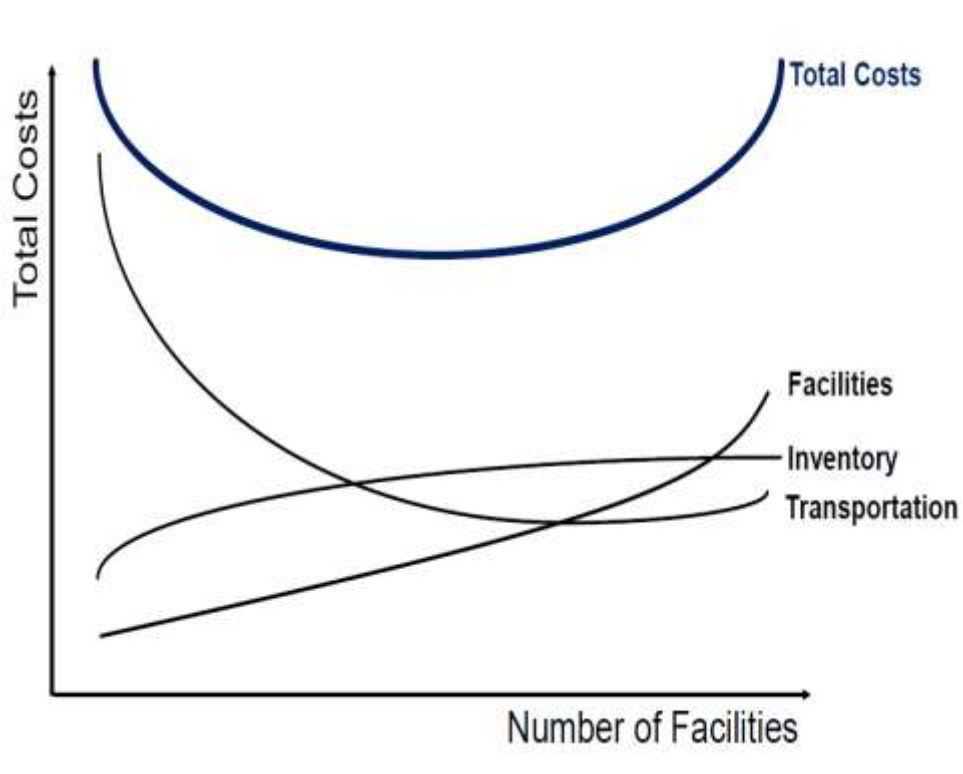
Total Costs Related to Number of Facilities



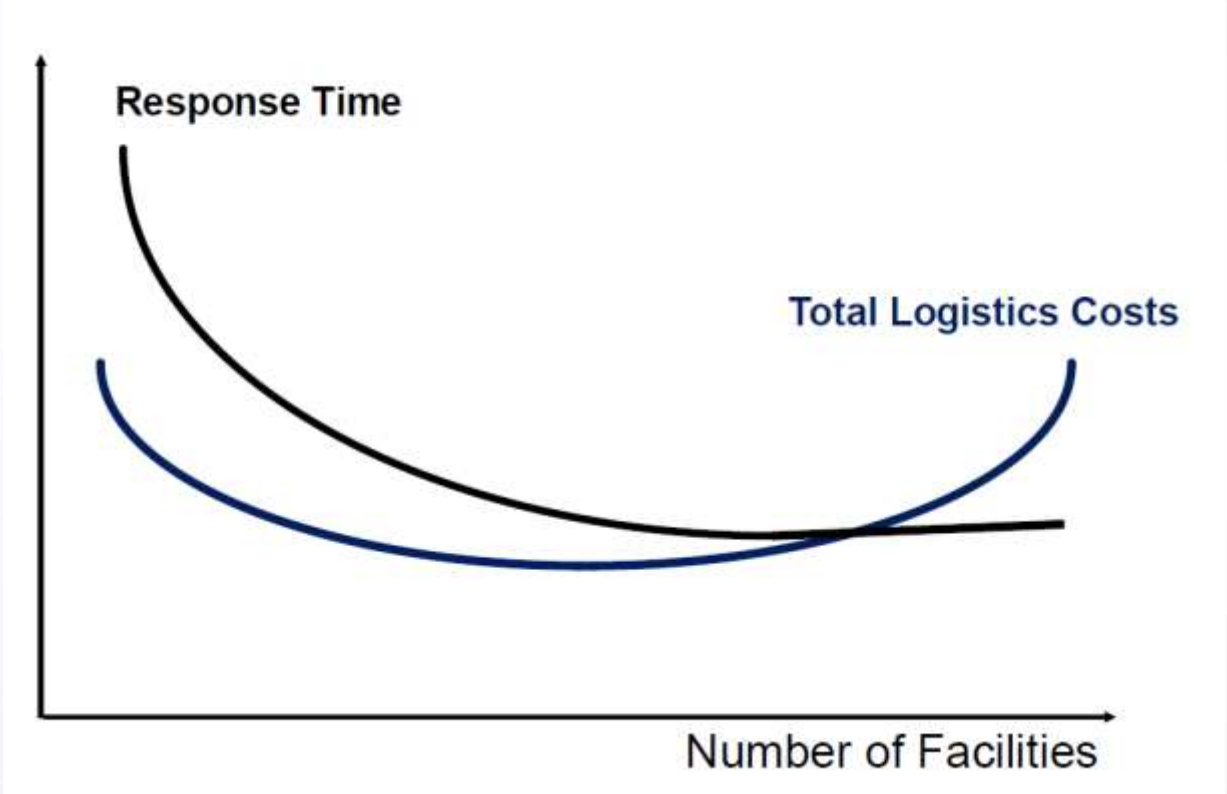
Service and Number of Facilities



Total Costs Related to Number of Facilities

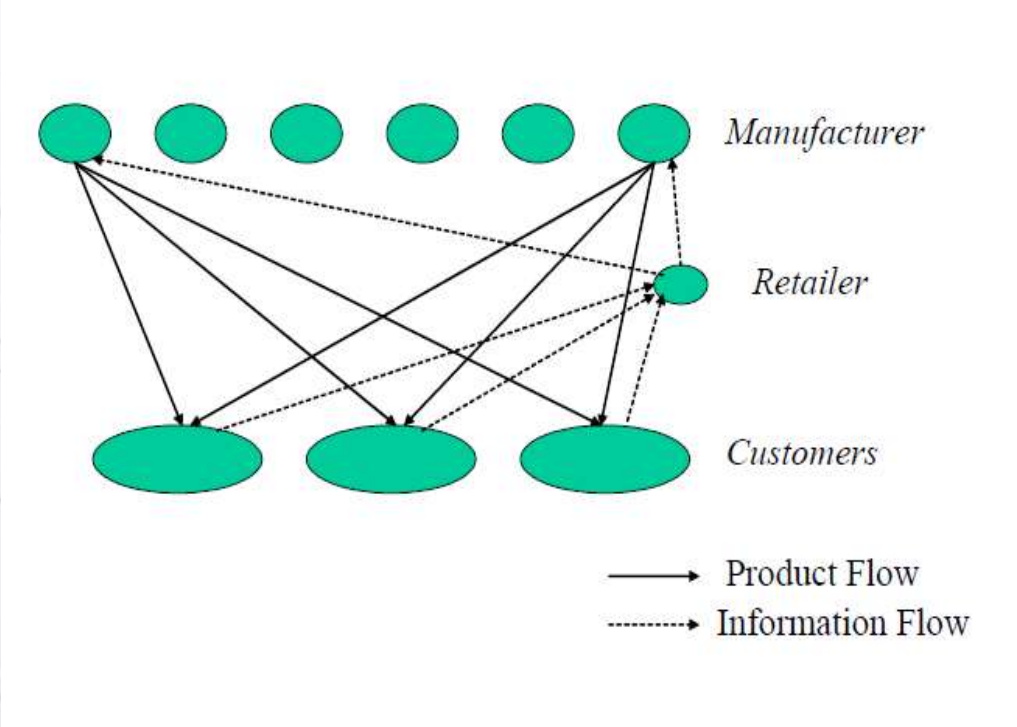


Variation in Logistics Costs and Response Time with Number of Facilities



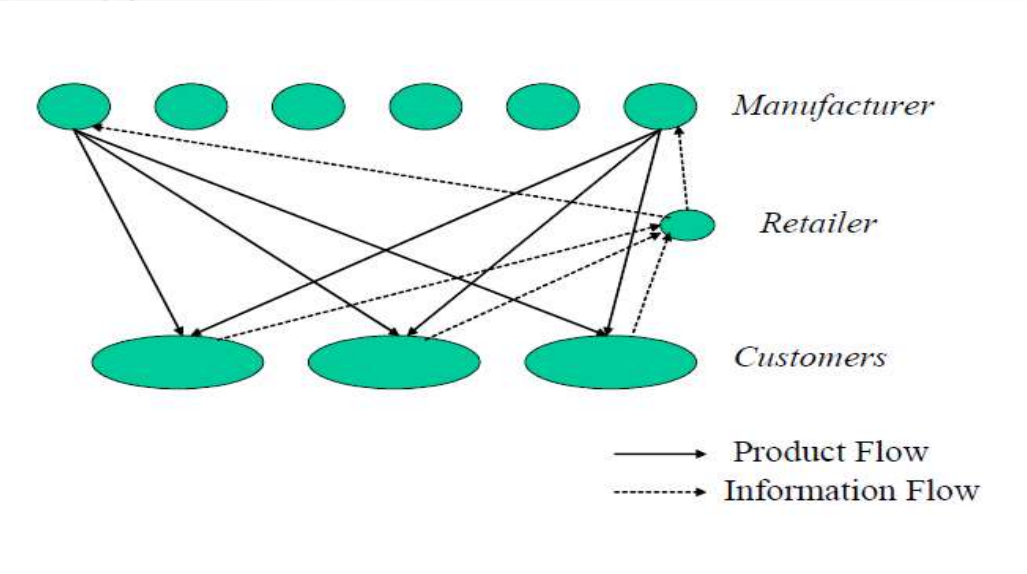
- Design Options for a Distribution Network:
  - Manufacturer Storage with Direct Shipping
  - Manufacturer Storage with Direct Shipping and In-Transit Merge
  - Distributor Storage with Carrier Delivery
  - Distributor Storage with Last-Mile Delivery
  - Manufacturer or Distributor Storage with Consumer Pickup
  - Retail Storage with Consumer Pickup

Manufacturer Storage with Direct Shipping



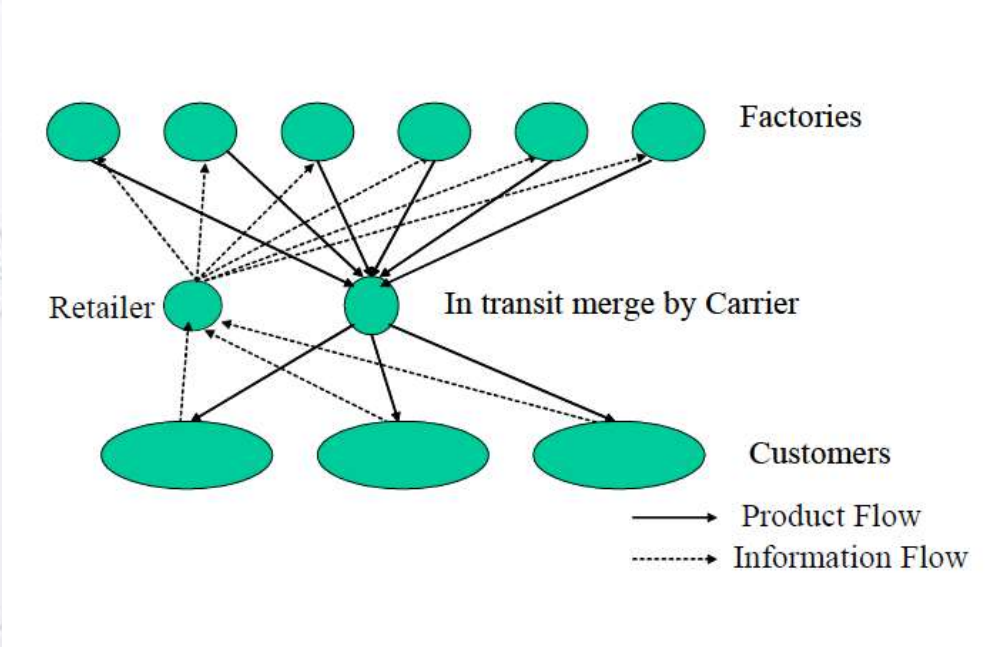
Cost Factor	Performance
Inventory	+ Lower costs because of aggregation. Benefits are highest for low-demand, high-value items. Benefits are large if product customization can be postponed at the manufacturer.
Transportation	– Higher transportation costs because of increased distance and disaggregate shipping.
Facilities and handling	+ Lower facility costs because of aggregation. Some saving on handling costs if manufacturer can manage small shipments or ship from production line.
Information	– Significant investment in information infrastructure to integrate manufacturer and retailer.

Manufacturer Storage with Direct Shipping



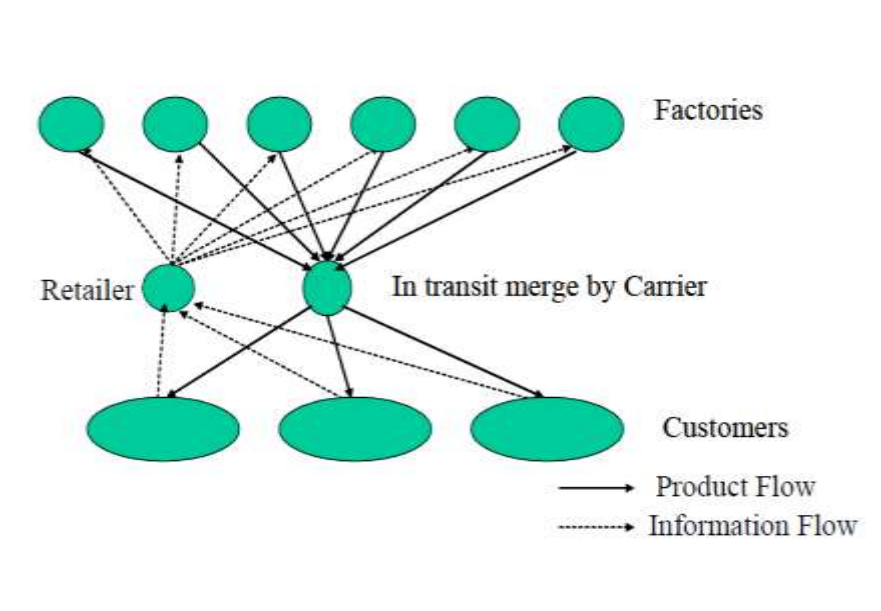
Service Factor	Performance
Response time	– Long response time of one to two weeks because of increased distance and two stages for order processing. Response time may vary by product, thus complicating receiving.
Product variety	+ Easy to provide a high level of variety.
Product availability	+ Easy to provide a high level of product availability be-cause of aggregation at manufacturer.
Customer experience	+ Good in terms of home delivery, – but can suffer if order from several manufacturers is sent in partial shipments.
Time to market	+ Fast, with the product available as soon as the first unit is produced
Order visibility	– More difficult but also more important from a customer service perspective
Returnability	– Expensive and difficult to implement.

Manufacturer Storage with Direct Shipping and In-Transit Merge



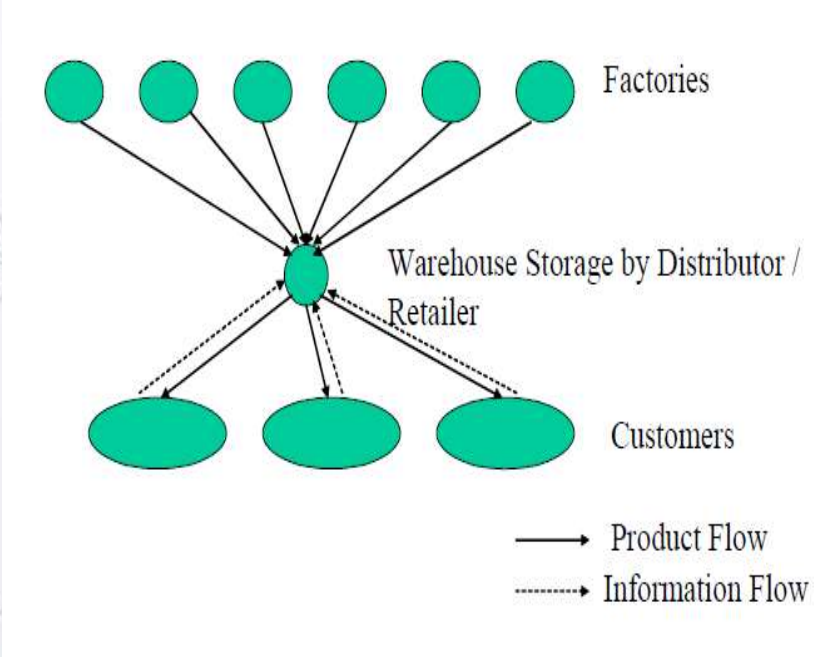
Cost Factor	Performance
Inventory	+ Similar to drop-shipping (Lower costs because of aggregation etc.)
Transportation	+ Somewhat lower transportation costs than drop-shipping.
Facilities and handling	+ Handling costs are higher than drop-shipping at carrier; receiving costs lower at customer.
Information	– Investment is somewhat higher than for drop-shipping.

