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

The Logistics Model: An Umbrella Store

- ◆ Ordering
- ◆ Transportation Costs
- ◆ Storage

Deterministic Use Rate and Delivery Time
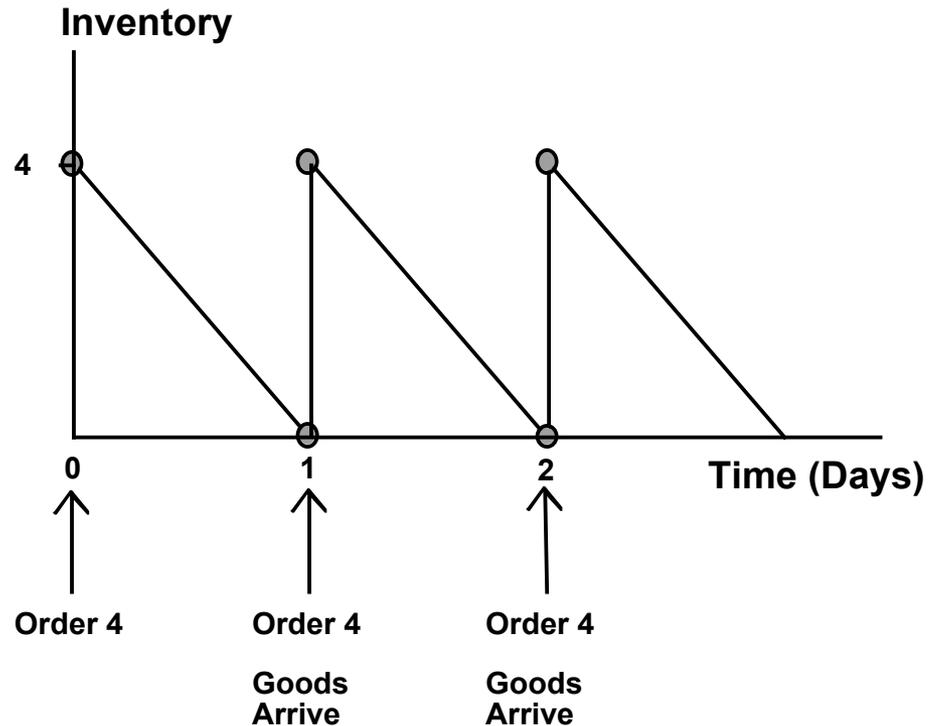
In-Store Inventory vs. Time

