Introduction to Transportation Systems

PART II:

FREIGHT TRANSPORTATION

Chapter 12:

The Logistics System and Freight Level-of-Service

Freight Outline

- Freight level-of-service -- the inventory model
- Freight modes
  - Rail
  - Truck
  - Ship
  - Intermodal/International
- Summary -- commonalities and differences

Figure 12.1

The Logistics Model: An Umbrella Store

- Ordering
- Transportation Costs
- Storage

Deterministic Use Rate and Delivery Time

In-Store Inventory vs. Time

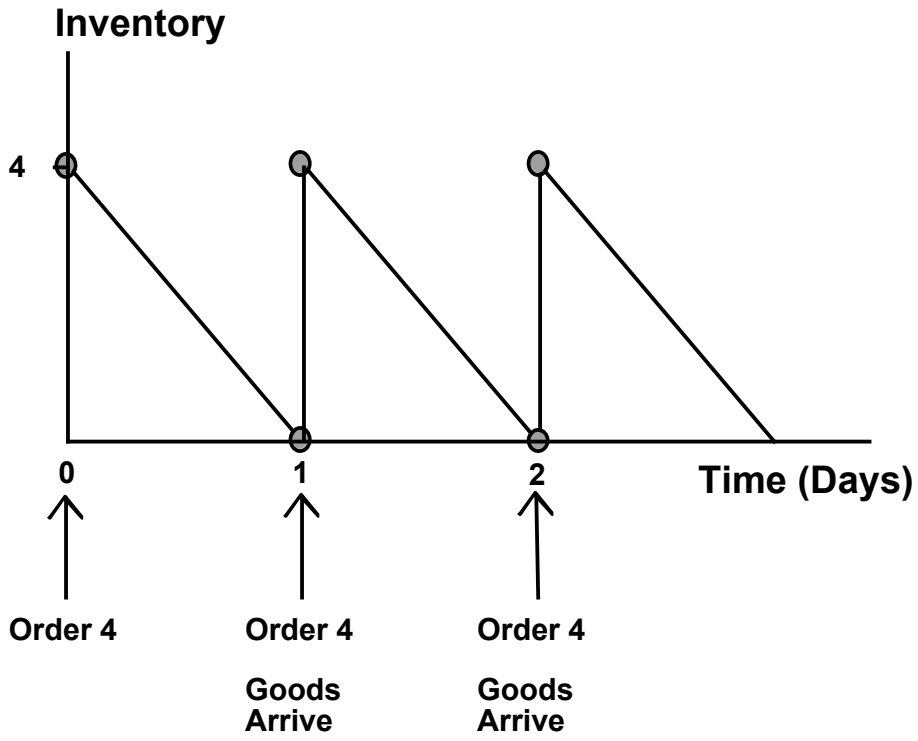


Figure 12.2

In-Transit Inventory Pipeline