Manufacturer Storage with Direct Shipping and In-Transit Merge



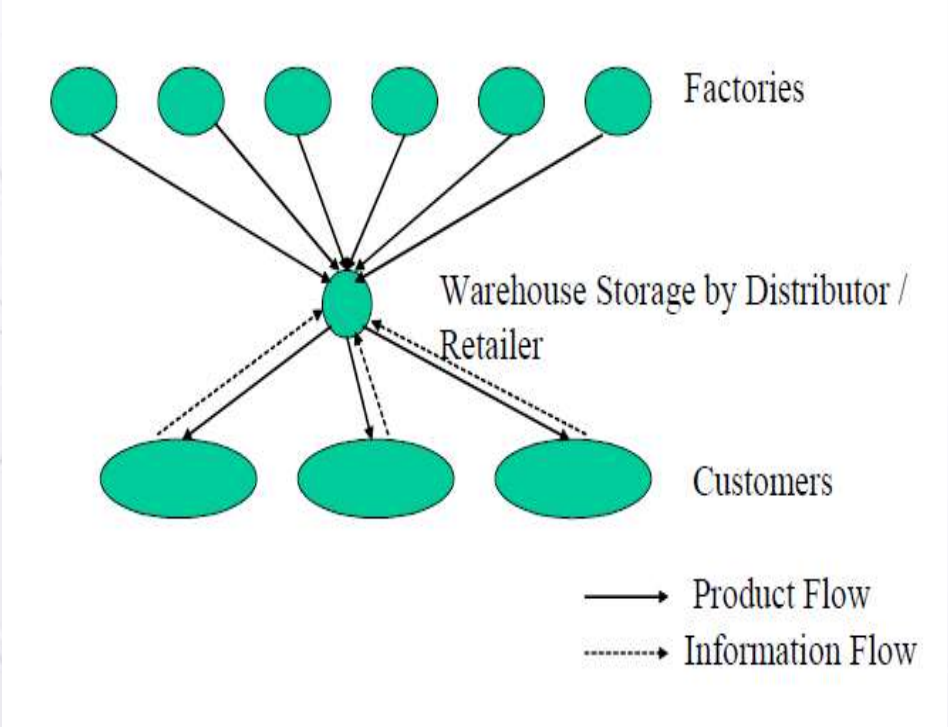
Service Factor	Performance
Response time	– Similar to drop-shipping (long response time etc.); may be marginally higher.
Product variety	– Similar to drop-shipping (long response time etc.); may be marginally higher.
Product availability	+ Similar to drop-shipping.
Customer experience	+ Better than drop-shipping because only a single delivery has to be received.
Time to market	+ Similar to drop-shipping.
Order visibility	+ Similar to drop-shipping.
Returnability	+ Similar to drop-shipping.

Distributor Storage with Carrier Delivery



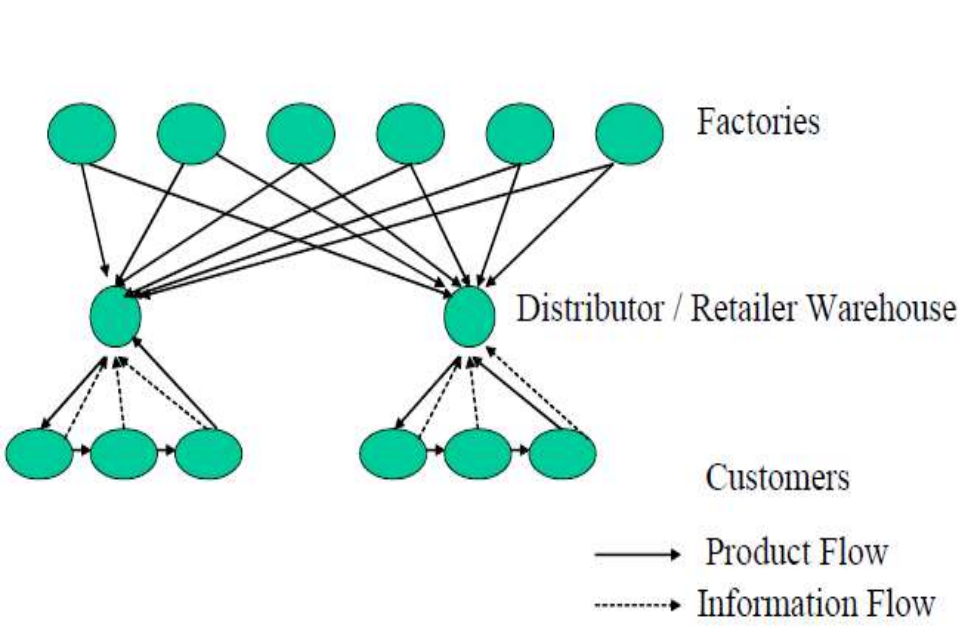
Cost Factor	Performance
Inventory	– Higher than manufacturer storage. Difference is not large for faster moving items but can be large for very slow-moving items.
Transportation	+ Lower than manufacturer storage. Reduction is highest for faster moving items.
Facilities and handling	– Somewhat higher than manufacturer storage. The difference can be large for slow-moving items.
Information	+ Simpler infrastructure compared to manufacturer storage.

Distributor Storage with Carrier Delivery



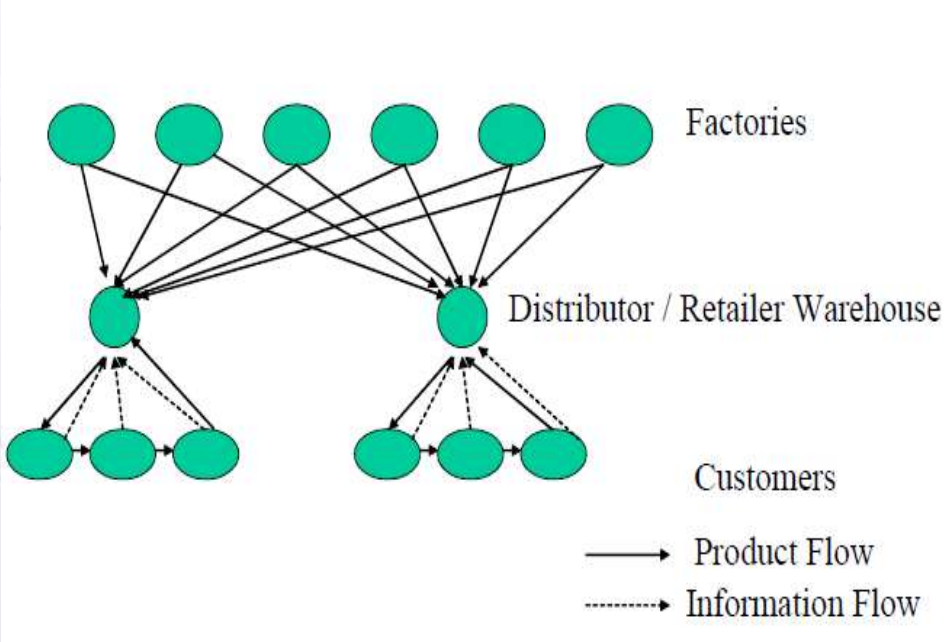
Service Factor	Performance
Response time	+ Faster than manufacturer storage.
Product variety	– Lower than manufacturer storage.
Product availability	– Higher cost to provide the same level of availability as manufacturer storage.
Customer experience	+ Better than manufacturer storage with drop-shipping.
Time to market	– Higher than manufacturer storage.
Order visibility	+ Easier than manufacturer storage.
Returnability	+ Easier than manufacturer storage.

Distributor Storage with Last-Mile Delivery



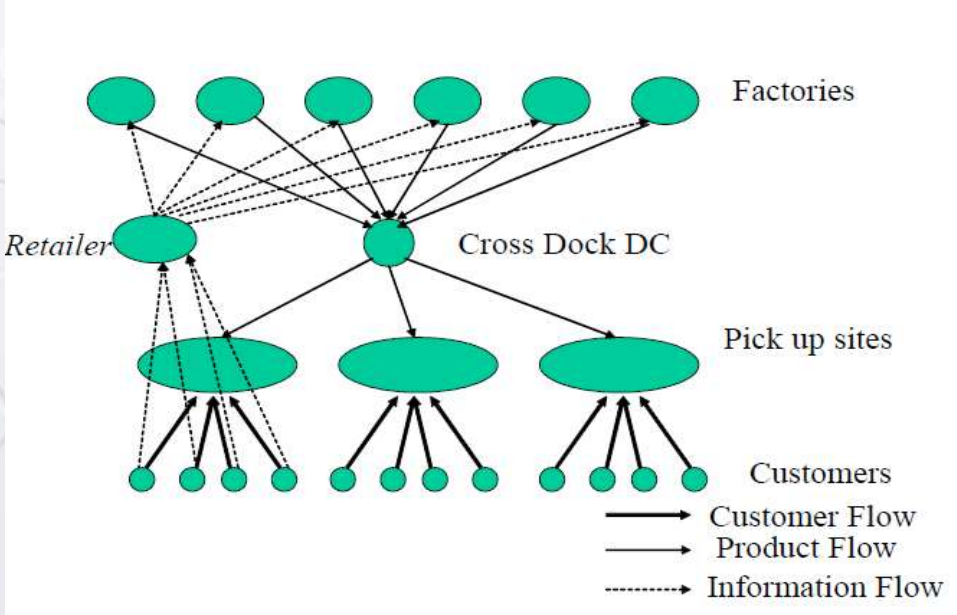
Cost Factor	Performance
Inventory	– Higher than distributor storage with package carrier delivery.
Transportation	– Very high cost given minimal scale economies. Higher than any other distribution option.
Facilities and handling	– Facility costs higher than manufacturer storage or distributor storage with package carrier delivery, + but lower than a chain of retail stores.
Information	+ Similar to distributor storage with package carrier delivery, – but it requires the additional capability of scheduling deliveries.

Distributor Storage with Last-Mile Delivery



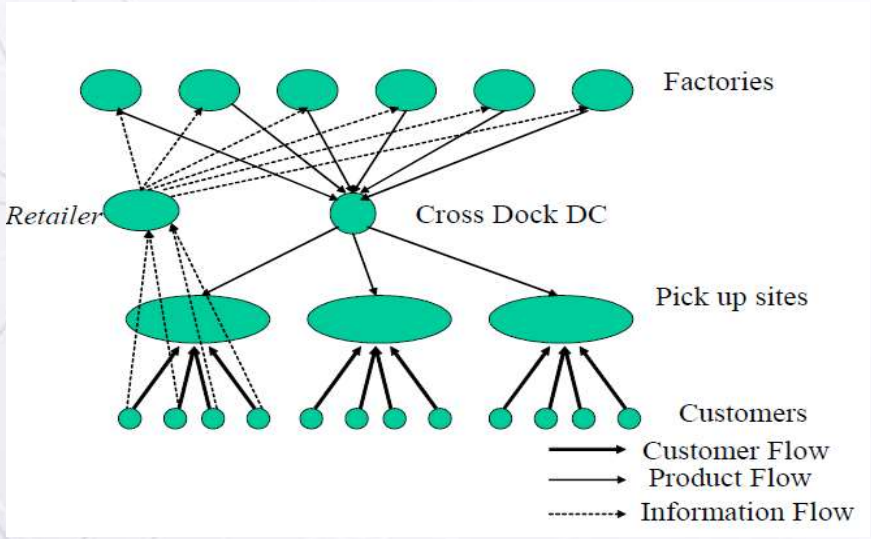
Service Factor	Performance
Response time	+ Very quick. Same day to next-day delivery.
Product variety	+ Somewhat less than distributor storage with package carrier delivery, – but larger than retail stores.
Product availability	– More expensive to provide availability than any other option except retail stores.
Customer experience	+ Very good, particularly for bulky items.
Time to market	– Slightly higher than distributor storage with package carrier delivery.
Order visibility	+ Less of an issue and easier to implement than manufacturer storage or distributor storage with package carrier delivery.
Returnability	+ Easier to implement than other previous options. – Harder and more expensive than a retail network.

Manufacturer or Distributor Storage with Consumer Pickup



Cost Factor	Performance
Inventory	Can match any other option, depending on the location of inventory
Transportation	+ Lower than the use of package carriers, especially if using an existing delivery network.
Facilities and handling	– Facility costs can be high if new facilities have to be built. + Costs are lower if existing facilities are used. – The increase in handling cost at the pickup site can be significant.
Information	– Significant investment in infrastructure required.

Manufacturer or Distributor Storage with Consumer Pickup



Service Factor	Performance
Response time	+ Similar to package carrier delivery with manufacturer or distributor storage. Same-day delivery possible for items stored locally at pickup site.
Product variety	Similar to other manufacturer or distributor storage options.
Product availability	Similar to other manufacturer or distributor storage options.
Customer experience	– Lower than other options because of the lack of home delivery. Experience is sensitive to capability of pickup location.
Time to market	+ Similar to manufacturer storage options.
Order visibility	– Difficult, but essential.
Returnability	+ Somewhat easier given that pickup location can handle returns.

Retail Storage with Consumer Pickup

Cost Factor	Performance
Inventory	– Higher than all other options.
Transportation	+ Lower than all other options.
Facilities and handling	– Higher than other options. The increase in handling cost at the pickup site can be significant for online and phone orders.
Information	– Some investment in infrastructure required for online and phone orders.

Service Factor	Performance
Response time	+ Same-day (immediate) pickup possible for items stored locally at pickup site.
Product variety	– Lower than all other options.
Product availability	– More expensive to provide than all other options.
Customer experience	Related to whether shopping is viewed as a positive or negative experience by customer.
Time to market	– Highest among distribution options because the new product has to penetrate through the entire supply chain before it is available to customers.
Order visibility	+ Trivial for in-store orders. – Difficult, but essential, for online and phone orders.
Returnability	+ Easier than other options because retail store can provide a substitute.

Retail Storage with Consumer Pickup

Cost Factor	Performance
Inventory	– Higher than all other options.
Transportation	+ Lower than all other options.
Facilities and handling	– Higher than other options. The increase in handling cost at the pickup site can be significant for online and phone orders.
Information	– Some investment in infrastructure required for online and phone orders.

Service Factor	Performance
Response time	+ Same-day (immediate) pickup possible for items stored locally at pickup site.
Product variety	– Lower than all other options.
Product availability	– More expensive to provide than all other options.
Customer experience	Related to whether shopping is viewed as a positive or negative experience by customer.
Time to market	– Highest among distribution options because the new product has to penetrate through the entire supply chain before it is available to customers.
Order visibility	+ Trivial for in-store orders. – Difficult, but essential, for online and phone orders.
Returnability	+ Easier than other options because retail store can provide a substitute.

Comparative Performance of Delivery Network Designs : (1 corresponds to the strongest performance and 6 the weakest performance).

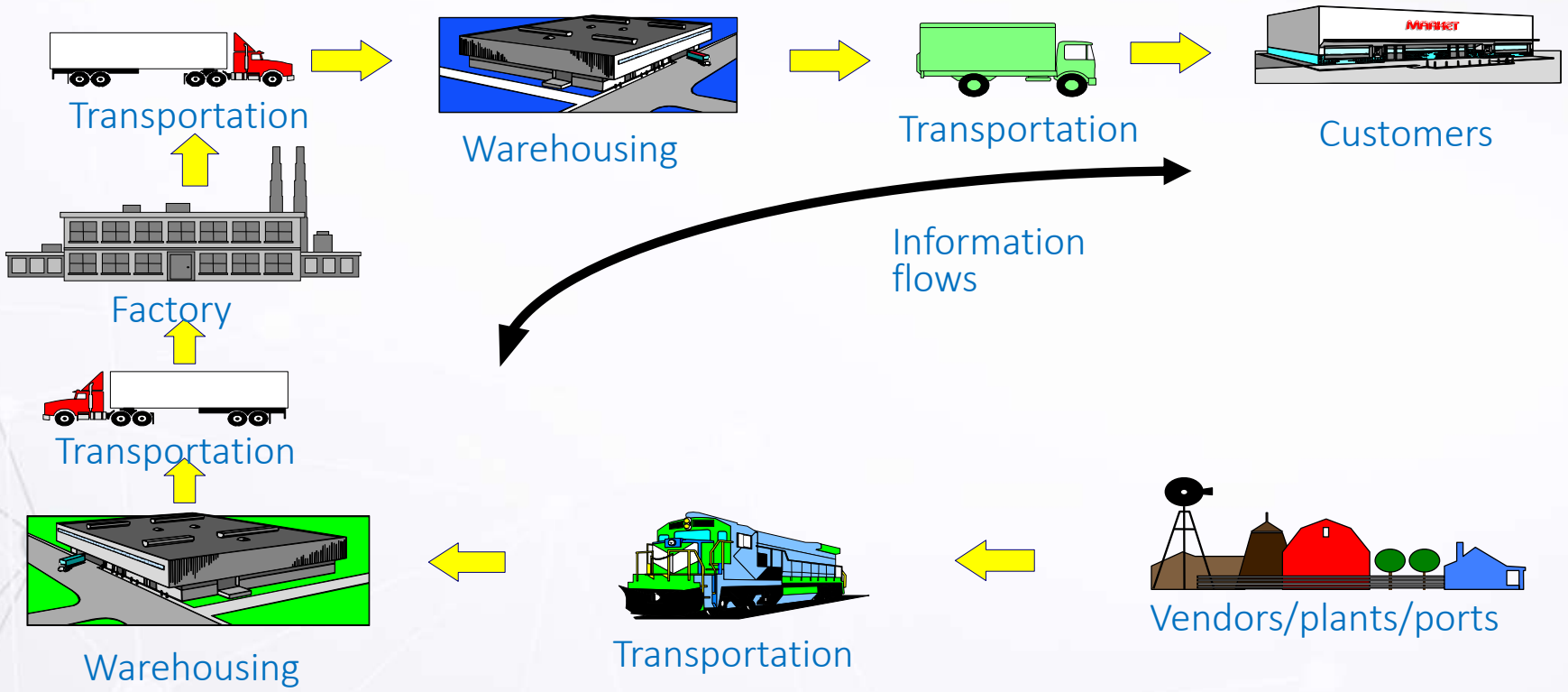
	Retail Storage with Customer Pickup	Manufacturer Storage with Direct Shipping	Manufacturer Storage with In-Transit Merge	Distributor Storage with Package Carrier Delivery	Distributor Storage with Last Mile Delivery	Manufacturer Storage with Pickup
Response time	1	4	4	3	2	4
Product variety	4	1	1	2	3	1
Product availability	4	1	1	2	3	1
Customer experience	1–5	4	3	2	1	5
Time to market	4	1	1	2	3	1
Order visibility	1	5	4	3	2	6
Returnability	1	5	5	4	3	2
Inventory	4	1	1	2	3	1
Transportation	1	4	3	2	5	1
Facility and handling	6	1	2	3	4	5
Information	1	4	4	3	1	5

- Product Characteristics Vs Customer Preferences to Network Design
- (+2 = very suitable; +1 = somewhat suitable; 0 = neutral; –1 = somewhat unsuitable; –2 = very unsuitable).