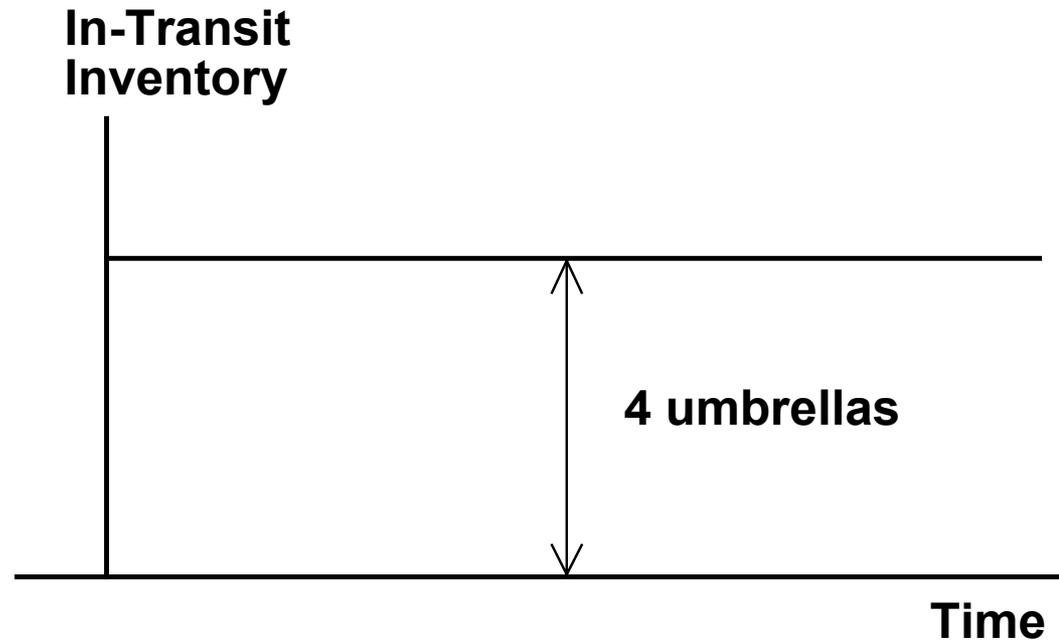Figure 12.2

In-Transit Inventory Pipeline

In-Transit Inventory

4 umbrellas

Time

Figure 12.3

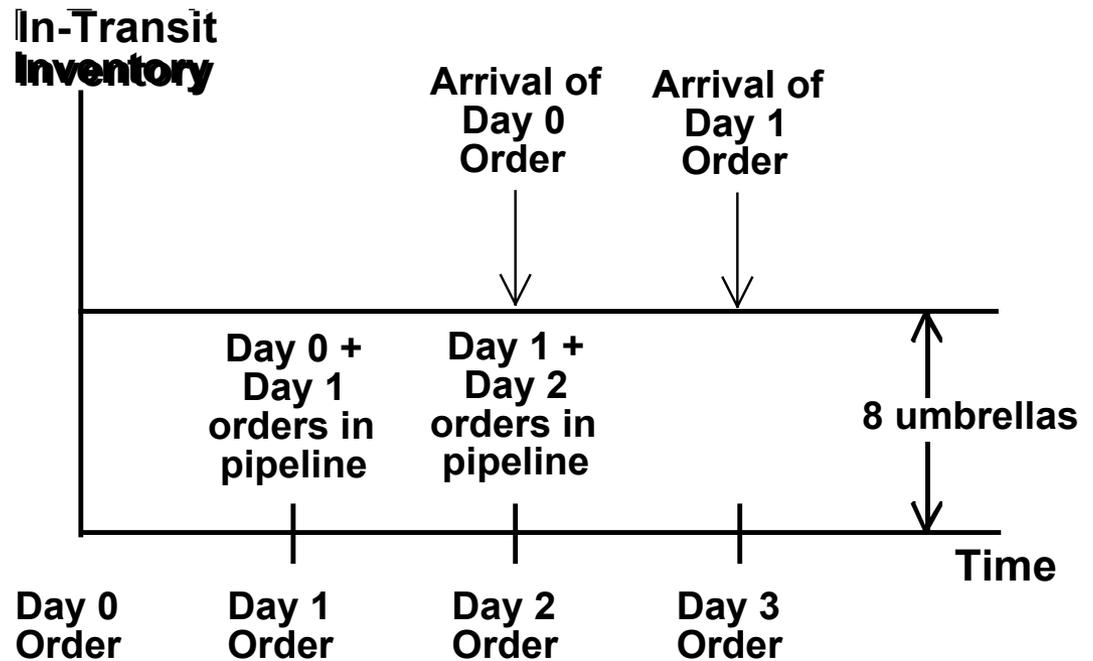# Order Pipeline, but with Longer Delivery Time