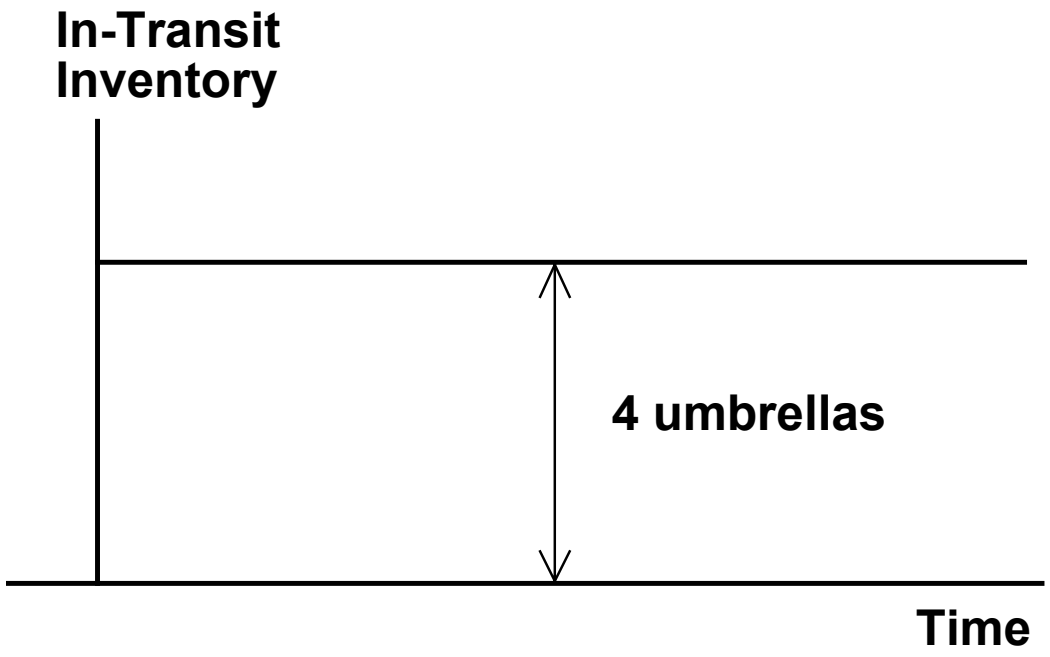


Figure 12.3

Order Pipeline, but with Longer Delivery Time

Order Pipeline

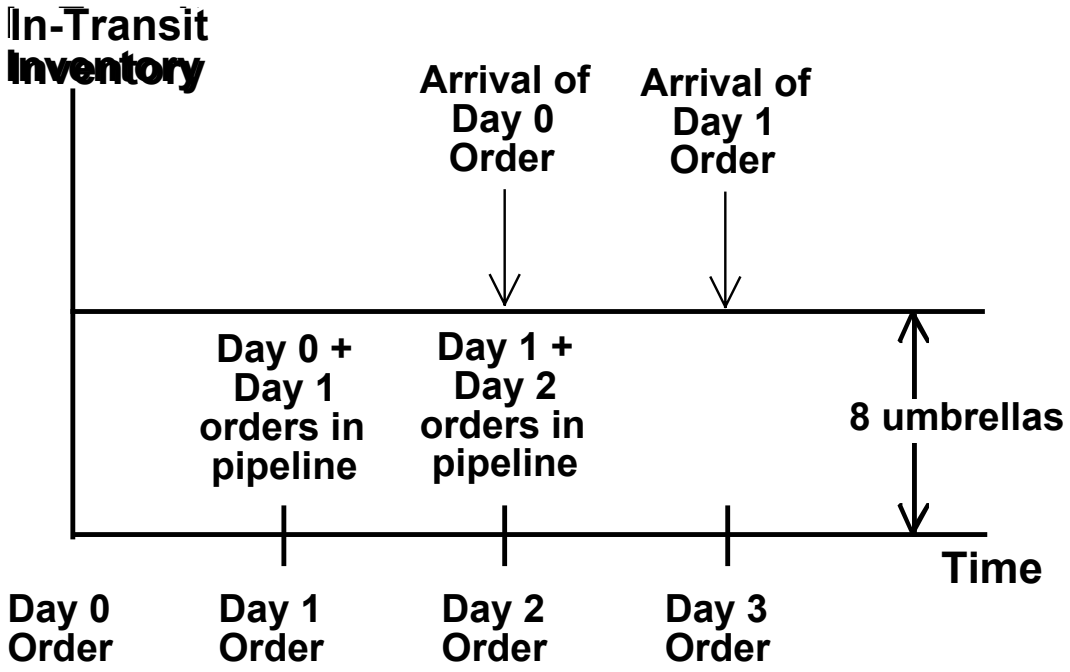


Figure 12.4

A New, Faster Mode

- Suppose a new premium transportation mode became available that allowed you to go from this new supplier to your retail outlet in one day, rather than two days.
- Your inventory costs would be reduced. Your pipeline is now only one day long, rather than two days long, which has value to you.
- And you would compare this value with the price that you were being charged for using this high-speed premium mode.