	Retail Storage with Customer Pickup	Manufacturer Storage with Direct Shipping	Manufacturer Storage with In-Transit Merge	Distributor Storage with Package Carrier Delivery	Distributor Storage with Last Mile Delivery	Manufacturer Storage with Pickup
High-demand product	+2	–2	–1	0	+1	–1
Medium-demand product	+1	–1	0	+1	0	0
Low-demand product	–1	+1	0	+1	–1	+1
Very low-demand product	–2	+2	+1	0	–2	+1
Many product sources	+1	–1	–1	+2	+1	0
High product value	–1	+2	+1	+1	0	+2
Quick desired response	+2	–2	–2	–1	+1	–2
High product variety	–1	+2	0	+1	0	+2
Low customer effort	–2	+1	+2	+2	+2	–1

Distribution Networks & Logistics

Supply Chain Overview

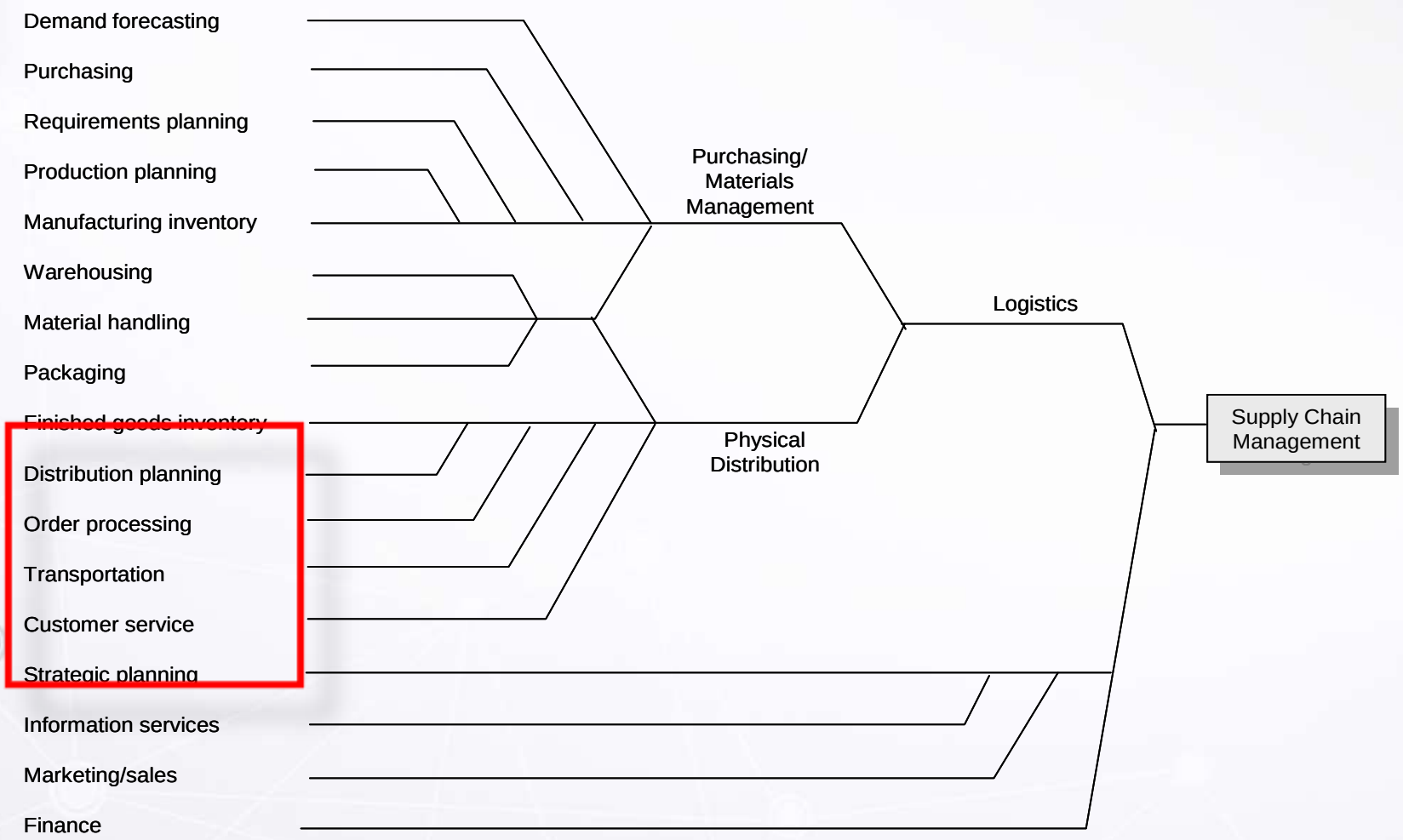


Logistics vs Supply Chain Management

- “Logistics is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods and related information from the point of origin to point of consumption for the purpose of conforming to customer requirements.”

- SCM is the integration of all activities associated with the flow and transformation of goods from raw materials through to end user, as well as information flows, through improved supply chain relationships, to achieve a sustainable competitive advantage.

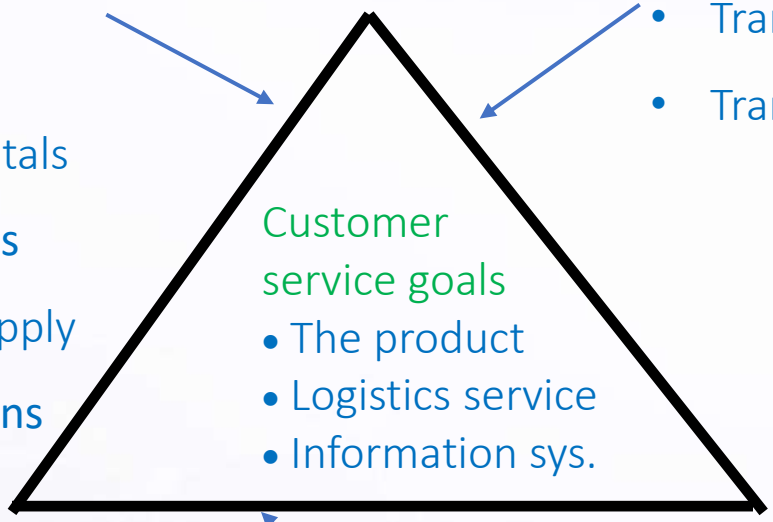
Evolution of Supply Chain Management



The Logistics Strategy Triangle (4 problem areas)

Inventory Strategy

- Forecasting
- Storage fundamentals
- Inventory **decisions**
- Purchasing and supply scheduling **decisions**
- **Storage decisions**



Transport Strategy

- Transport fundamentals
- Transport decisions

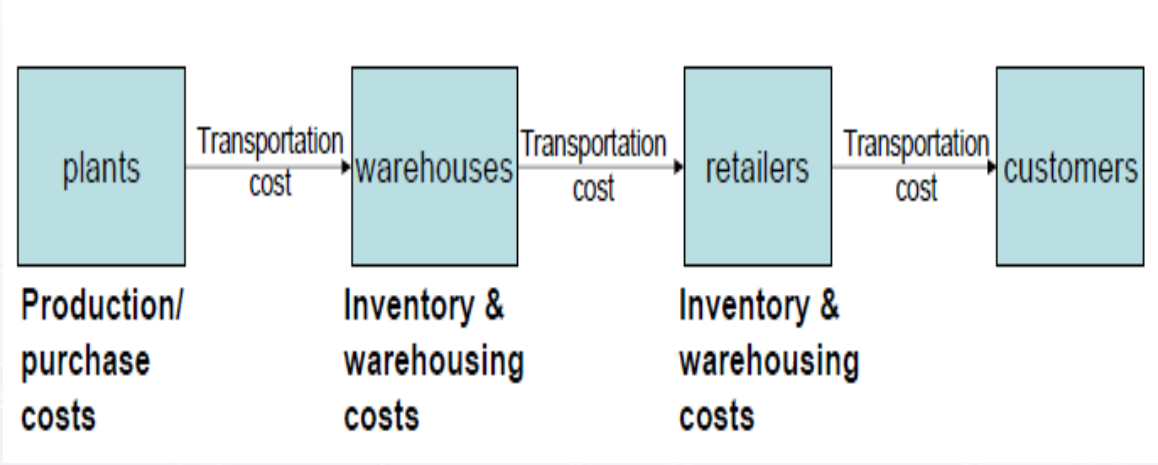
Location Strategy

- **Location decisions**
- The network planning process

Typical Logistics / distribution network Configuration

Logistics cost components to be considered:

- Transportation cost
- Inventory cost and warehousing cost.



Costs of Inventory

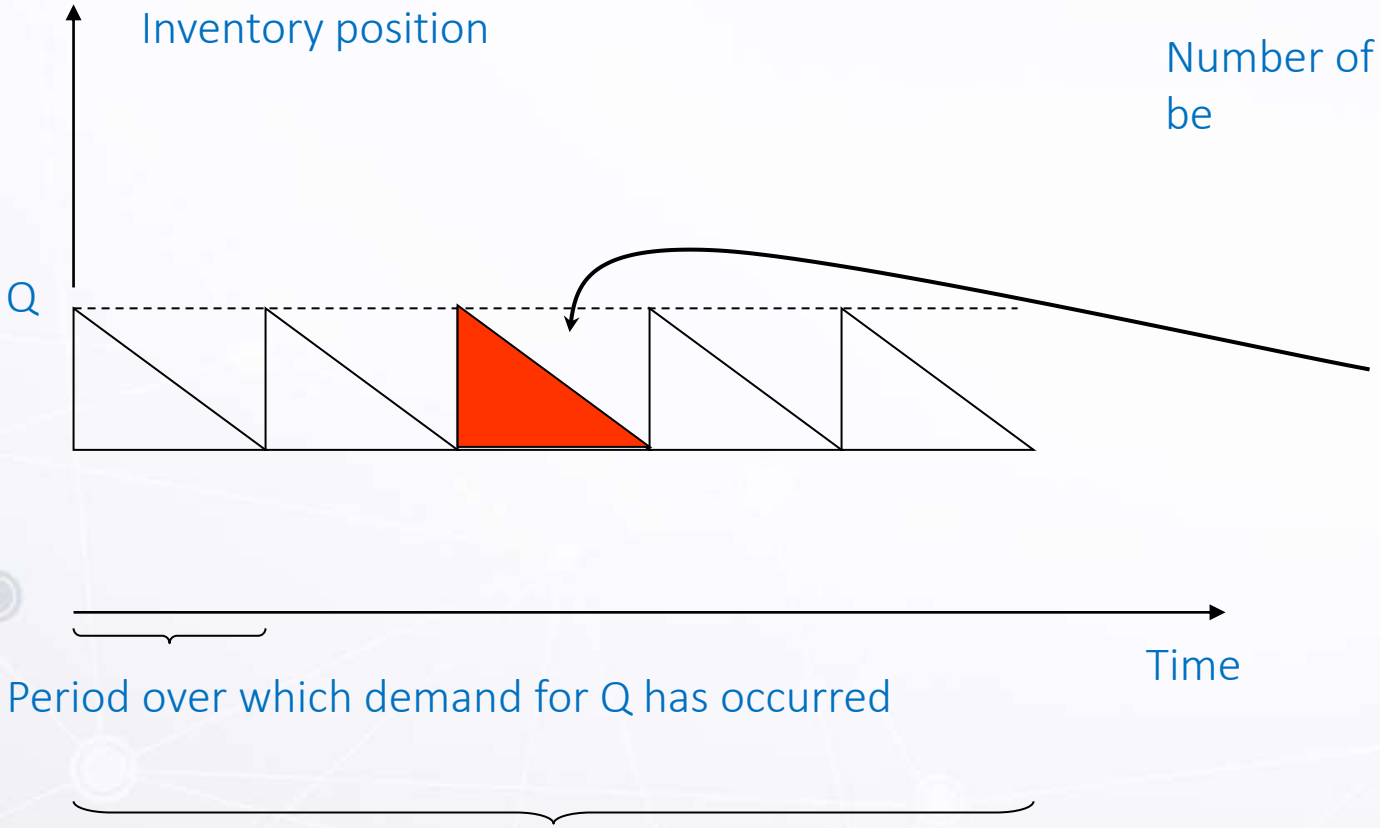
- Physical holding costs:
- out of pocket expenses for storing inventory (insurance, security, warehouse rental, cooling)
- All costs that may be entailed before you sell it (obsolescence, spoilage, rework...)
- Opportunity cost of inventory: foregone return on the funds invested.
- Operational costs:
- Delay in detection of quality problems.
- Delay the introduction of new products.
- Increase throughput times.

Benefits of Inventory

- Hedge against uncertain demand
- Hedge against uncertain supply
- Economize on ordering costs
- Smoothing
- To summarize, we build and keep inventory in order to match supply and demand in the most cost effective way.

- What is the optimal quantity to order?
- Total Cost = Purchasing Cost + Ordering Cost + Inventory Cost
- Purchasing Cost = (total units) x (cost per unit)
- Ordering Cost = (number of orders) x (cost per order)
- Inventory Cost = (average inventory) x (holding cost)

- Finding the optimal quantity to order…
- Let’s say we decide to order in batches of Q…



Number of periods will be $\frac{D}{Q}$

The average inventory for each period is…

$\frac{Q}{2}$

Finding the optimal quantity to order…

Purchasing cost = D x C

$$\text{Ordering cost} = \frac{D}{Q} \times S$$

$$\text{Inventory cost} = \frac{Q}{2} \times H$$

So what is the total cost?

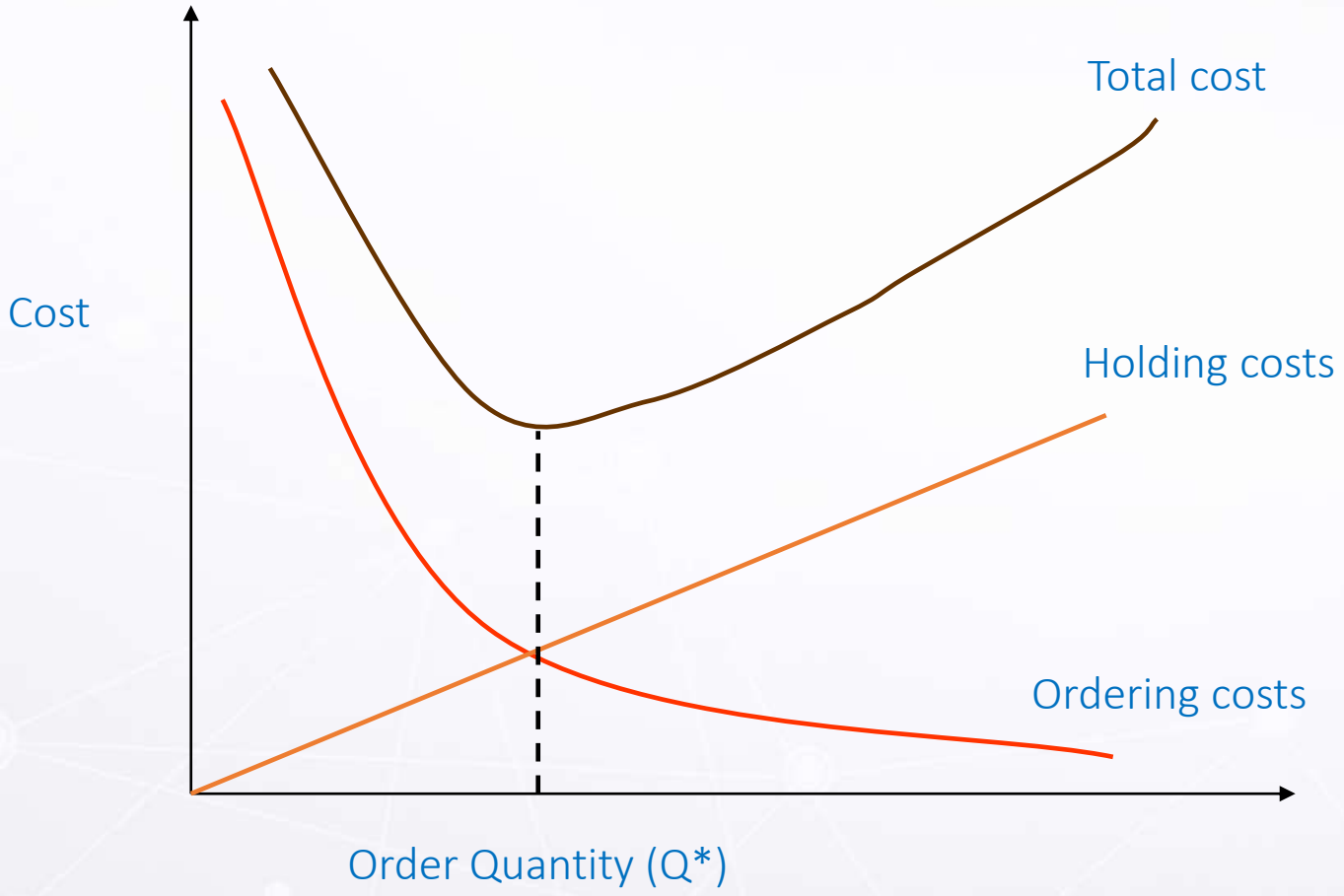
$$TC = DC + \frac{D}{Q} S + \frac{Q}{2} H$$

In order now to find the optimal quantity we need to optimize the total cost with respect to the decision variable (the variable we control)

Which one is the decision variable?

What is the main insight from EOQ?

There is a tradeoff between holding costs and ordering costs



Economic Order Quantity - EOQ

$$Q^* = \sqrt{\frac{2SD}{H}}$$

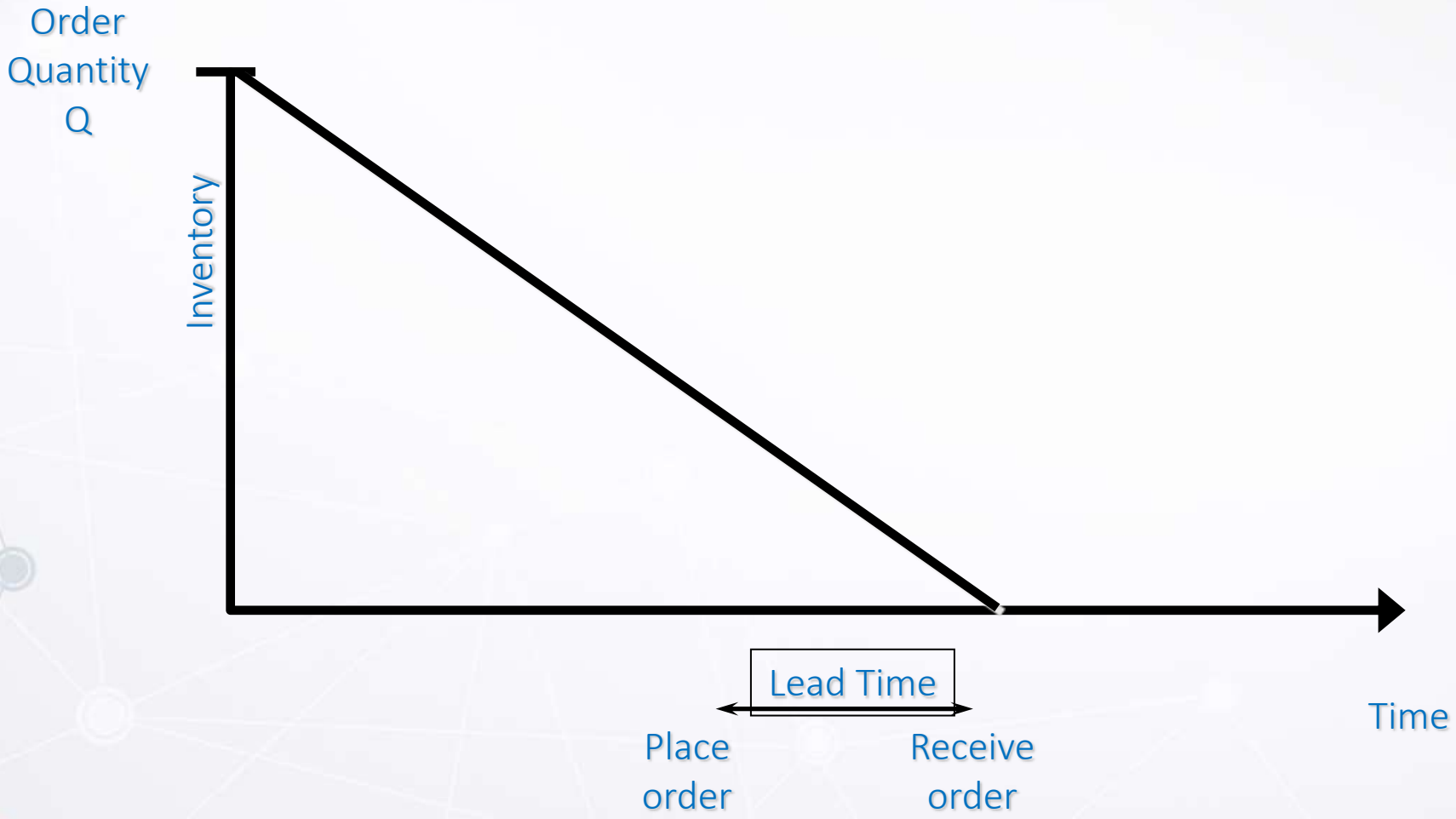
Example:

Assume a car dealer that faces demand for 5,000 cars per year, and that it costs $15,000 to have the cars shipped to the dealership. Holding cost is estimated at $500 per car per year. How many times should the dealer order, and what should be the order size?