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.
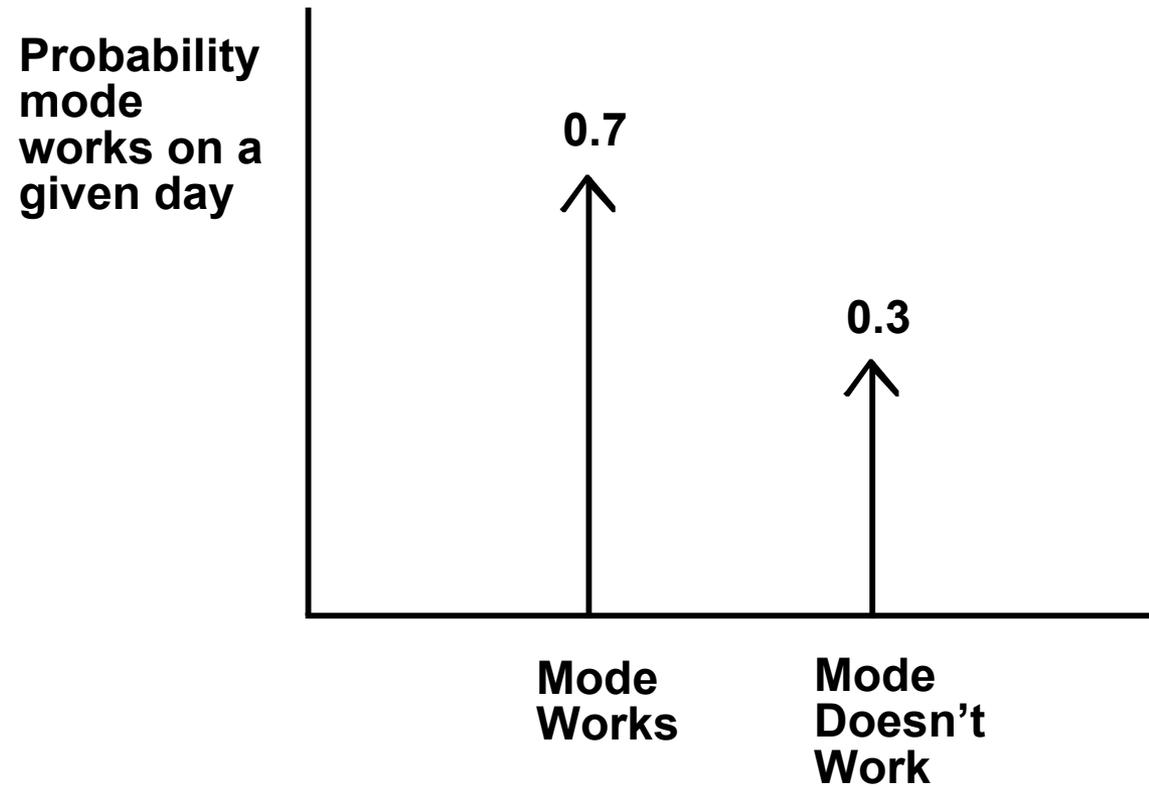
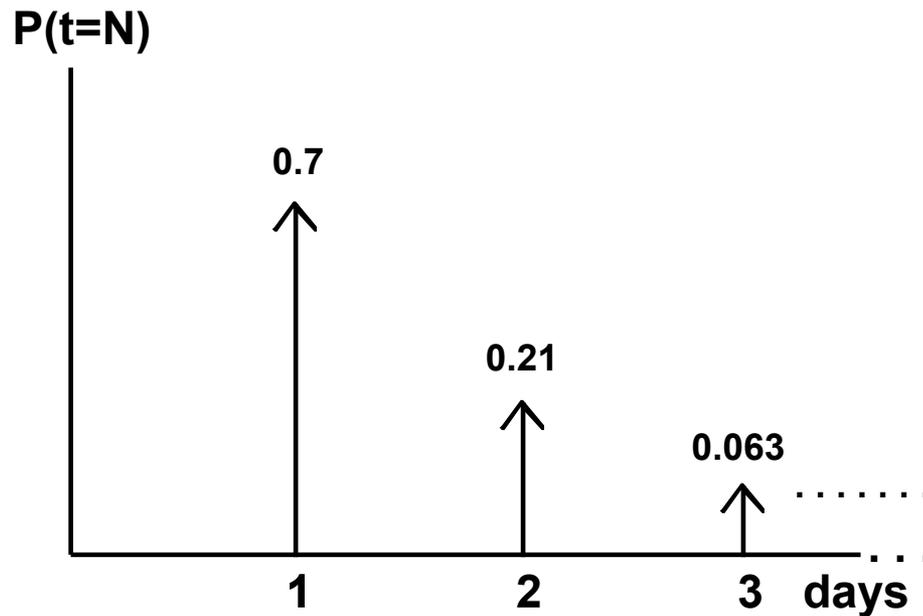# Unreliable Transportation Mode

Figure 12.5

Probability of Time until Delivery

P(t=N)

0.7

0.21

0.063

. . . .

. . . .

1   2   3   days

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?
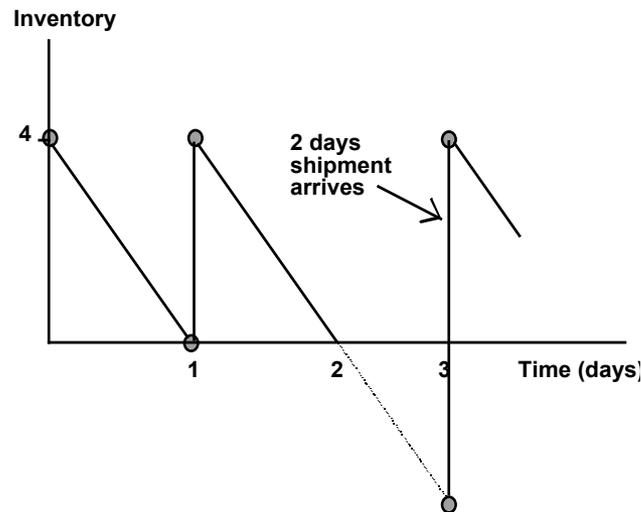
Backorders