Unreliable Transportation Mode

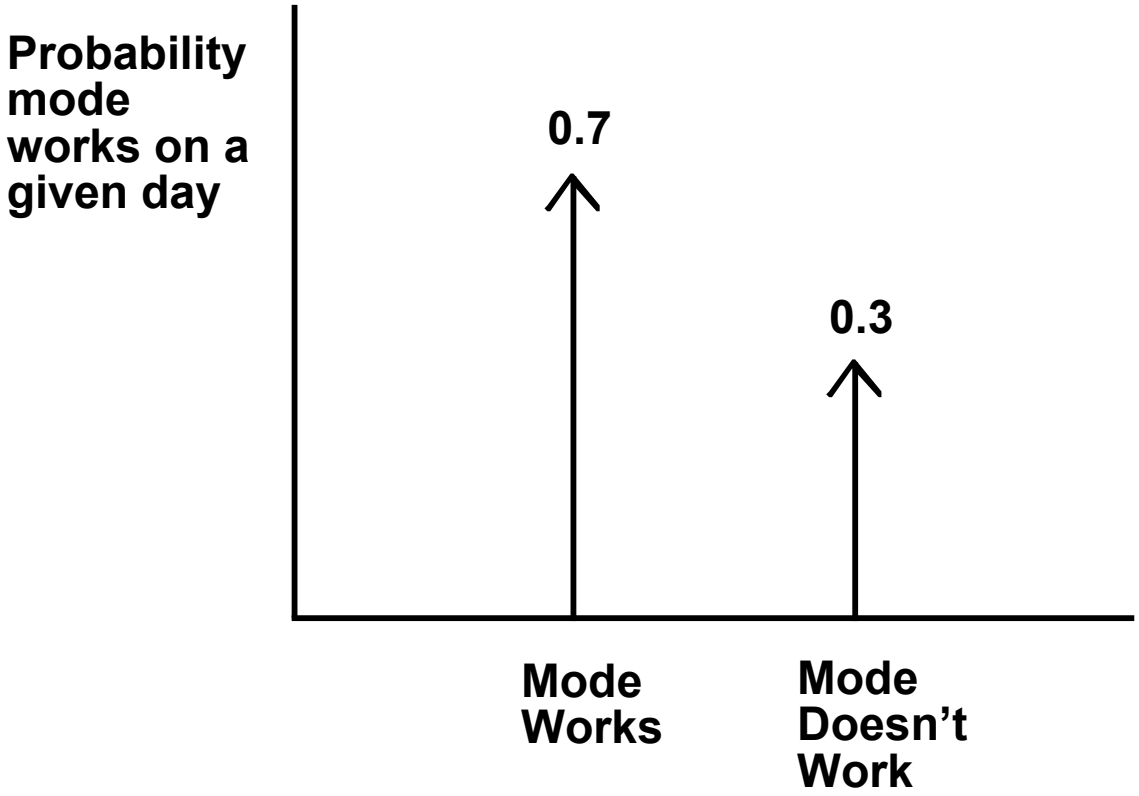
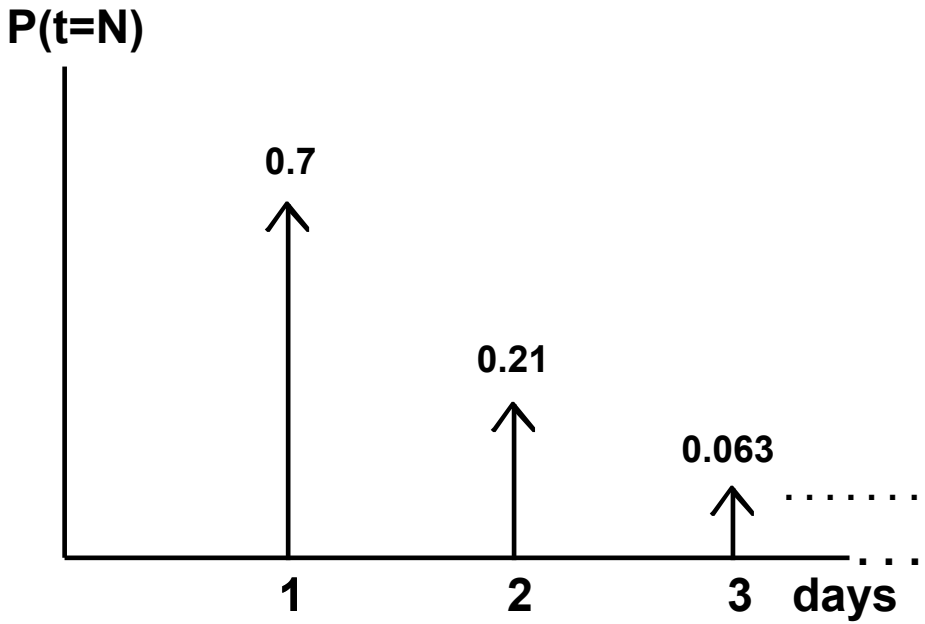


Figure 12.5

Probability of Time until Delivery



For umbrellas ordered on Day 0, probability of arrival on a given day.