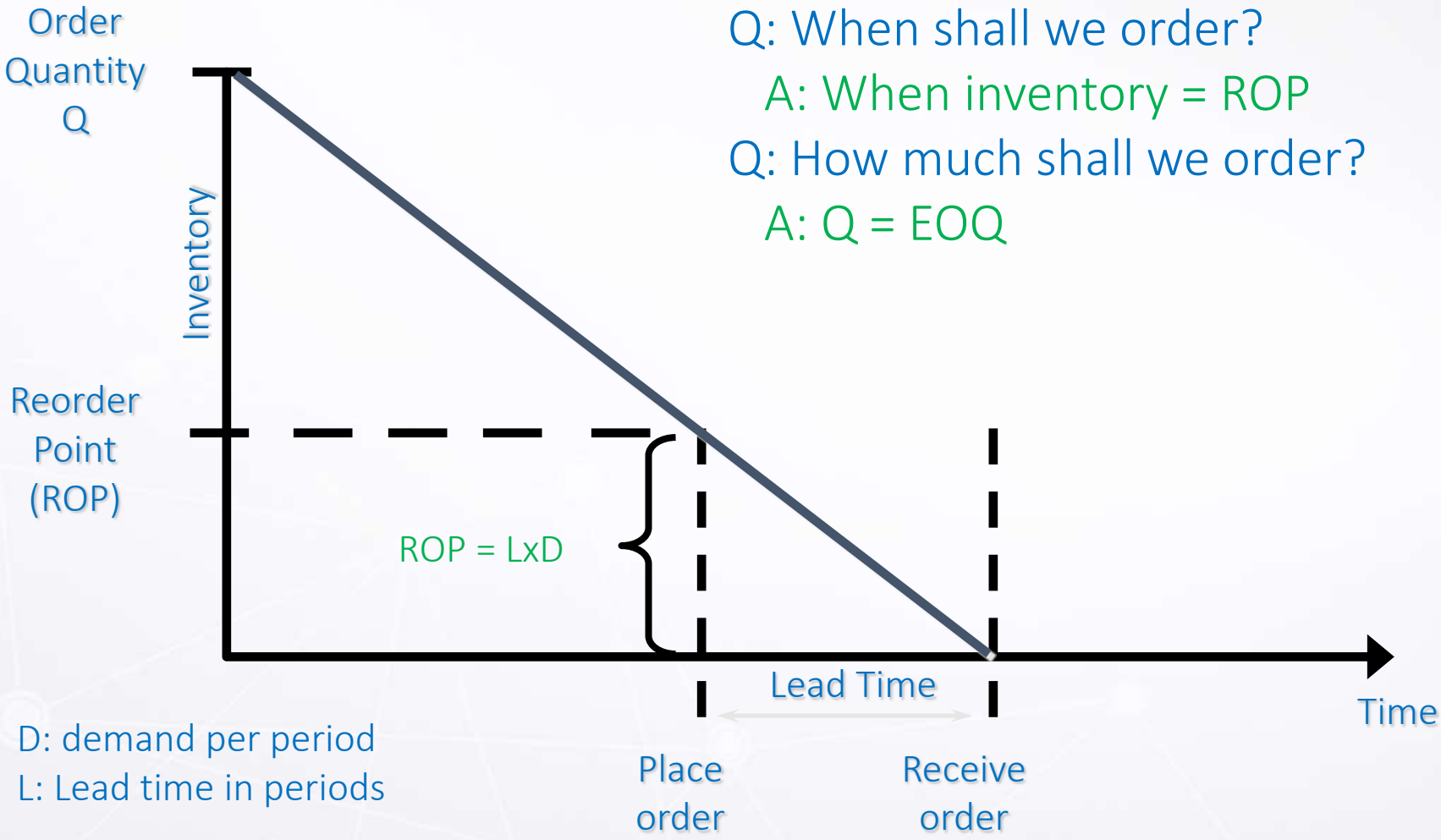
$$Q^* = \sqrt{\frac{2(15{,}000)(5{,}000)}{500}} = 548$$

If delivery is not instantaneous, but there is a lead time L:

When to order? How much to order?



If demand is known exactly, place an order when inventory equals demand during lead time.



Q: When shall we order?

A: When inventory = ROP

Q: How much shall we order?

A: Q = EOQ

D: demand per period

L: Lead time in periods

Example (continued)…

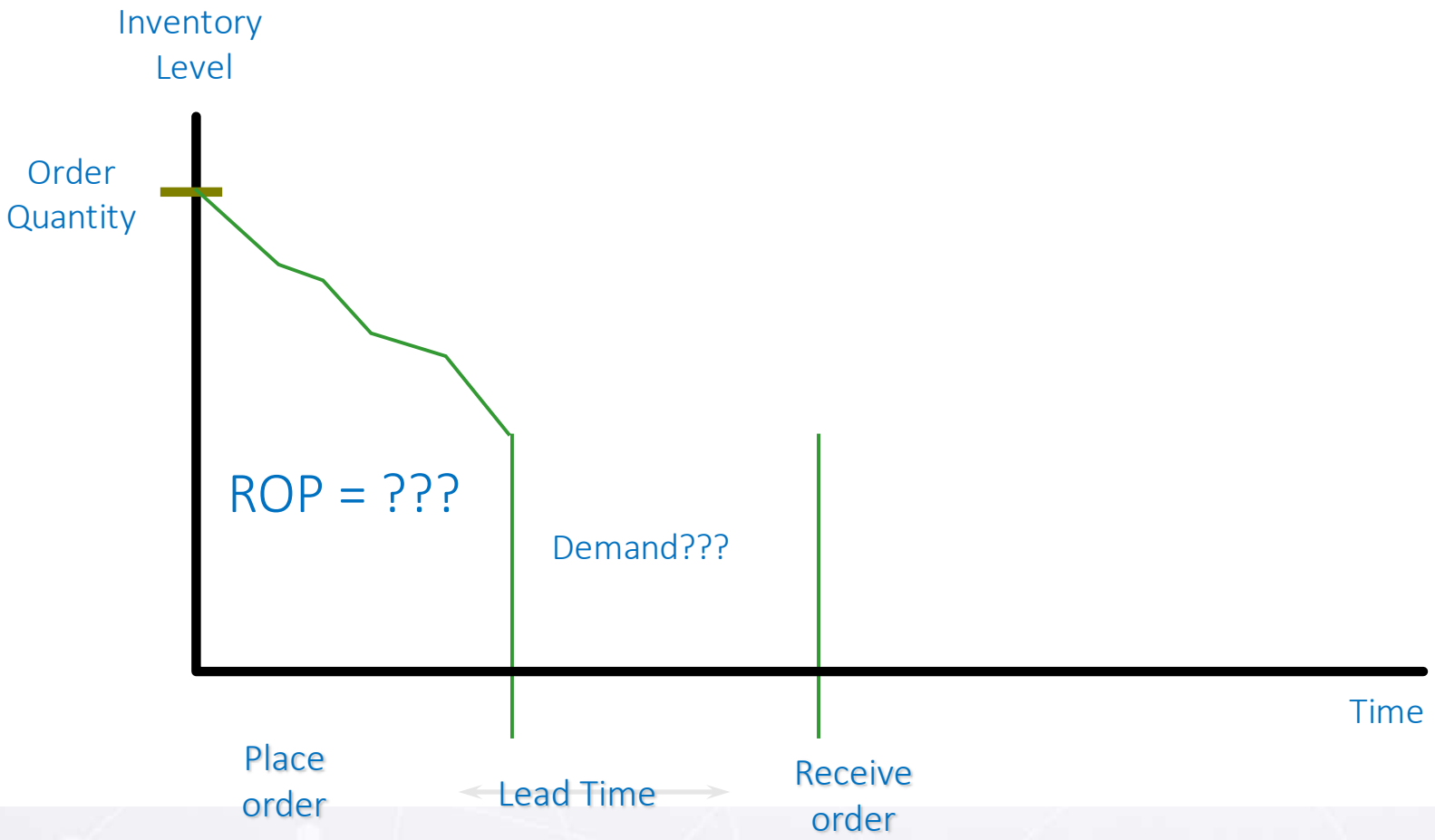
What if the lead time to receive cars is 10 days? (when should you place your order?)

Since D is given in years, first convert: 10 days = 10/365yrs

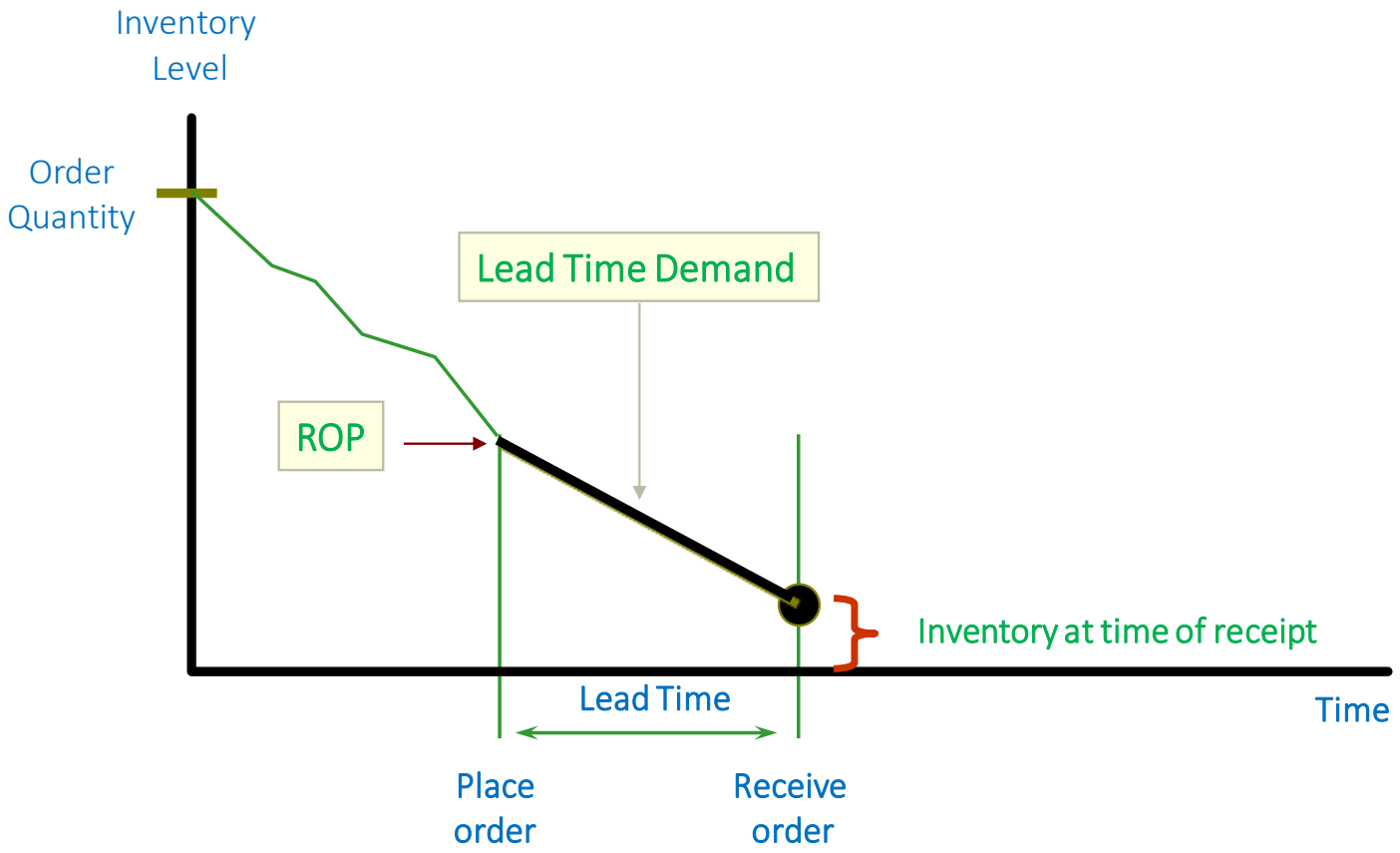
$$R = \frac{10}{365} D = \frac{10}{365} 5000 = 137$$

So, when the number of cars on the lot reaches 137, order 548 more cars.

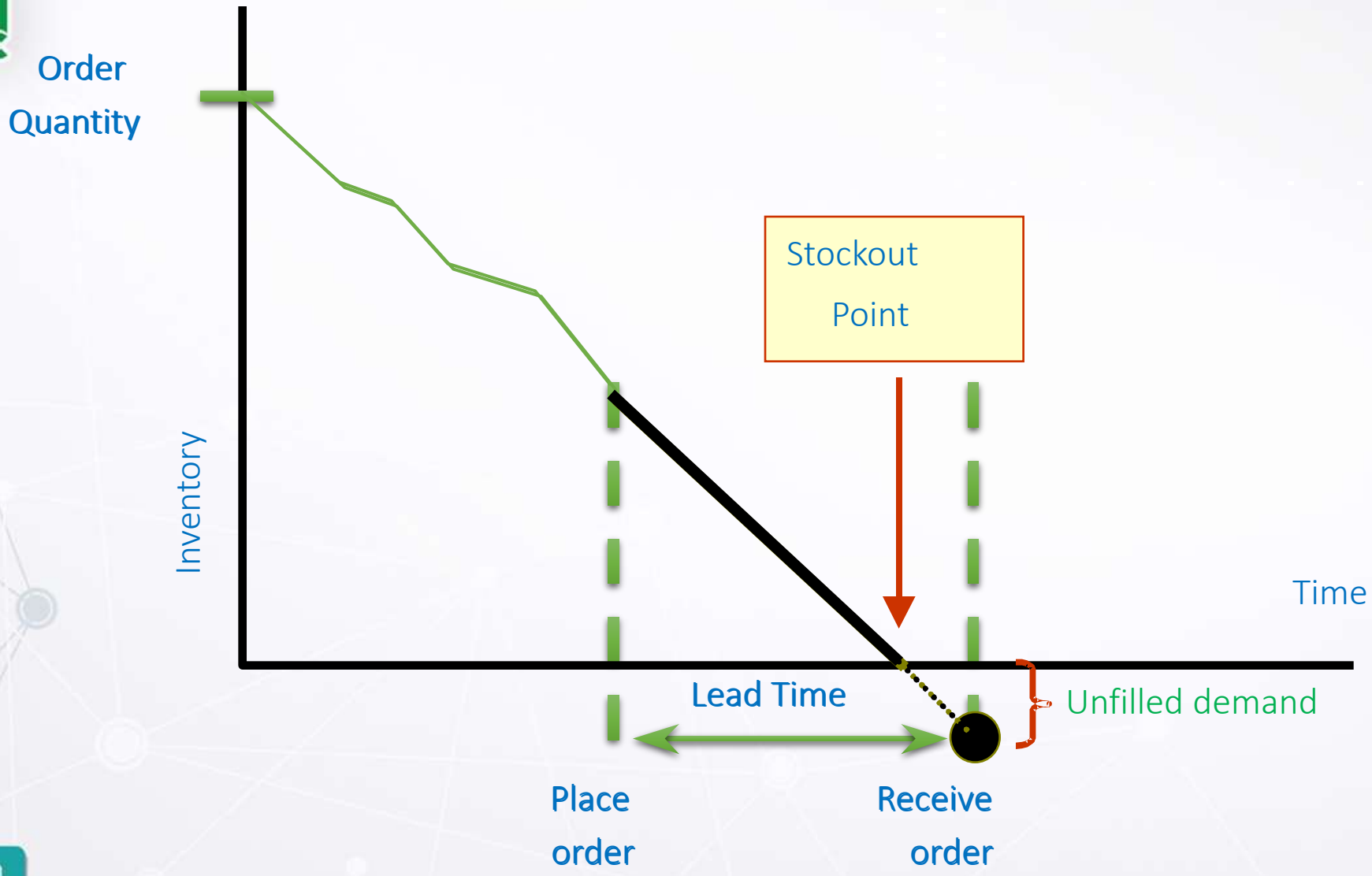
But demand is rarely predictable!