Inventory

4

2 days
shipment
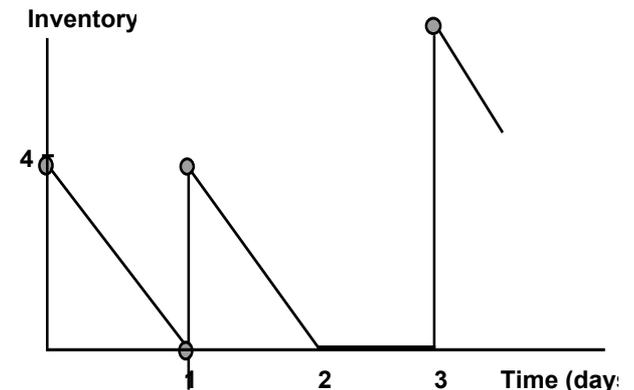arrives

1   2   3   Time (days)

Figure 12.7

No Backorders

Inventory

4

1   2   3   Time (days)

Figure 12.8

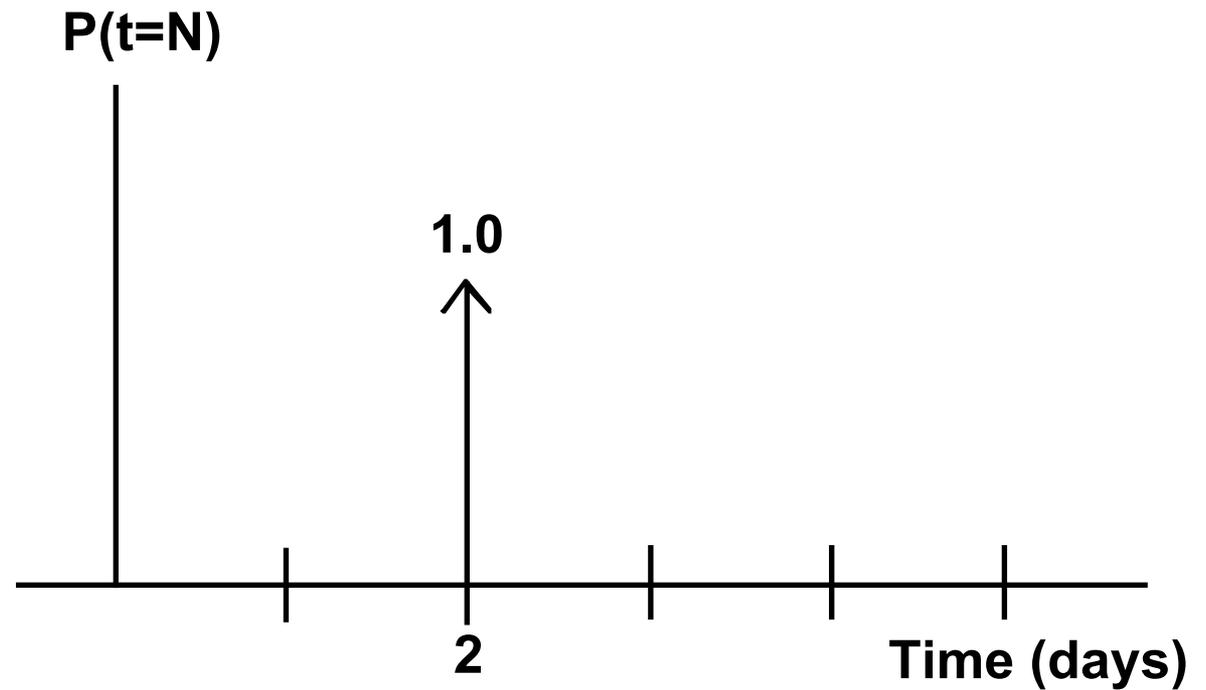# Deterministic Service

P(t=N)