Figure 12.6

So, how would we go about thinking through whether this new service, this *less reliable service*, is good for us? What kinds of issues do we need to deal with in this circumstance?

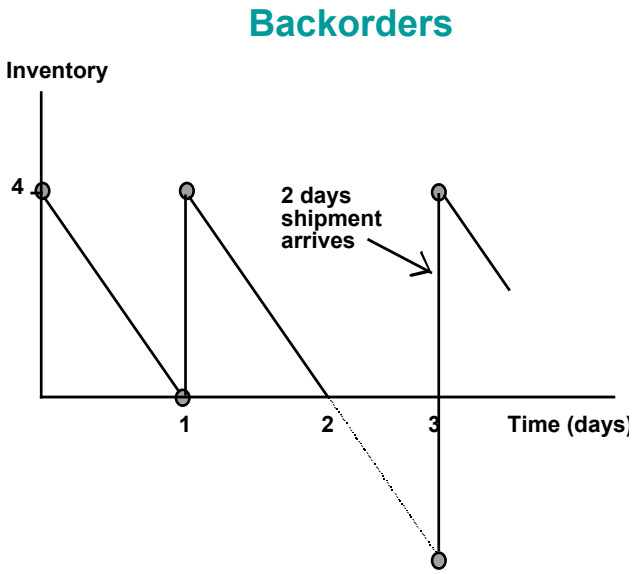


Figure 12.7

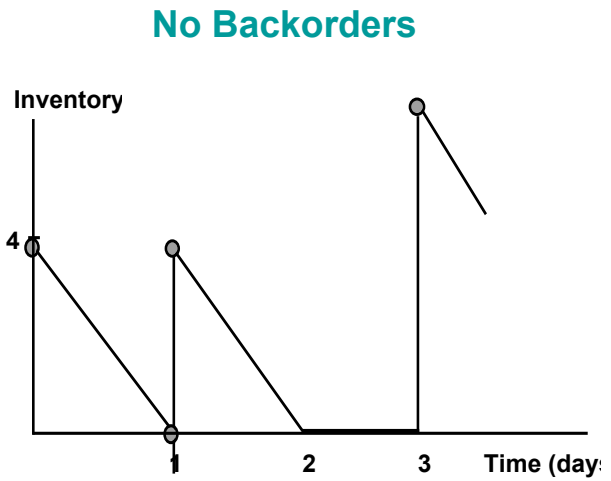


Figure 12.8

Deterministic Service

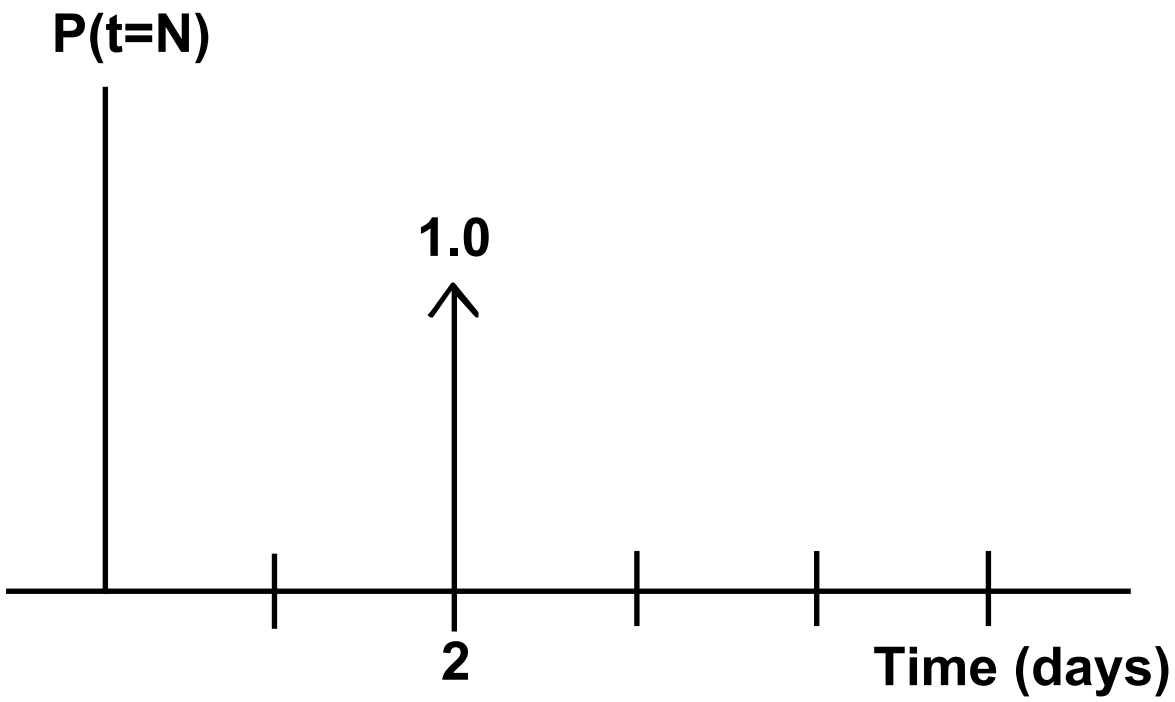


Figure 12.9

Safety Stock

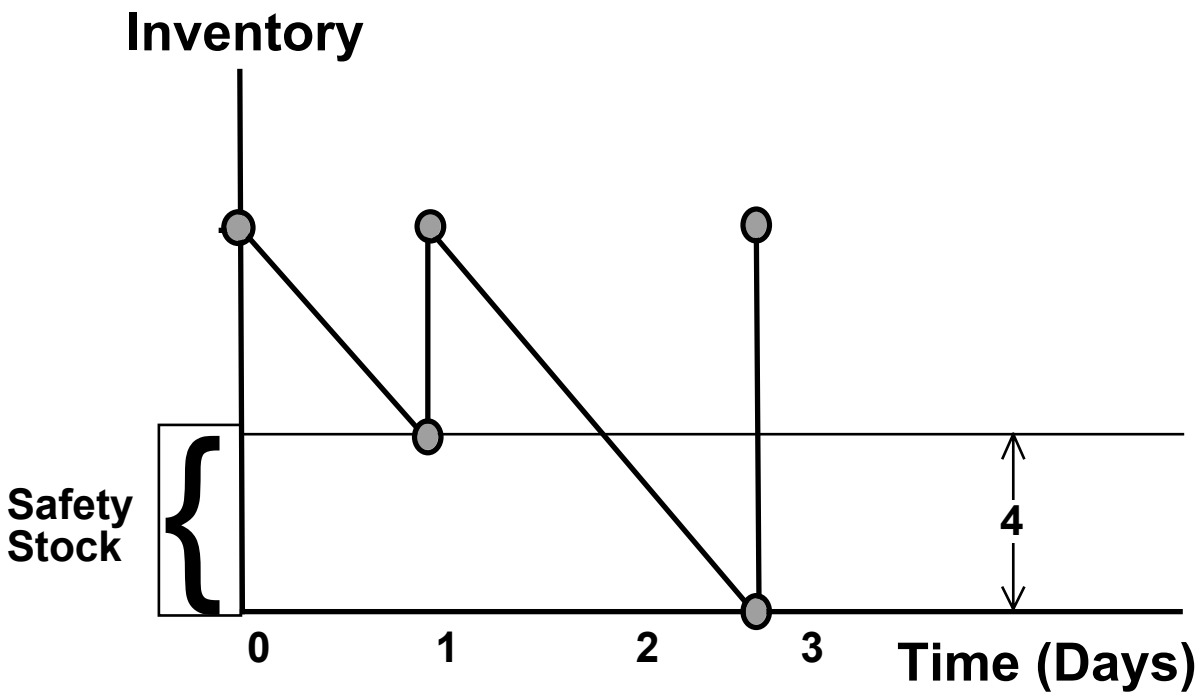


Figure 12.10

The Key Issue: Valuing a Stock-Out

- Examples
  - Our umbrella store
  - A large automobile manufacturer
  - A blood bank

CLASS DISCUSSION

Service Reliability as a Level-of-Service Variable

- Variability in the time for goods to travel from origin to destination is one of the prime causes of stock-outs.
- The term that we used for the variability of transit time is *service reliability*.