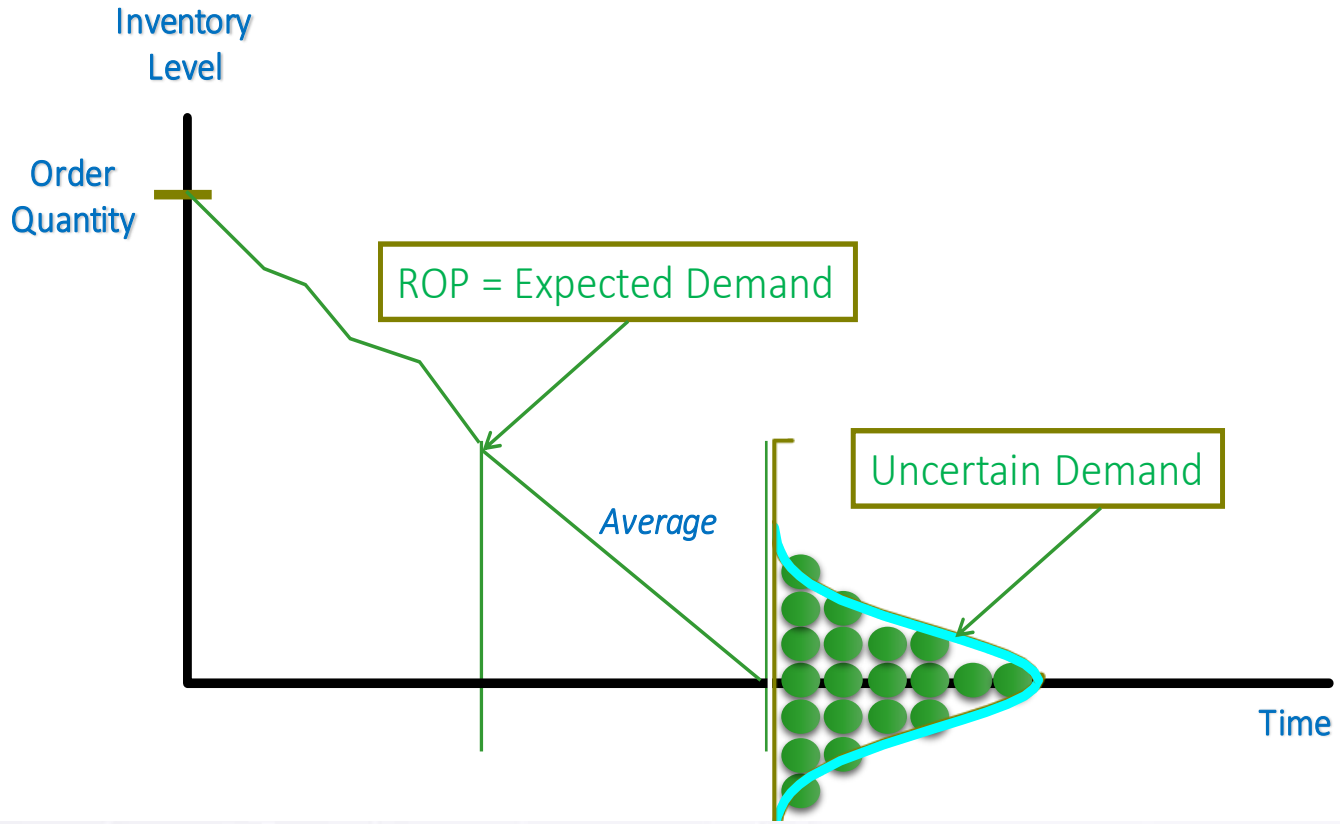
Actual Demand < Expected Demand



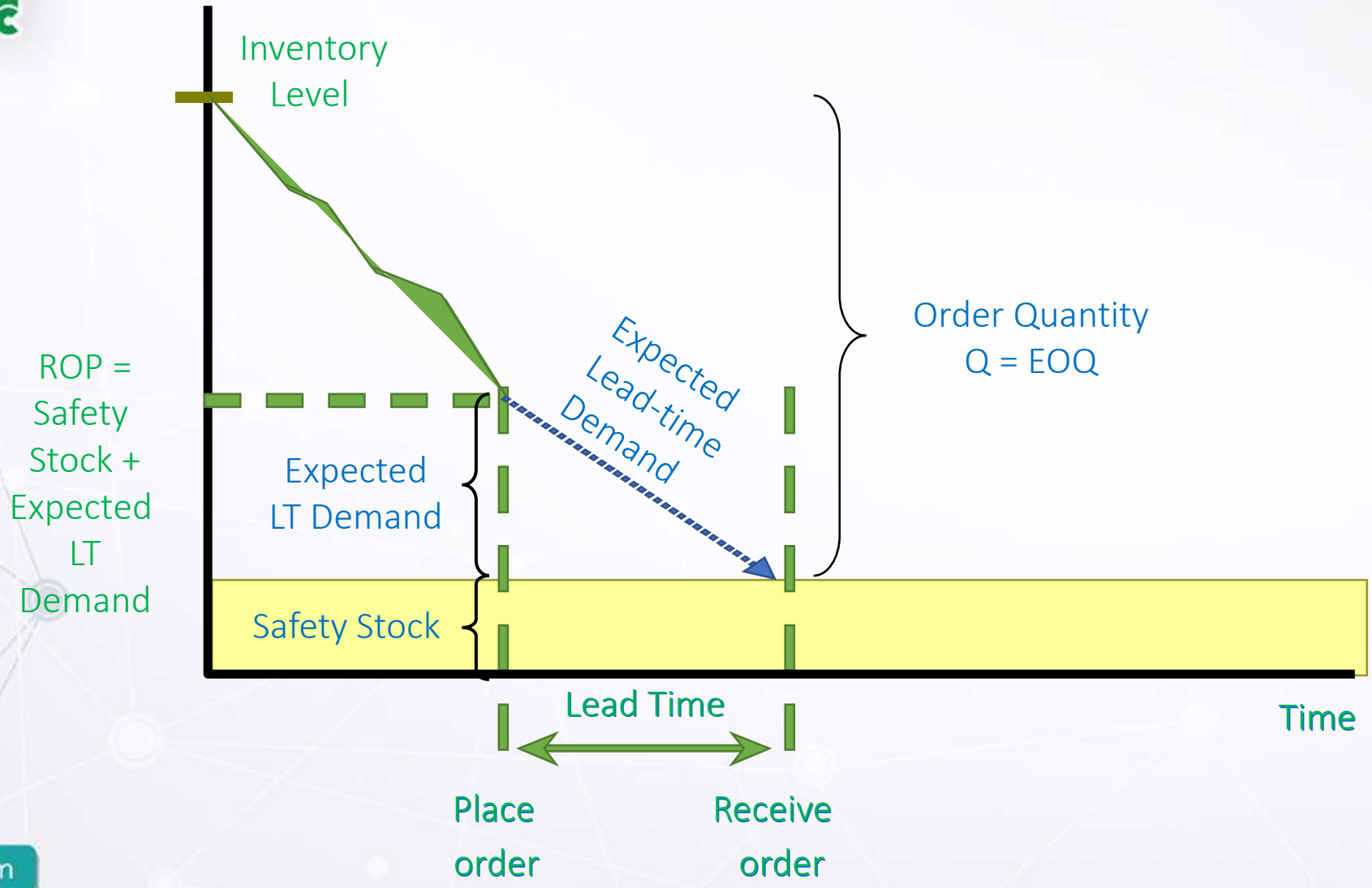
If Actual Demand > Expected, we Stock Out



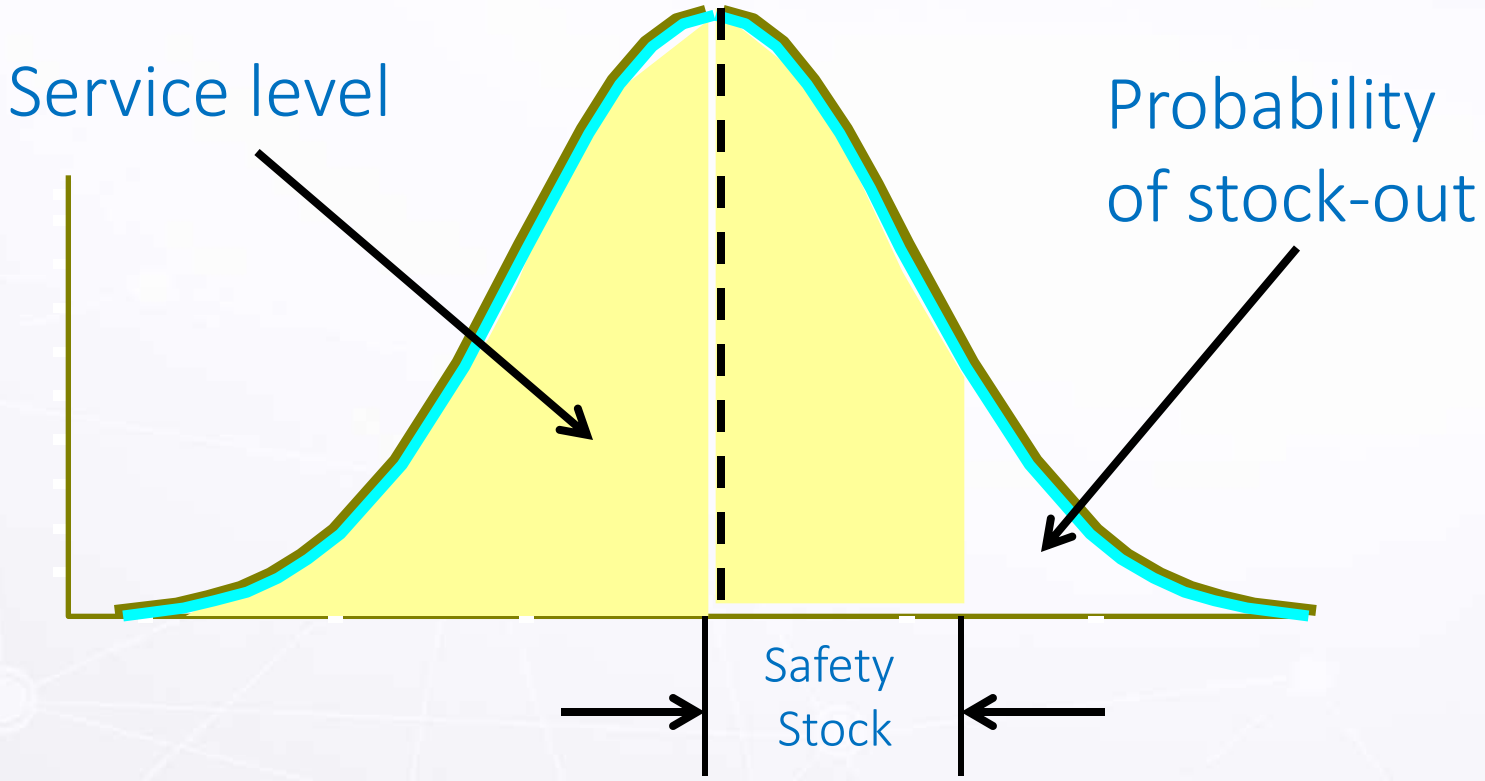
If ROP = expected demand, service level is 50%. Inventory left 50% of the time, stock outs 50% of the time.



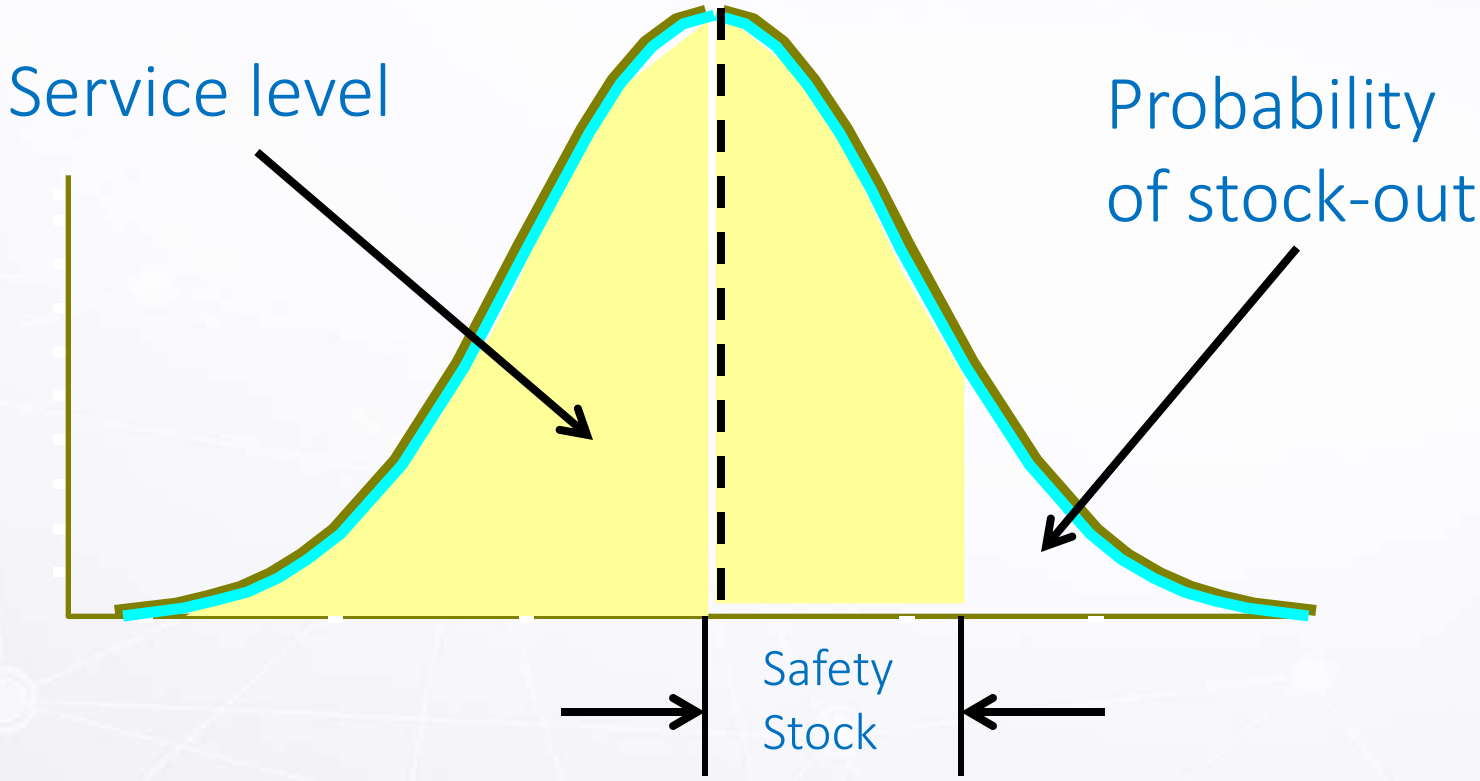
To reduce stockouts we add safety stock



Decide what Service Level you want to provide (Service level = probability of NOT stocking out)



Safety stock =
(safety factor z)(std deviation in LT demand)



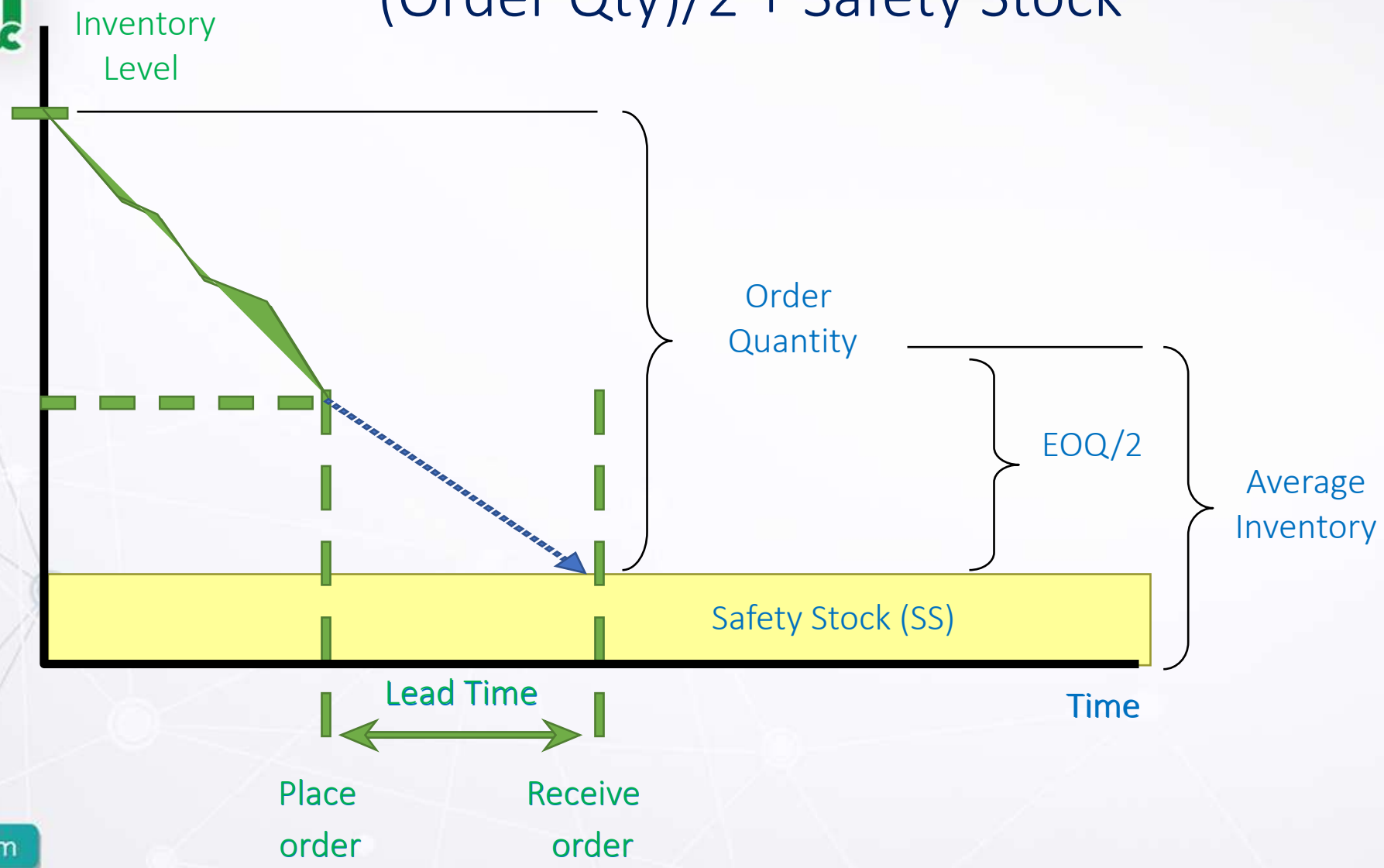
Read z from Normal table for a given service level

Caution: Std deviation in LT demand

Variance over multiple periods = the sum of the variances of each period (assuming independence)

Standard deviation over multiple periods is the square root of the sum of the variances, not the sum of the standard deviations!!!