1.0
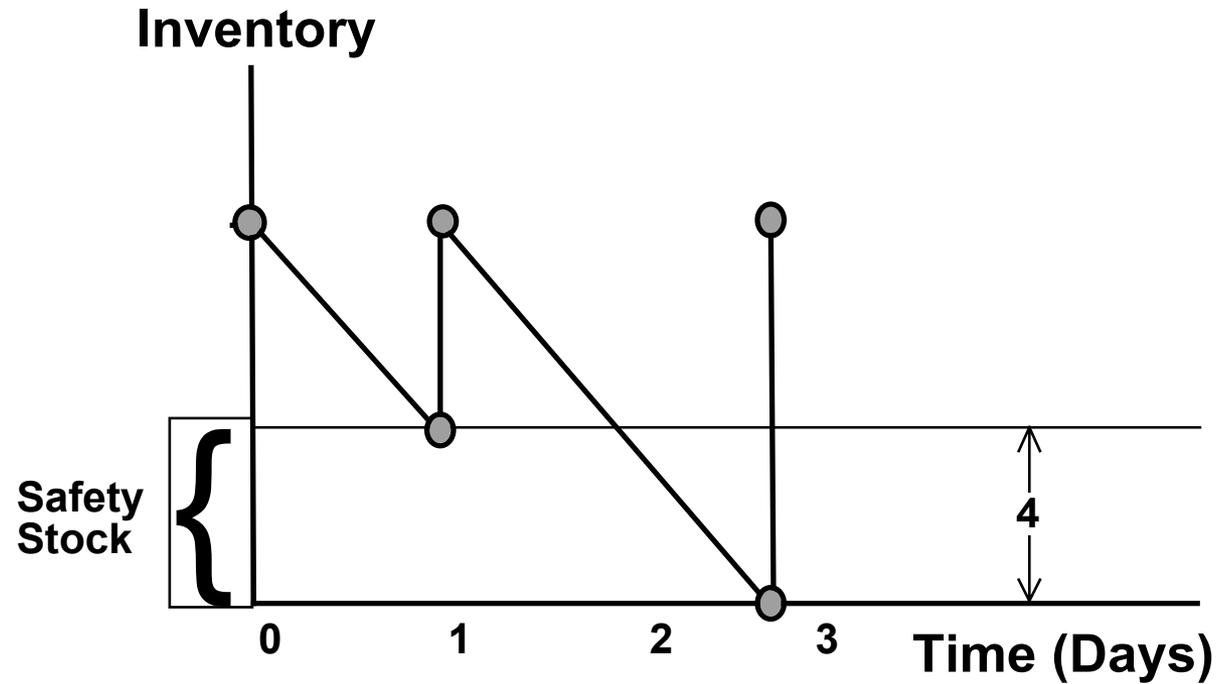
2

Time (days)

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
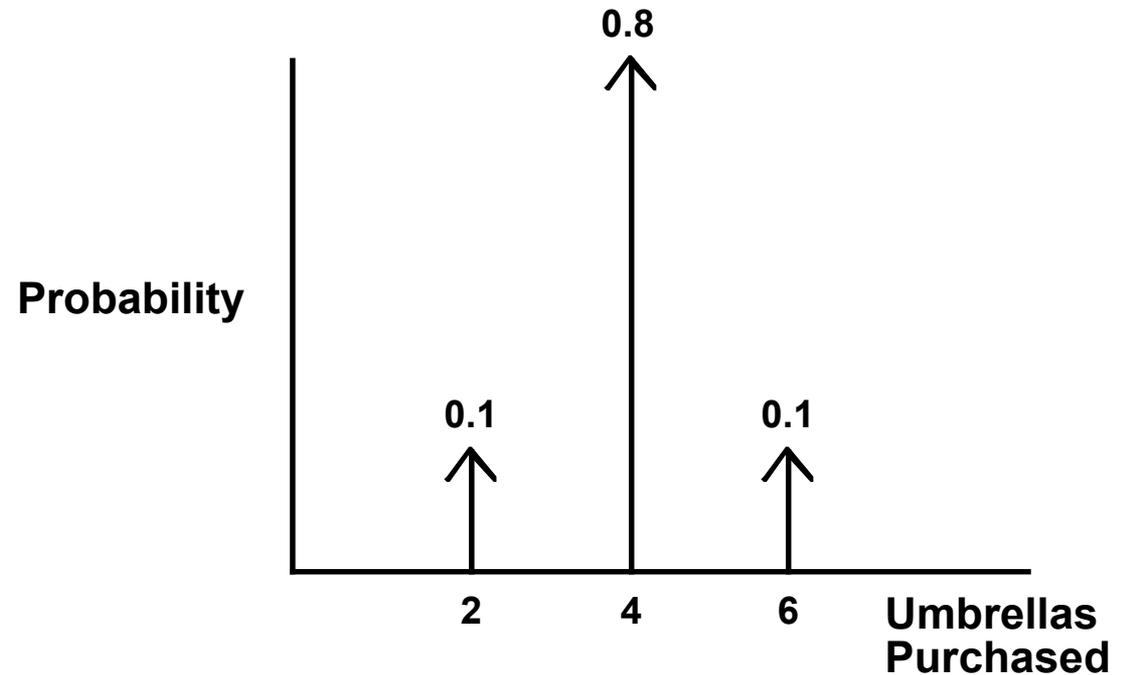