Probabilistic Use Rates

Probabilistic Use Rate of Umbrellas

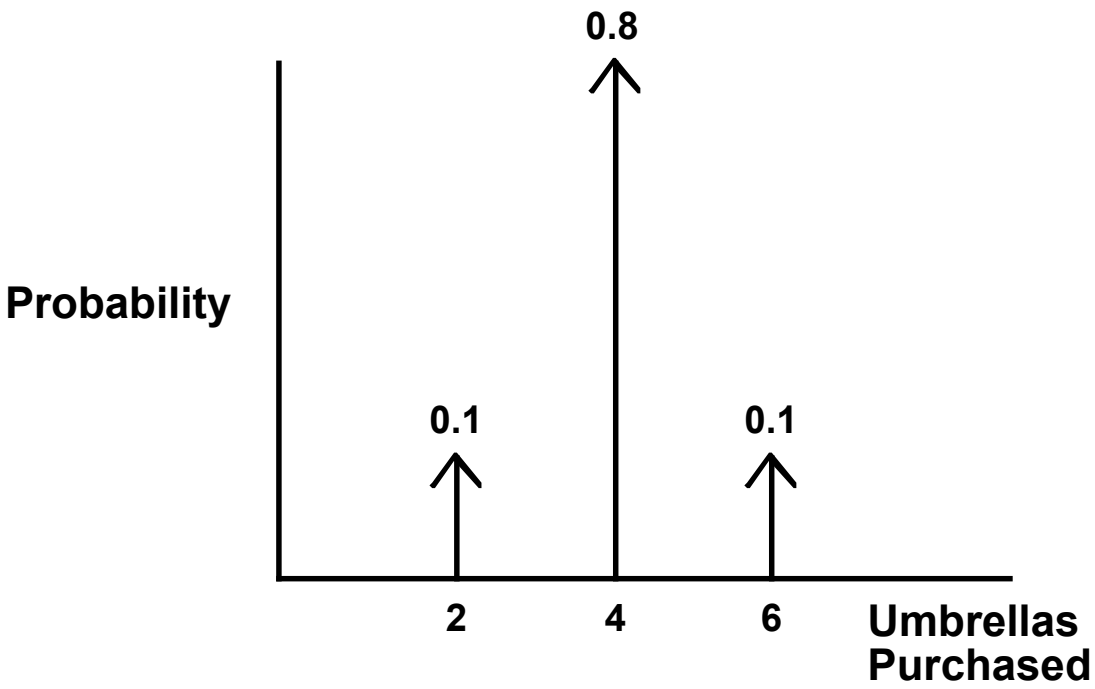


Figure 12.11

Inventory with Probabilistic Use Rate

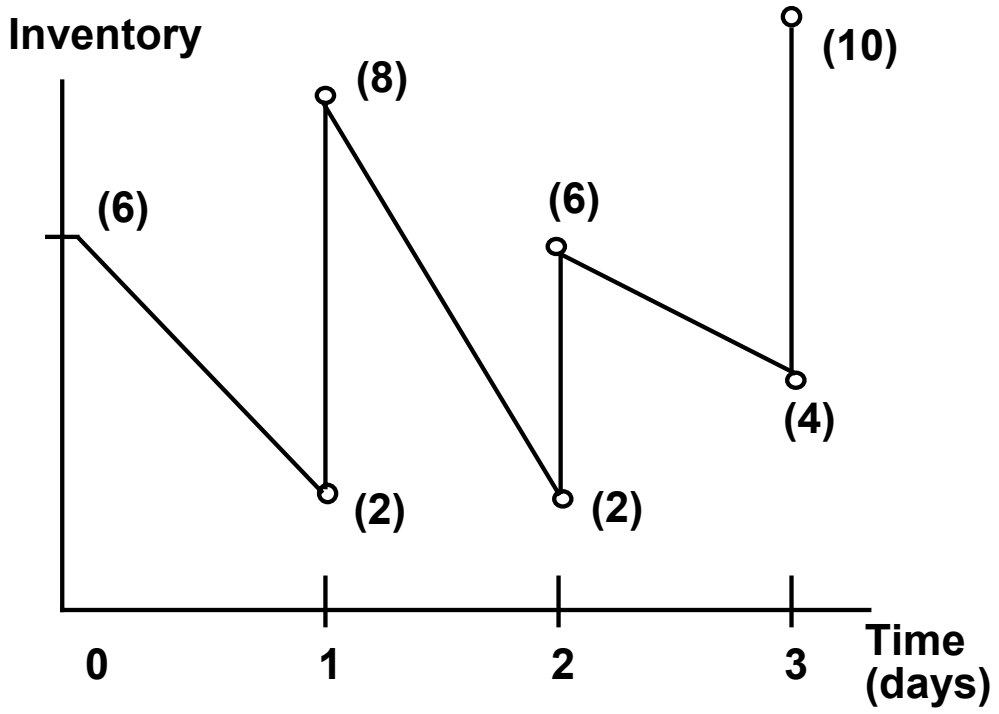


Figure 12.12

Inventory Minimization

- If one needs a greater amount of inventory because of unreliability in the transportation system *or* probabilistic use rate, you generate costs as a result of needing larger inventory to avoid stock-outs.
- We try to balance the costs of additional inventory with the costs of stock-outs.