Average Inventory = (Order Qty)/2 + Safety Stock



How to find ROP & Q

- Order quantity Q = $EOQ = \sqrt{\frac{2SD}{H}}$
- To find ROP, determine the service level (i.e., the probability of NOT stocking out.)
- Find the safety factor from a z-table or from the graph.
- Find std deviation in LT demand: square root law.

$$std\ dev\ in\ LT\ demand\ =\ (std\ dev\ in\ daily\ demand\ )\ \sqrt{days\ in\ LT}$$

$$\sigma_{LT} = \sigma_D \sqrt{LT}$$

- Safety stock is given by:
- SS = (safety factor)(std dev in LT demand)
- Reorder point is: ROP = Expected LT demand + SS
- Average Inventory is: SS + EOQ/2

Example (continued)…

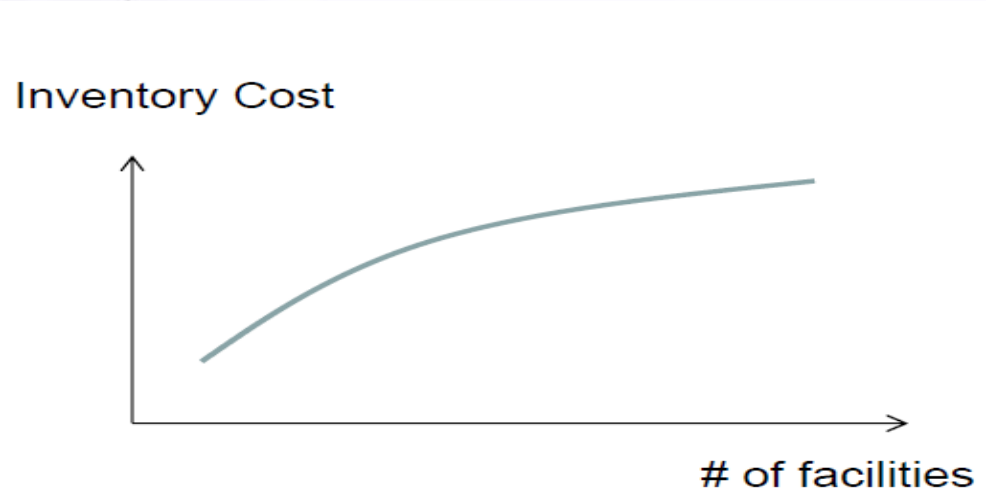
Back to the car lot… recall that the lead time is 10 days and the expected yearly demand is 5000. You estimate the standard deviation of daily demand demand to be $\sigma_d = 6$. When should you re-order if you want to be 95% sure you don't run out of cars?

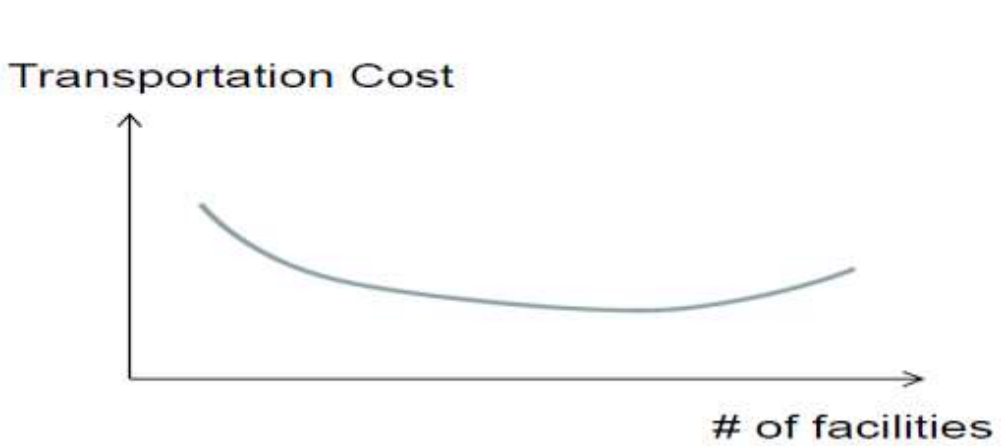
Since the expected yearly demand is 5000, the expected demand over the lead time is 5000(10/365) = 137. The z-value corresponding to a service level of 0.95 is 1.65. So

$$ROP = 137 + 1.65\sqrt{10(36)} = 168$$

Order 548 cars when the inventory level drops to 168.

Why do logistics cost change with the number of facilities?





Cost increase in the number of facilities because of:

- Less Economies of scale
- Increasing safety stock

Transportation cost change in the number of facilities because:

- outbound transportation cost decrease with the increase in the number of facilities.
- inbound transportation cost increase with the increase in the number of facilities.

Logistics Performance Measures

- On-time Deliveries
- Damage
- Demurrage Cost Percentage
- Assessorials Cost Percentage
- Missed Appointments Percentage
- Freight Bill Accuracy
- Cost per Order
- Cost as % of Sales

Responsiveness

- The best decision making is executed on the basis of events as or before, not after, they occur
- Responsive logistics systems provide discipline and control that is based not only upon plans and performance goals, but also upon the dynamics of actual operations

Modes of transportation

Truck	– Moving wide variety of freight shipped over a wide range of distances – Middle ground between the extremes of high prices and short lead-times of air and low prices and long lead-times of rail or water – Vast road networks throughout the world
Rail	Raw materials, autos, machinery shipped over long distances (>500 miles)
Air	– About 27% is associated with international shipments – Small, high value, perishable or time sensitive product shipped over long distances (>500 miles)
Water	– About 82% is associated with international shipments – Inland: Raw materials shipped over long distances (>300 miles) – Ocean: wide variety shipped over long distances
Pipeline	– Liquids and gases shipped over a range of distances

Costs & segments of trucking industry

- Variable trucking costs include (Fuel, labour, usage taxes)
- Fixed costs include (Investment costs in terminals and trucks):
- Truckload (TL): TL shipments are full truckloads
- Generally travel from a single origin to a single destination
- Less-than-truckload (LTL): An LTL shipment consumes a fraction of a truck's capacity
- LTL carriers consolidate multiple LTL shipments on a single truck
- Compared to TL an LTL shipment is:
- More expensive per pound
- Takes longer to deliver
- More susceptible to damage

Rail

- Relatively low cost, mode is attractive for:
- Long distance shipping of large and heavy loads
- Items for which short and reliable lead-times are not critical
- Coal, grain, lumber, paper, autos, and heavy machinery
- Variable costs are lower for rail (than for truck), but fixed costs are higher
- Fixed costs of maintaining rail tracks
- Costs associated with equipment and terminals
- There exists economic incentives to run trains with many railcars
- Travel time can be less than half of the delivery lead-time
- Load may spend time in a rail yard waiting for a suitable number of railcars before departing
- Usually not from a single origin to single destination
- Time is spent in rail yards as railcars are moved between trains enroute to their destination

Air

- Advantage
- Short delivery lead-times over long distances
- Disadvantage
- High cost
- Availability of service is limited by the location of airports
- used in combination with truck
- Commonly used for high value and time sensitive items
- High variable and relatively low fixed costs (airports and terminals are generally publicly maintained)

Water

- Inland waterway & ocean
- Barges are common for river and canal traffic
- Capacity is very high (up to about 40000 tons a barge)
- Low variable and moderate fixed costs
- Travel speeds are slow
- Limited waterway accessibility (not easily offset by combining with truck due to large differences in capacity)
- Good for low value commodities for which short lead-time is not a priority
- • Large cargo ships for ocean freight
- High capacity
- Faster than barges
- Delivery leadtimes (especially international) are long and highly variable due to weather, delays in loading/unloading, customs clearance.

Pipeline

- Limited use
- Liquids such as petroleum products
- Natural gas
- Very low variable cost
- Large fixed investment to build
- Very slow, but continuous

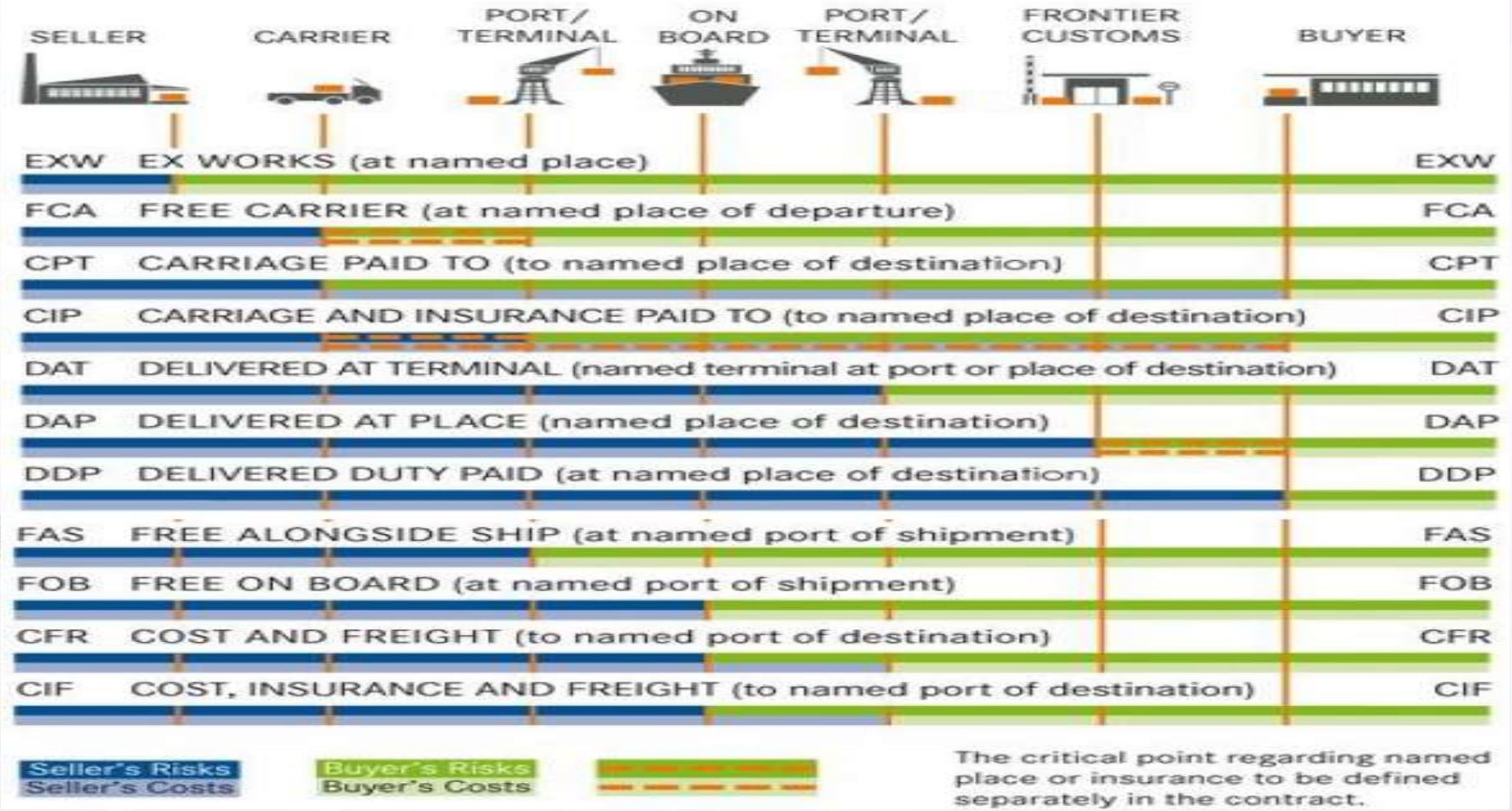
Qualitative characteristics of alternative modes

	Truck	Rail	Air	Water
Operational Cost	Moderate	Low	High	Low
Market Coverage	Pt to Pt	Terminal to Terminal	Terminal to Terminal	Terminal to Terminal
Level of competition	High	Few	Moderate	Few
Traffic Type	All Types	Low to Mod Value, Mod to High density	High value, Low density	Low value, High density
Length of haul	Short – Long	Medium – Long	Long	Med - Long
Capacity (tons)	10 – 25	50 – 12,000	5-12	1,000-6000

Mode comparison matrix

	Truck	Rail	Air	Water
Speed	Moderate	Slow	Fast	Slow
Availability	High	Moderate	Moderate	Low
Consistency (delivery time)	High	Moderate	Moderate	Low
Loss & Damage	Low	High	Low	Moderate
Flexibility	High	Low	Moderate	Low

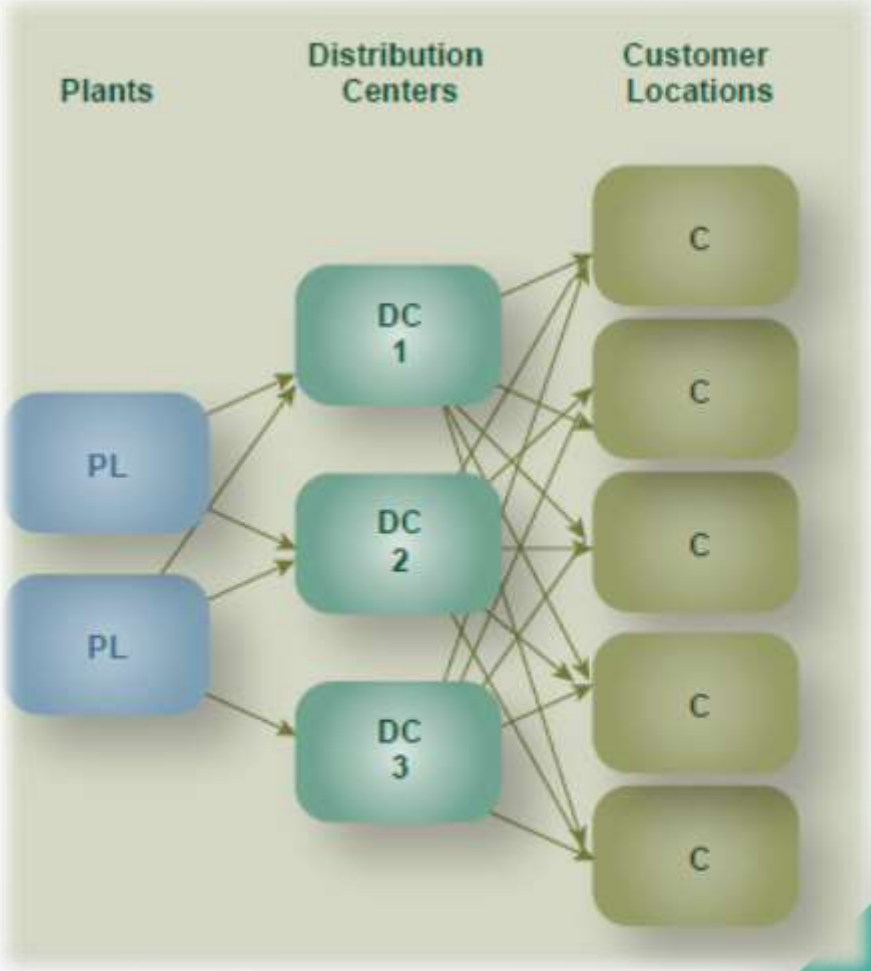
International Commercial Terms(Incoterms) of the International Chamber of Commerce (ICC)



General Roadmap for Distribution network Design

Distribution network may hold the key to competitive advantage and market success through focusing on the two dimensions of the distribution network:

- Maximize
- customer service level
- Flexibility & Agility
- Minimize
- Operating costs
- Capital investment
- Risk

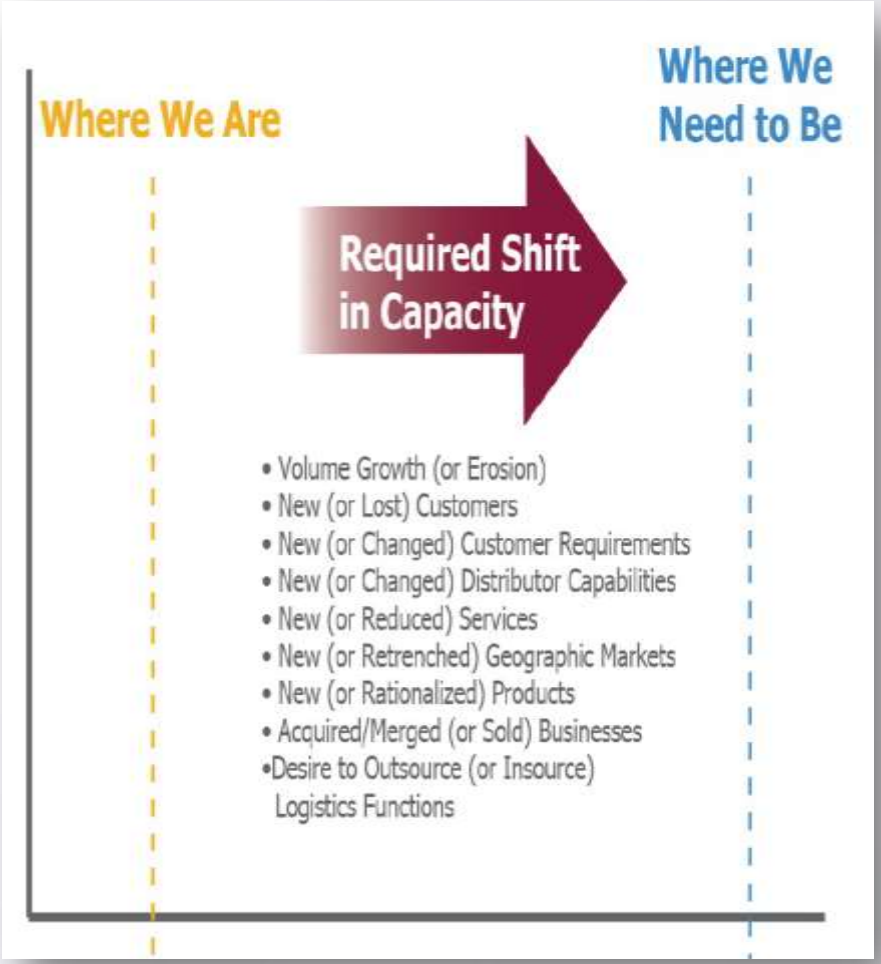


In order to design a distribution network that lines up with your unique business model and unlocks competitive advantage for your company you need to follow the following guide lines:

- Identify Scope and Current Network Constraints
- Determine Your Goals
- Gather Data on the Current Network Situation
- Cleanse and Verify the Data
- Select Design Tools
- Build Baseline Models
- Model Potential Strategic Network Scenarios
- Conduct Further Analysis of Your Top Options
- Determine Capital Investment Requirements
- Prepare to Justify the Recommended Network Changes
- Recommend and Develop Your Implementation Plan