Figure 12.11

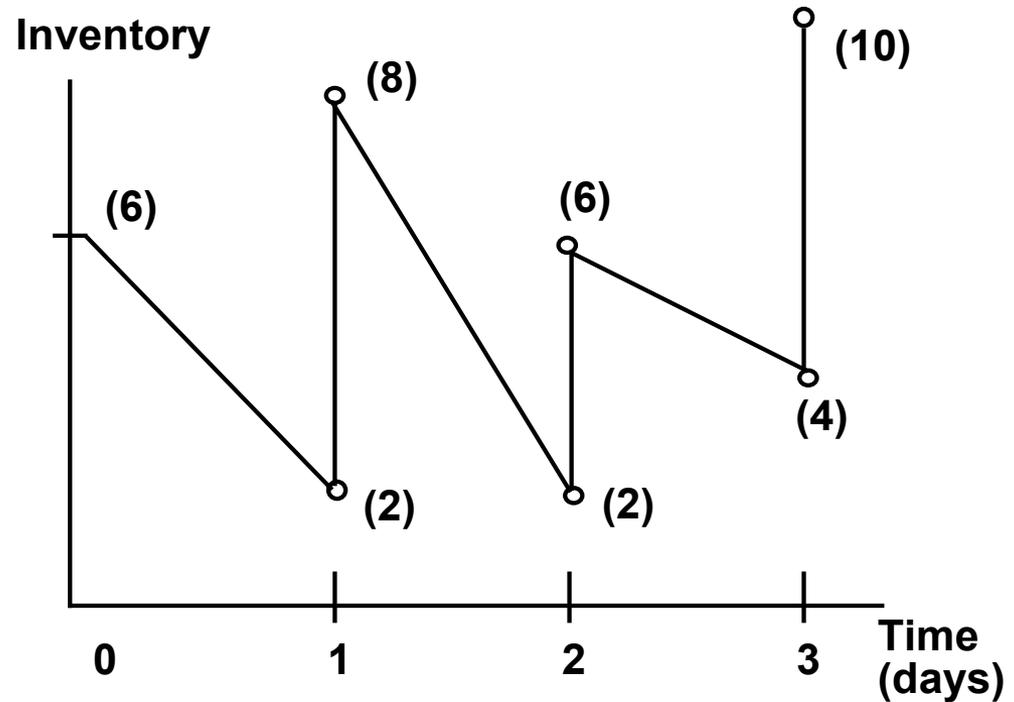# Inventory with Probabilistic Use Rate

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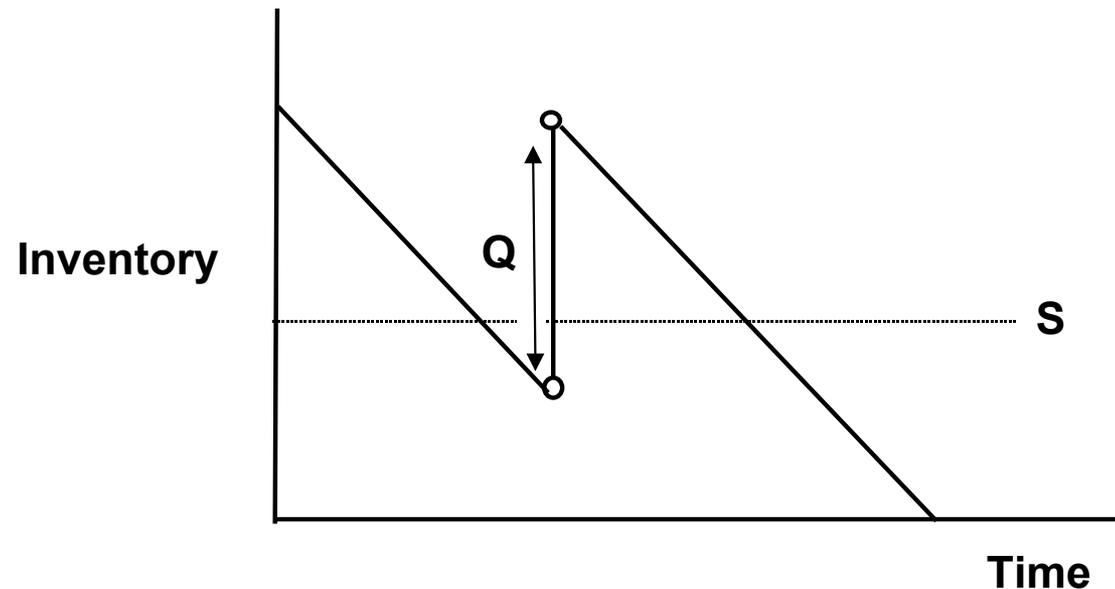
The operating rule is: *When the inventory reaches 'S', reorder 'Q' items, where 'Q' is the reorder quantity*.