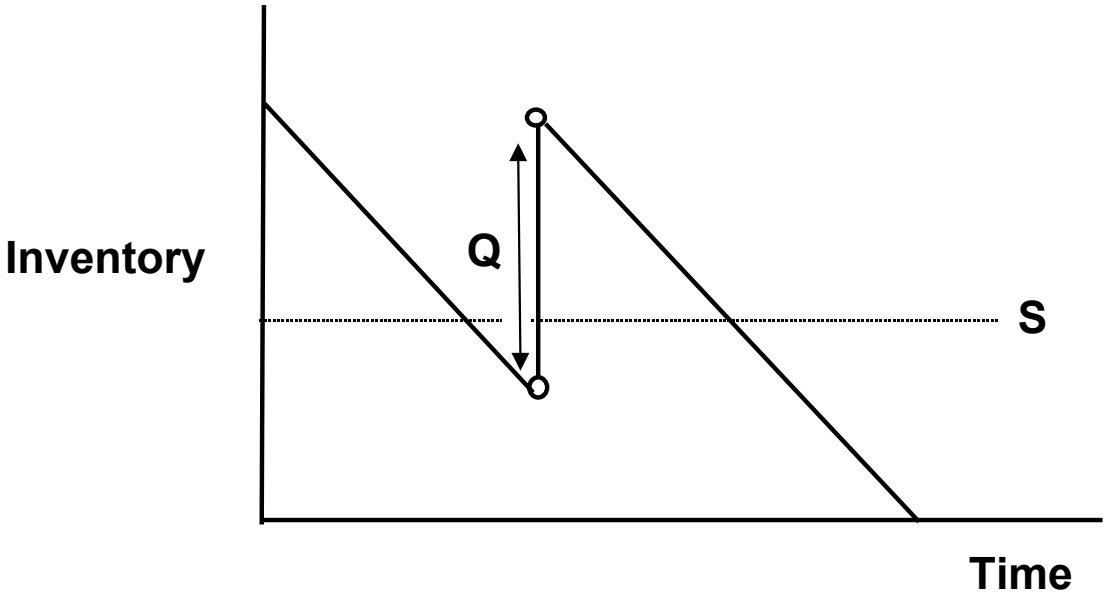
Just-In-Time Systems

- The fundamental idea is to keep very low inventories, so as to not generate high inventory costs, by receiving goods “exactly” when they are needed -- JIT -- to keep the assembly process going, or to have goods to sell to your customers, etc.
- Now if one is going to operate just-in-time systems and keep costs lower by having smaller inventories (and smaller rather than larger warehouses), *it requires a very reliable transportation mode*.

Shifting the Costs of Inventory

- Suppose you have Toyota receiving goods from a supplier on a JIT basis. Imagine that Toyota is this supplier's best customer.
- So from the supplier's main warehouse, he ships goods to Toyota several times per day because Toyota insists on just-in-time delivery.
- But, the supplier keeps some additional inventory in a warehouse close to Toyota in which he is carrying safety stock *"just-in-case"*.

Trigger Point Inventory System



The operating rule is: *When the inventory reaches 'S', reorder 'Q' items, where 'Q' is the reorder quantity*.

Figure 12.13

Total Logistics Costs (TLC)