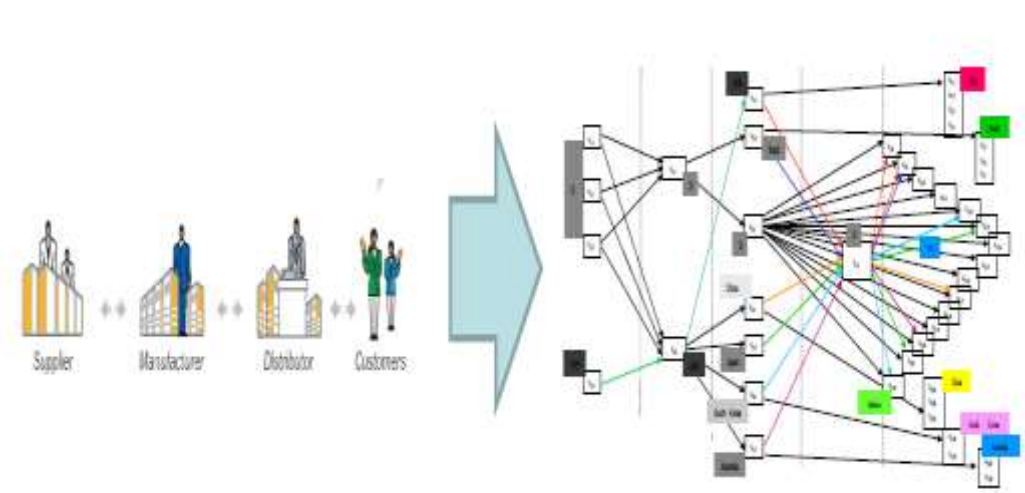
1. Identify Scope and Current Network Constraints:

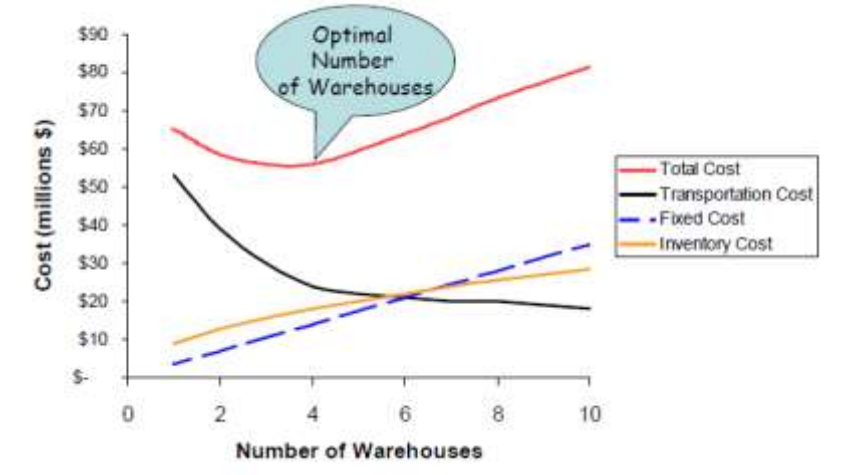
- Distribution throughput and storage capacity
- Expansion potential at eaxisting sites
- Material handling requirements for products being manufactured and distributed
- Budgetary constraints on capital investment
- Production line capacities
- Remaining lease timeline and remaining life on facilities and equipment
- WMS and WCS constraints for distributing a SKU out of multiple facilities versus a single facility



1. Identify Scope and Current Network Constraints:

- Customer service requirements (next-day, two-day, standard, etc.)
- Order characteristics
- Limitations on transportation carrier availability
- Private fleet capacity
- Limitations on labour availability in current locations (to potentially expand operating shifts)
- Tolerance for risk



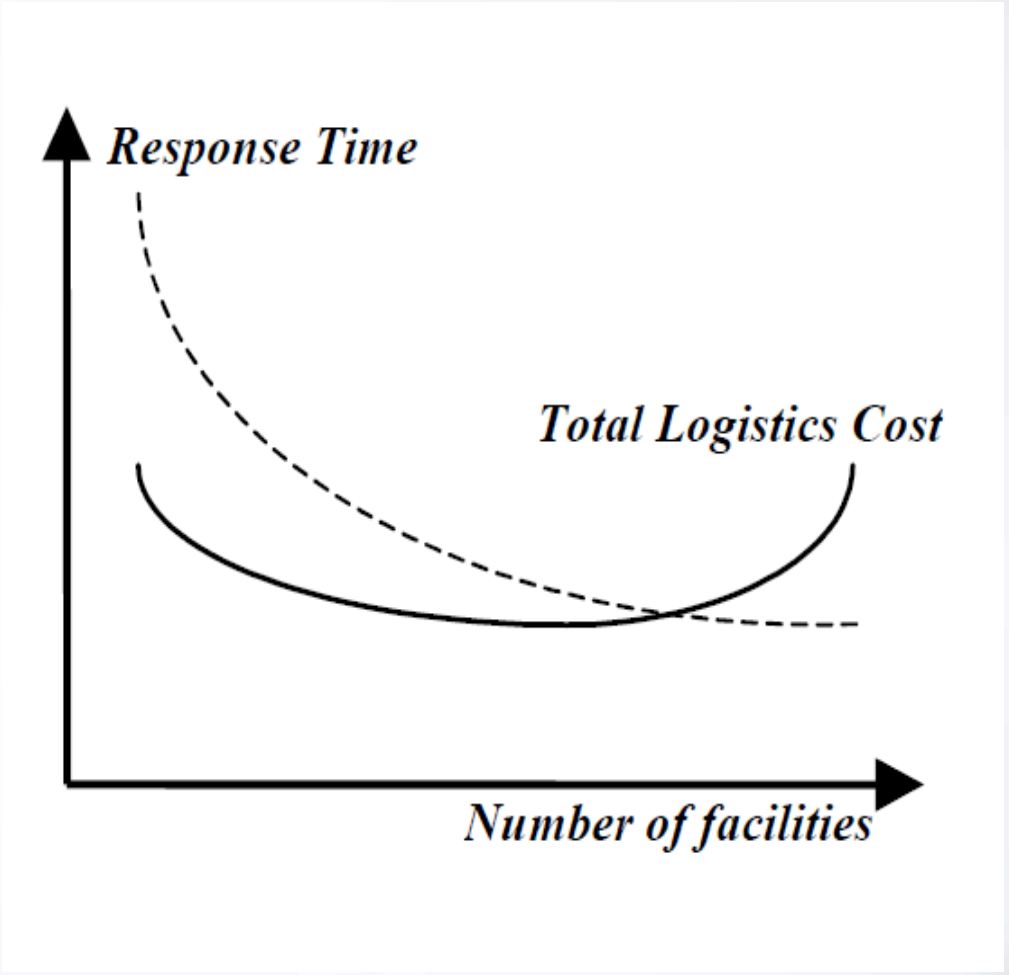


2. Determine Your Goals

- Tactics:

Cost Reduction:

- Rationalize Inventory Investment
- Minimize transportation cost
- Minimize Inventory carrying cost
- Minimize administrative cost
- Minimize fulfillment error cost
- Service Level improvement:
- Increase on time performance
- Increase fill rate %
- Increase Flexibility



2. Determine Your Goals

Increase the customer service level

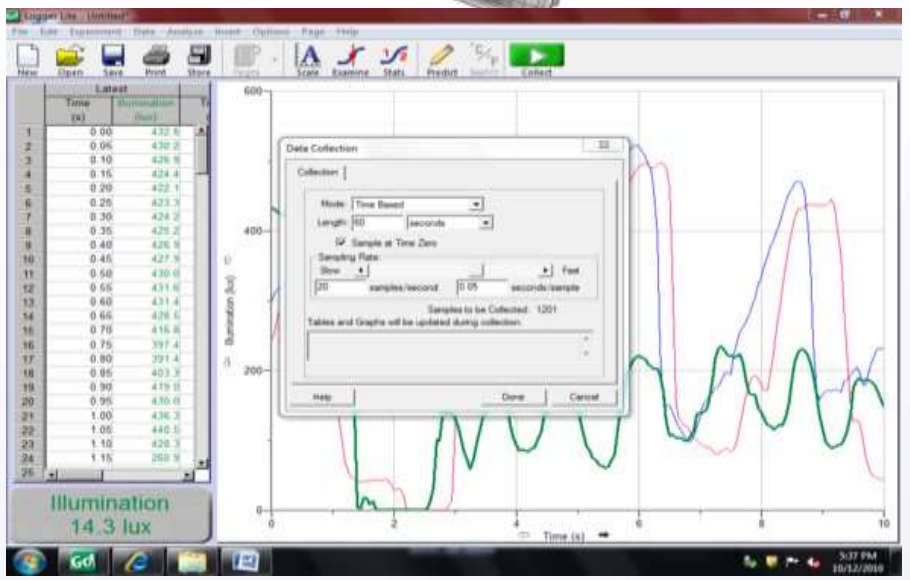
Operating cost reduction

Shifting the cost versus service curve is the fundamental goal of all distribution network strategies:

The tactics used to do so may work against each other. For example, improving customer service levels might lead to a decision to expand the number of facilities in a distribution network. While this may increase operating costs, improved customer service might result in increased revenues that would offset the increased distribution costs.

3. Gather Data on the Current Network Situation

- Understanding the current network thought:
- Data collection,
- Data validation and authentication
- Data analysis and accuracy verification
- For missing Data:
  - assumptions can be made with necessary sensitivity analysis
  - field measurements



3. Gather Data on the Current Network Situation

Types of data to be collected:

- Physical addresses of suppliers, customers, and facilities
- Historical line-item demand by SKU by customer for a 12-month period
- Historical line-item supply by SKU by vendor for a 12-month period
- Historical line-item production and/or throughput by SKU by facility for a 12-month period

3. Gather Data on the Current Network Situation

Types of data to be collected: (continued)

- Historical transportation costs and modes (LTL, parcel, truckload, rail, etc.) for all shipments being analyzed
- Historical facility labour and operating costs for each facility in the network
- Historical inventory level snapshots by SKU or product category
- Historical storage and production utilization rates
- Current productivity measures for each facility or process being studied

3. Gather Data on the Current Network Situation

- Types of data to be collected: (continued)
- Current throughput and storage capacities for each facility being studied
- Transportation rate tables for any mode of transportation being used in the network
- Service level requirements by customer and product category
- Production line rates and capacities,
- Retail store locations,
- Private fleet information,

3. Gather Data on the Current Network Situation

- Types of data to be collected: (continued)
- Growth forecast information for a planning horizon, including:
  - SKU growth
  - Sales demand growth
  - Unit demand growth
  - Customer growth
  - Regional/local growth trends differing from overall growth
  - Inventory growth and goals

4. Cleanse and Verify the DataTypes of data to be collected:

“Garbage In Garbage out”

Data needs to be cleansed and verified to insure that the inputs are the best accuracy possible. Then to set the data in the required formats for the selected tools for analysis.

Actions for data cleansing could be:

Look for text entries in numerical fields and vice versa, make sure zip codes have leading zeros, determine cause of blank fields or line items in data, and make sure line item information is properly aligned with the correct field designator. Do this for every data file.

4. Cleanse and Verify the DataTypes of data to be collected:

Actions for data cleansing could be: (Continued)

- Look for anomalies in historical databases. Examine shipments to the top 10-20% of customers and verify that the data totals match historical totals. Do the same for inbound shipments from top vendors.
- Determine timing of peak demand and supply periods for top customers and vendors and make sure that these appear accurate.
- Examine production and distribution by SKU or product category at each facility being studied.
- Examine quantities of units shipped by transportation lane and mode between facilities, to customers, and from suppliers. Look closely at specific product categories and SKUs as well to see if their data volumes match your actual performance.
- Examine historical inventory information by product category and by location for accuracy.
- Make sure location addresses are correct for vendors and customers. If billing addresses are inadvertently used instead of shipping addresses, a completely different (and incorrect) set of recommendations could result.
- Examine transportation and operating cost tables for accuracy. A slight error in cost per unit or pound calculations can change a location recommendation or cause misstatement of potential savings

5.Select Design Tools:

There are several tools that can support the development of the network designs with shorter time and high accuracy.

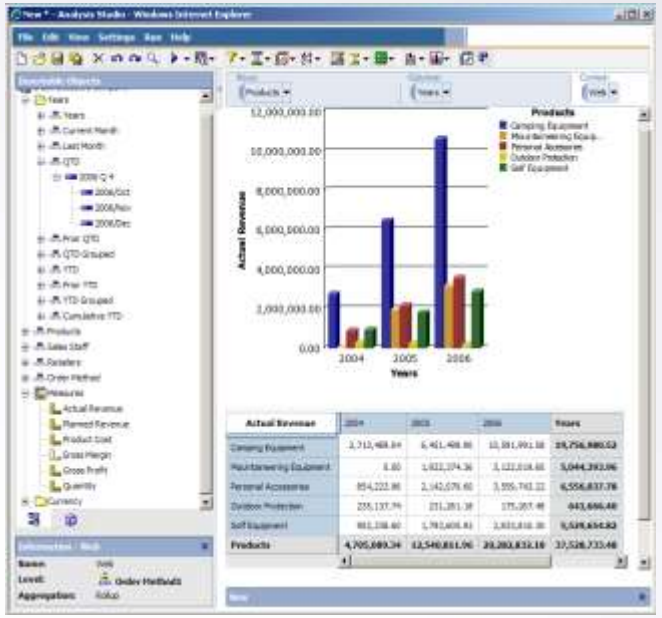
•Available types of Network Design Tools:

1.Database analysis software and spreadsheet software:

used to cleanse and verify data and to analyse alternatives for simple networks or small segments of large networks.

2.Mapping software:

illustrates changes in network structure without relying solely upon tables and graphs. Software that can illustrate changes in product flow and costs from location to location within a network provides valuable insight into the impact of “what if” type questions.



5.Select Design Tools:

•Available types of Network Design Tools: (Continued)

3.Transportation rating packages:

used for rating thousands of shipments at once for different transportation modes. Parcel and LTL rating packages are particularly useful as different weights impact the cost of a shipment (unlike truckload, rail or container shipments that operate primarily on a cost per mile or a cost per shipment basis).

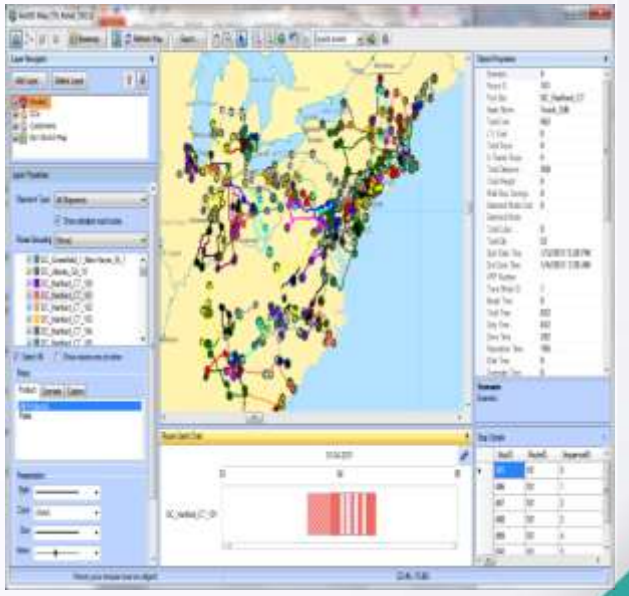
4.Mileage calculation software:

provides distance calculations between addresses, zip codes, or cities. These are extremely helpful with a network realignment in determining the impact on overall transit time and transportation cost (if lane costs are provided on a cost per mile basis).

5.Select Design Tools:

Available types of Network Design Tools: (Continued)

5.Supply chain optimization software:



does an excellent job of providing the best answer for particular time snapshots of a network, while taking into consideration the constraints outlined in Steps 1 and 2 (minimize cost, maximize revenue, improved customer service, etc.) There are a number of optimization tools available at varying levels of price and complexity.

6.Dynamic supply chain simulation software:

simulates the day-to-day operation of a network. Simulation software goes a step beyond optimization software by using randomized order profiles based on your network constraints. Network costs, volumes, inventories, production capacity, distribution capability, and customer service can be evaluated at a tactical level with this type of software.

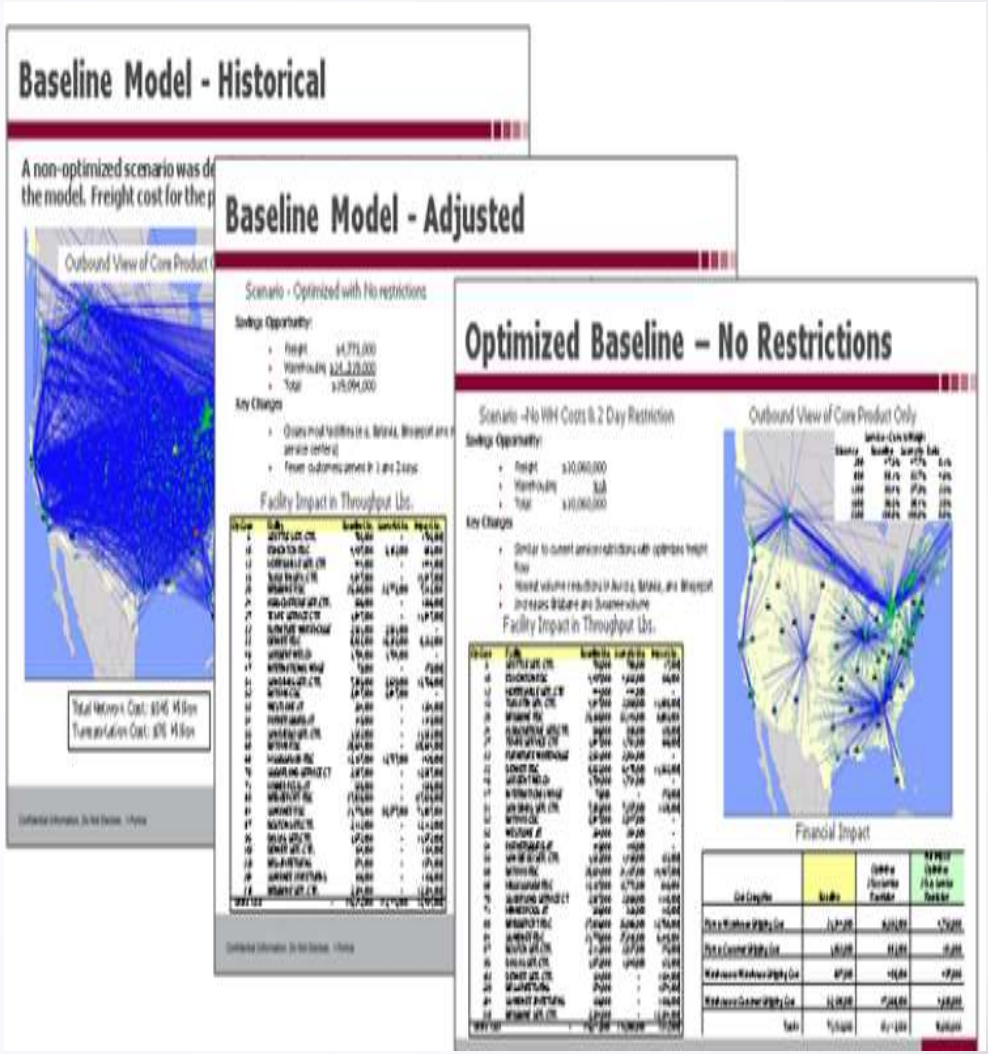
6. Build Baseline Models:

The baseline model reflects the current operation and capabilities of the distribution network.