Figure 12.13

22

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.)

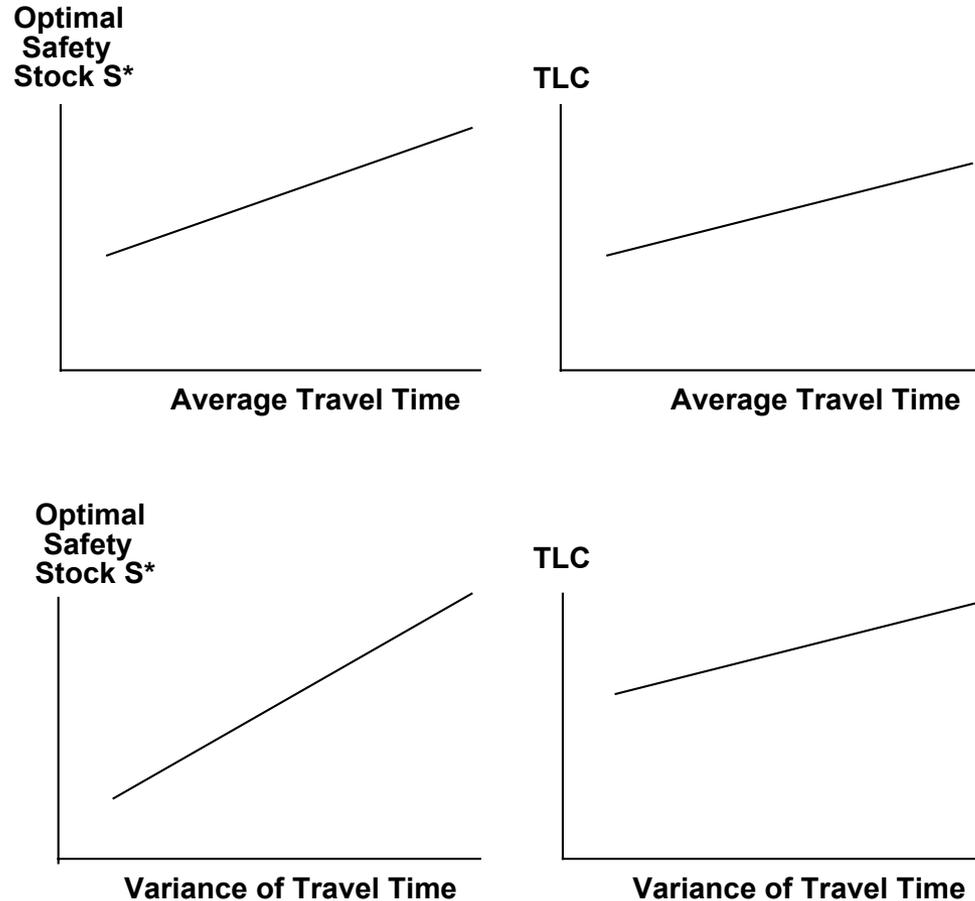# Travel Time Distribution from Shipper to Receiver

- ☞ 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