Total Logistics Costs (TLC) =

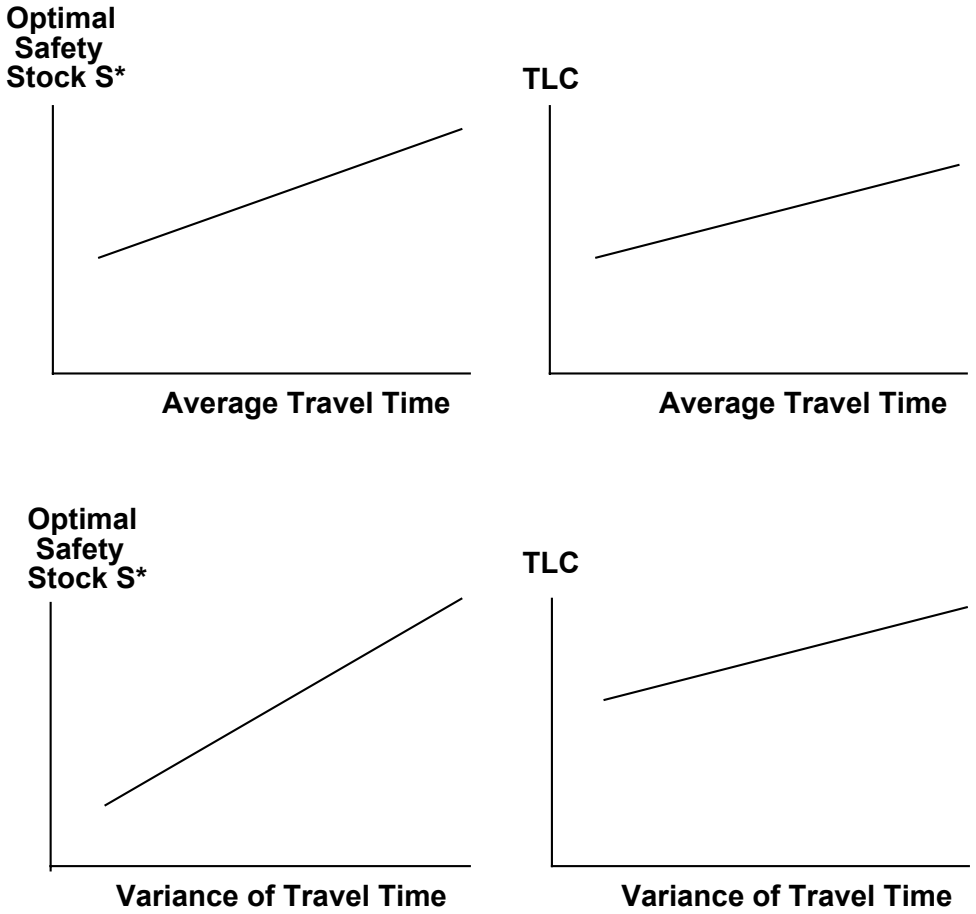
f (travel time distribution, inventory costs, stock-out costs, ordering costs, value of commodity, transportation rate, etc.)

Travel Time Distribution from Shipper to Receiver

- This probability density function defines how reliable a particular mode is.
- TLC is a function of the travel time distribution.
- As the average travel time and variance grows, larger inventories are needed.

Figure 12.14

TLC and Transportation LOS



Note that the above relationships are conceptual; they may not, in fact, be linear.

Figure 12.15

TLC and LOS of Transportation Service

- Why, as transportation people, are we interested in this analysis?
- It is because from these concepts *you can get a sense of what particular transportation services are worth to your customer*. You can *price* your different transportation services, if you have an estimate of what it is worth to your customer.

Market Segmentation (1)

- The recognition that a business has different kinds of customers who want various levels of service and want to pay a price commensurate with service quality.
- The transportation carrier is not providing service only to you, the umbrella retailer, but to the Toyota assembly plant and to a coal-burning power plant as well.
- The transportation company provides different services to all these businesses using the same infrastructure.
- Some of those services are of very high quality. High rates are charged for them; the transit time is fast; the variance of those transit times are low.
- The costs to the transportation company of providing this high-quality service is usually high.

Market Segmentation (2)

- Some customers more concerned with price of service than quality of service
- On the other hand, there is a set of services that are of poorer quality. Low rates are charged for them.
- The transit times tend to be long, and the variances tend to be high; but they are of lower cost for the transportation company to provide.
- There are customers that prefer the high-quality, high-price service, and those that prefer low-quality, low-price service.

Allocating Scarce Capacity

- Transportation companies need to allocate capacity (e.g., train capacity) among various customers with very different service requirements.
- Capacity is allocated among customers who require their high-quality service, for which they are willing to pay top dollar, and low-quality service for customers who do not want to pay so much.
- From a carrier viewpoint, the idea is to make a profit in each service class.

Other LOS Variables

- Loss and Damage
- Rate Structure
- Service Frequency
- Service Availability
- Equipment Availability and Suitability
- Shipment Size
- Information
- Flexibility