When complete, it should provide results that match historical results within a pre-determined confidence level.

Run the baseline model for the past year and the existing year forecast to show the impact of growth on existing operations and capabilities “do nothing” scenario.

Next, develop an “Optimized Baseline” scenario. This will be “perfect world” scenario, where it provides indicators of how the current network’s service and operating cost might be improved



7. Model Potential Strategic Network Scenarios:

Start modelling alternative network scenarios to understand the impact of specific changes on operating costs, service levels and transit times.

Options to consider in preparing the scenarios:

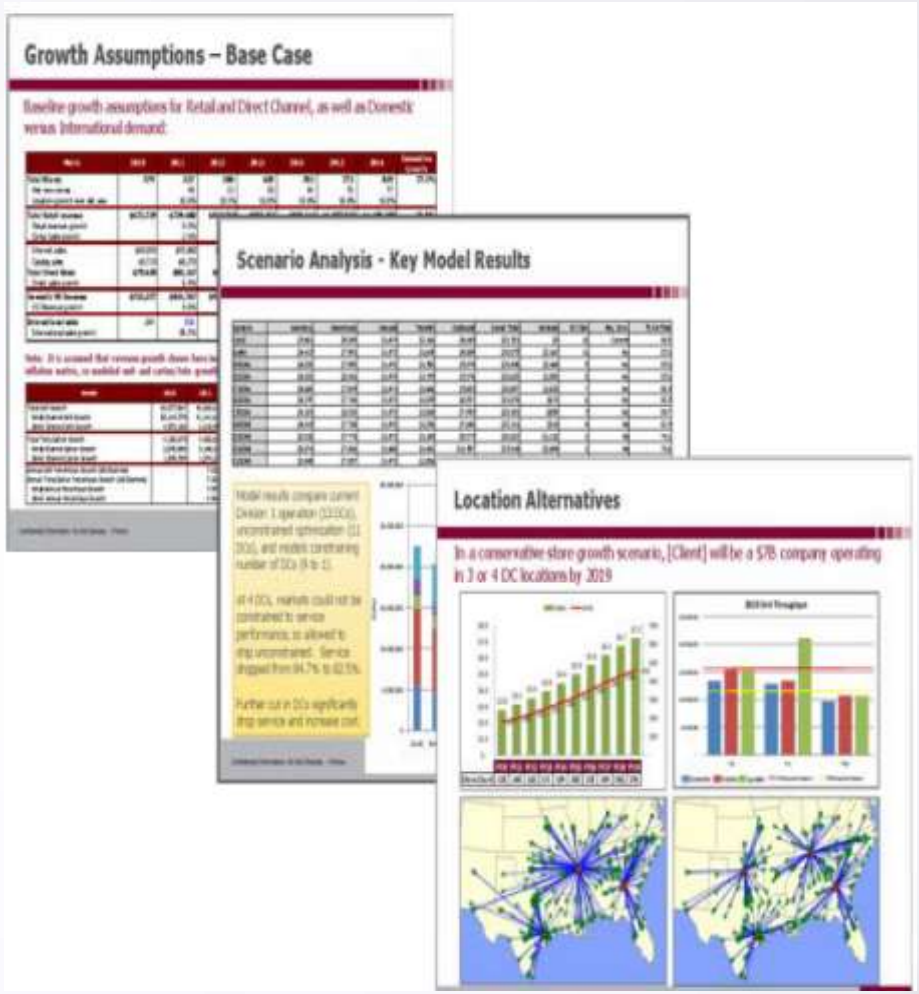
Varying the number and location of distribution points

Varying the location and capacity of production lines

Altering the sourcing for product families, service markets, or specific customers

Varying the strategic use of distribution locations

Changing inventory deployment practices



7. Model Potential Strategic Network Scenarios:

Options to consider in preparing the scenarios: (continued)

- Varying transportation modes
- Altering growth and acquisition strategies
- Changing customer service level requirements—number of weekly or monthly deliveries, order size, etc.
- Impact of tax burden upon a distribution network configuration
- Impact of eliminating certain constraints on the network
- Impact of changing channel mix (Retail vs. Wholesale vs. Direct to Consumer, etc.)

8. Conduct Further Analysis of Your Top Options:

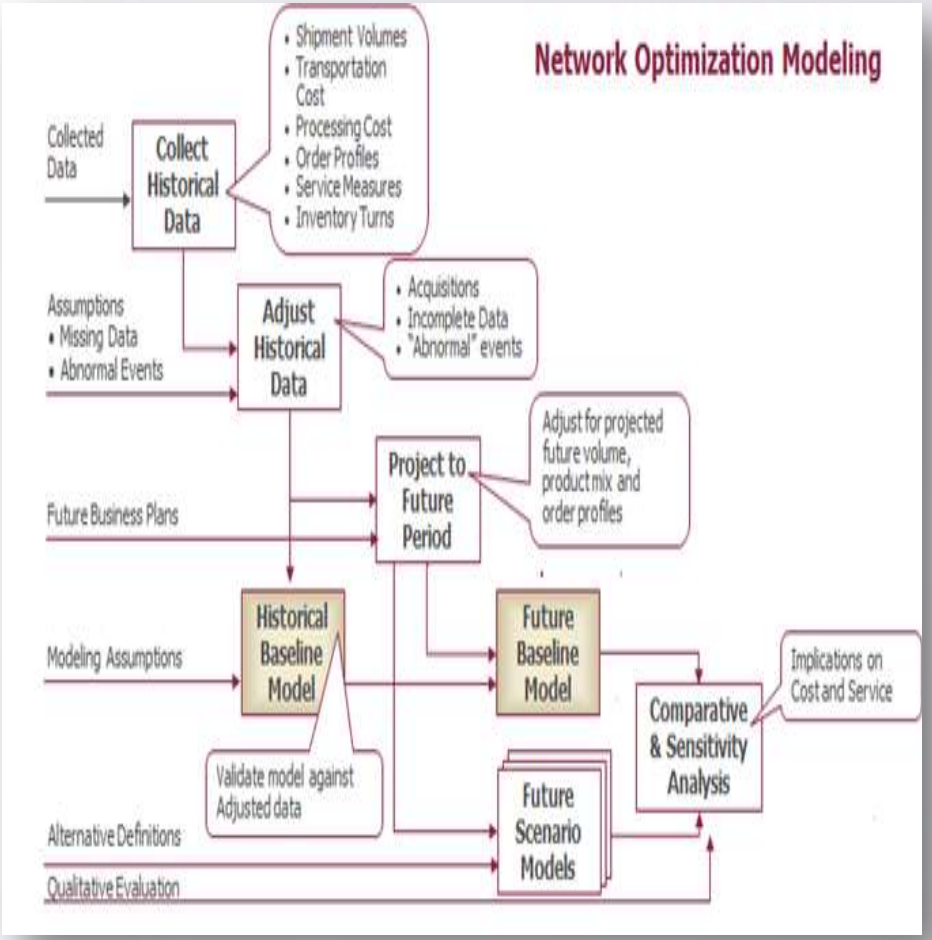
After a set of scenarios are developed and evaluated, the top 3 options should be selected for further analysis. This further analysis might include:

determining capital investment

transition cost requirements

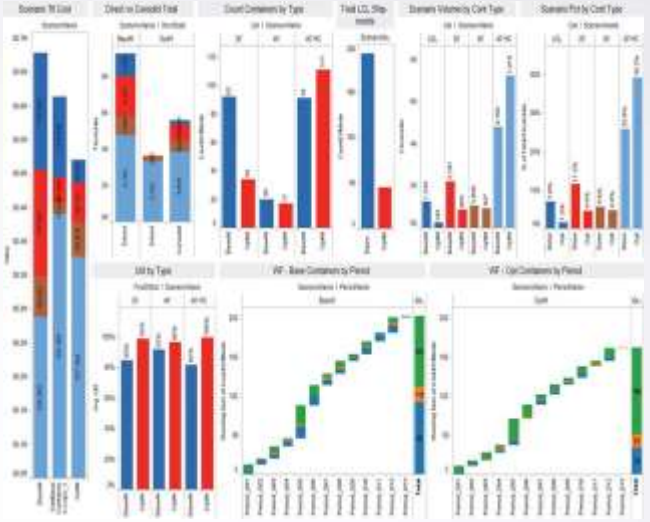
financial and qualitative justification

design recommendations for future supply chain processes



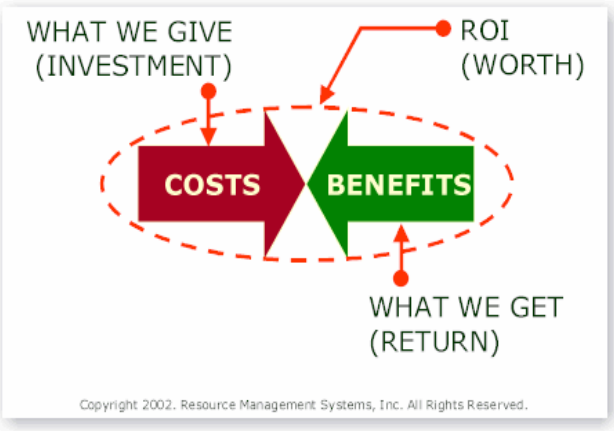
8. Conduct Further Analysis of Your Top Options:

- Typical variables studied during this type of analysis include:
  - growth
  - seasonality of demand
  - freight cost
  - freight mode profile
  - wages
  - inventory levels
  - tax burden
  - facility operating costs



	Base case (util. 90% + growth 2%)	Scenario 1 (util. 90% + growth 5%)	Scenario 2 (util. 85% + growth 5%)
Status quo – Do nothing	Capacity just balanced No flexibility Risk of stock-out	Under-capacity Stock-out	Severe under-capacity Bad delivery performance X%
Potential solution B: Site shifts	Capacity balanced and incl. flexibility	Capacity balanced and incl. flexibility	Extra costs for transport mDKK Y Sales ok
Potential solution C: Prioritise customers	Not relevant		Say "no" to customers Lost sales mDKK Z

9. Determine Capital Investment Requirements:



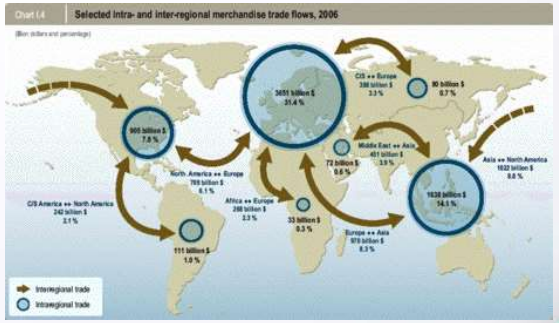
All the previous efforts help to understanding how network changes impact operating costs, service levels, and inventory requirements.

Capital investments will likely be required to realize any reduction in operating costs or service level improvements, like:

Throughput and storage capacity requirements of each facility.

Facility size and equipment requirements.

Inventory requirements for the new network alignment.

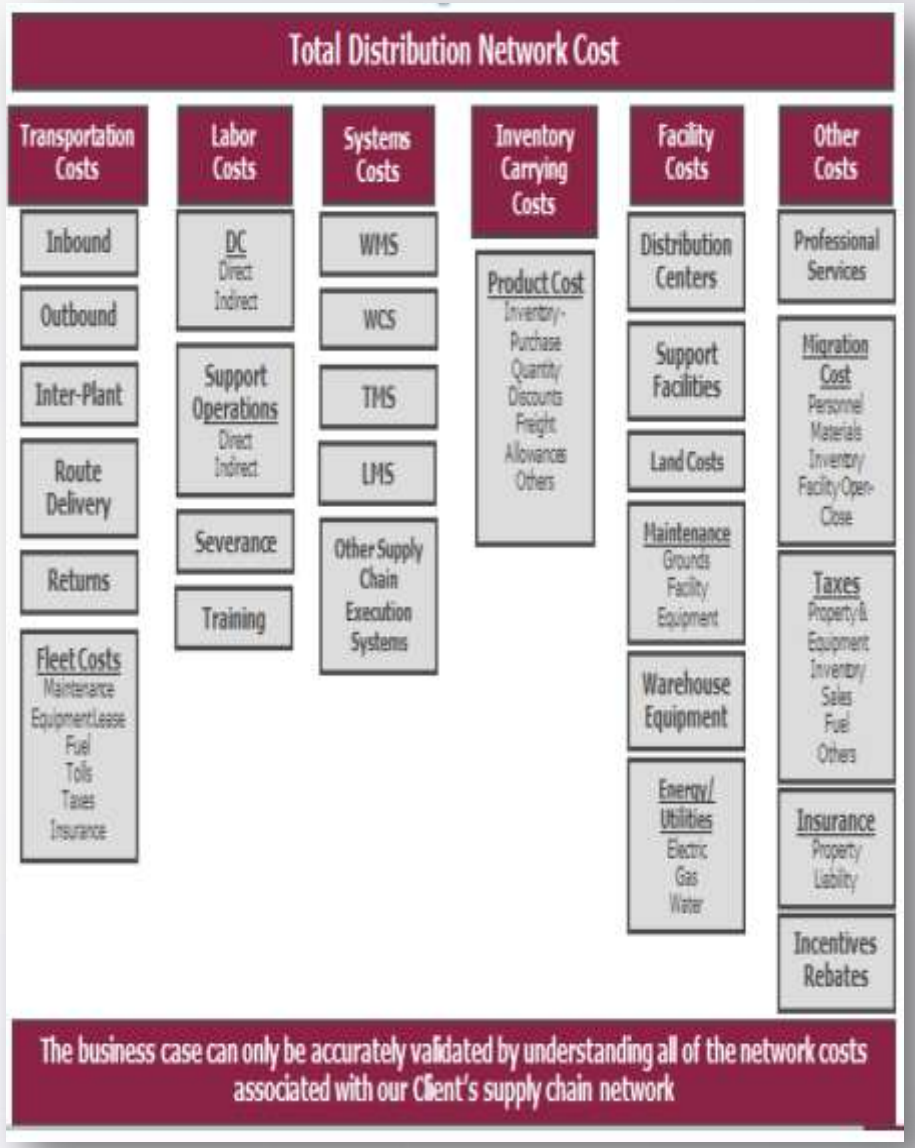


Costs associated with facility acquisition or expansion and material handling equipment procurement

Systems costs associated with network changes (order management, warehouse management, warehouse control, demand planning, labour management, and transportation management, etc).

9. Determine Capital Investment Requirements:

- Additional costs to cover the transition period during implementation should be included, such as:
  - Site acquisition costs
  - Facility construction costs
  - Facility modification or up-fit costs for existing facilities
  - Relocation packages
  - Severance packages
  - Recruitment and training cost
  - Inventory relocation expense
  - Lease break costs for existing facilities
  - Sale of existing facility and equipment

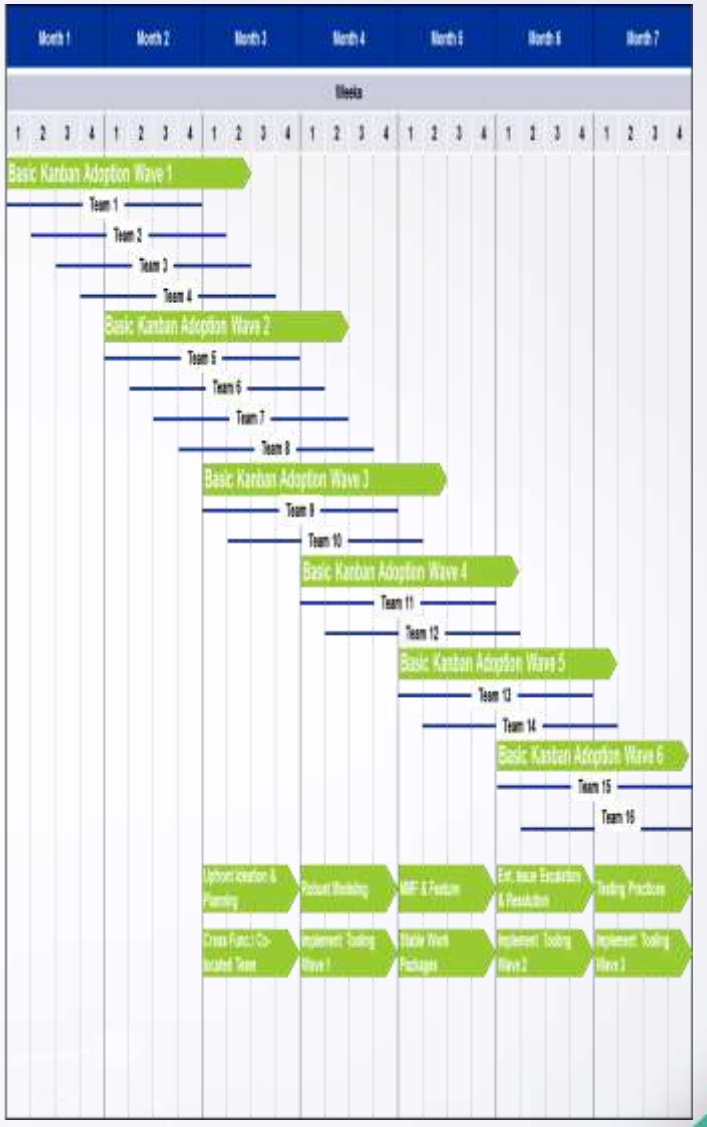


10. Prepare to Justify the Recommended Network Changes:

- Answers and justifications should be prepared to answer the management questions:
- How much is needed as Capital Investment?
- Do the company can afford that requested fund?
- What are the financial results expected to be achieved from that investment?
- Does the financial results meets the management level of expectation?
- What are the risks, back-up plans and exit plans?
- What are the political implications?
- What is the impact of the organizational changes due to that proposal?

11. Recommend and Develop Your Implementation Plan:

- Once justification of the scenarios is complete, a single scenario or a couple of scenarios may rise to the top.
- The final selected scenario shall be transformed into an action plan and timeline should be developed in order to provide structure to the implementation process.
- During implementation planning, time must be set aside for:
- Site selection
- Facility construction or up-fit
- Facility equipment design
- Material handling equipment installation
- Systems development and installation
- Organizational development
- Hiring and training of personnel
- Inventory strategy and relocation.



Thank You

e3melbusiness.com