Logistics Management
Customer Service

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Customer Service Defined

- Customer service is generally presumed to be a means by which companies attempt to differentiate their product, keep customers loyal, increase sales, and improve profits.
- Its elements are:
  - Price
  - Product quality
  - Service
- It is an integral part of the marketing mix of:
  - Price
  - Product
  - Promotion
  - Physical Distribution
- Relative importance of service elements
  - Physical distribution variables dominate price, product, and promotional considerations as customer service considerations
  - Product availability and order cycle time are dominant physical distribution variables

Customer Service Elements

Customer service

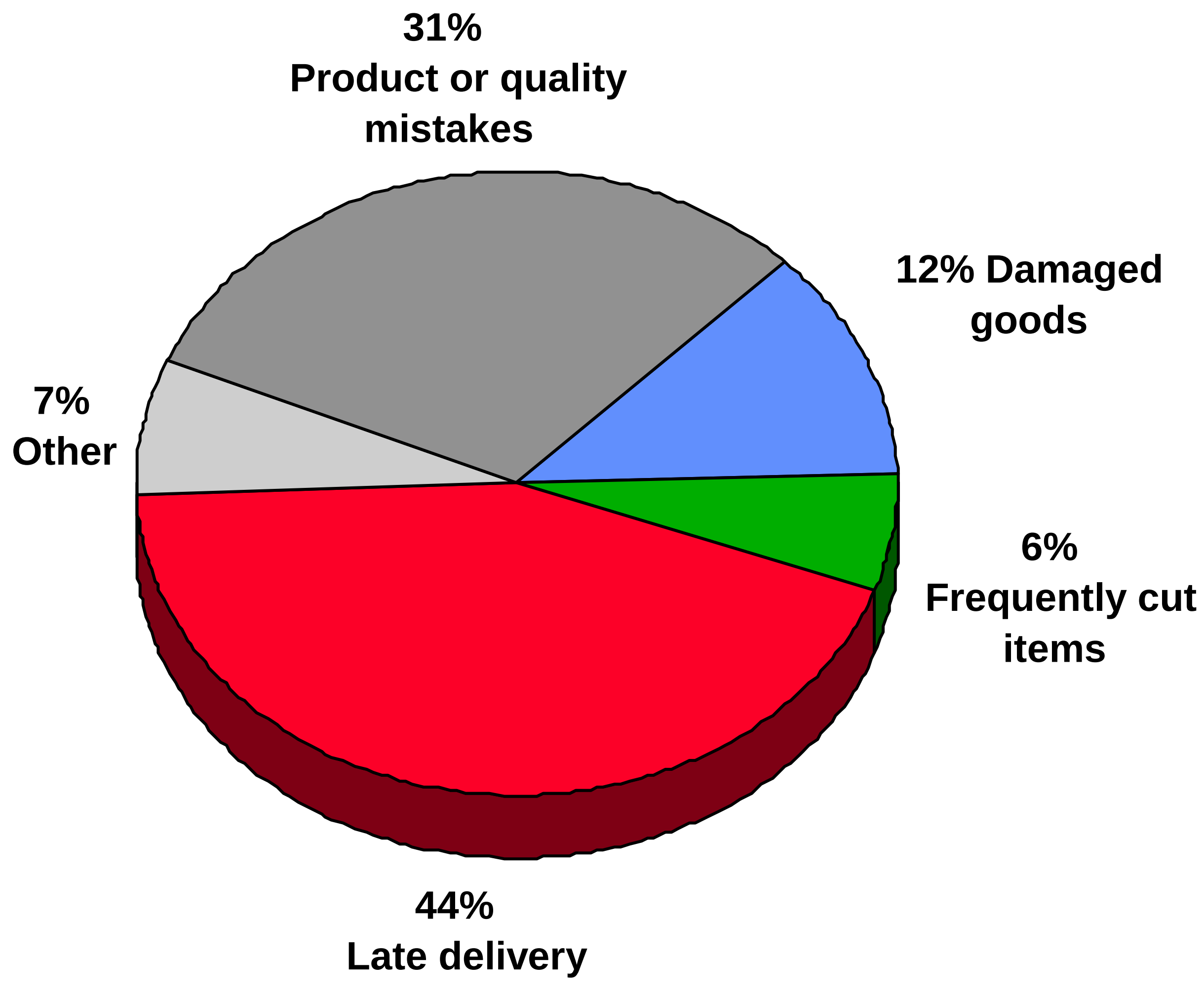
Pretransaction elements
- Written statement of policy
- Statement in hands of customer
- Organizational structure
- System flexibility
- Technical services

Transaction elements

Stockout level
- Ability to back order
- Elements of order cycle
- Time
- Transship
- System accuracy
- Order conveniences
- Product substitution

Posttransaction elements
- Installation, warranty alterations, repairs, parts
- Product tracking
- Customer claims, complaints
- Product packaging
- Temporary replacement of product during repairs

Common Customer Service Complaints



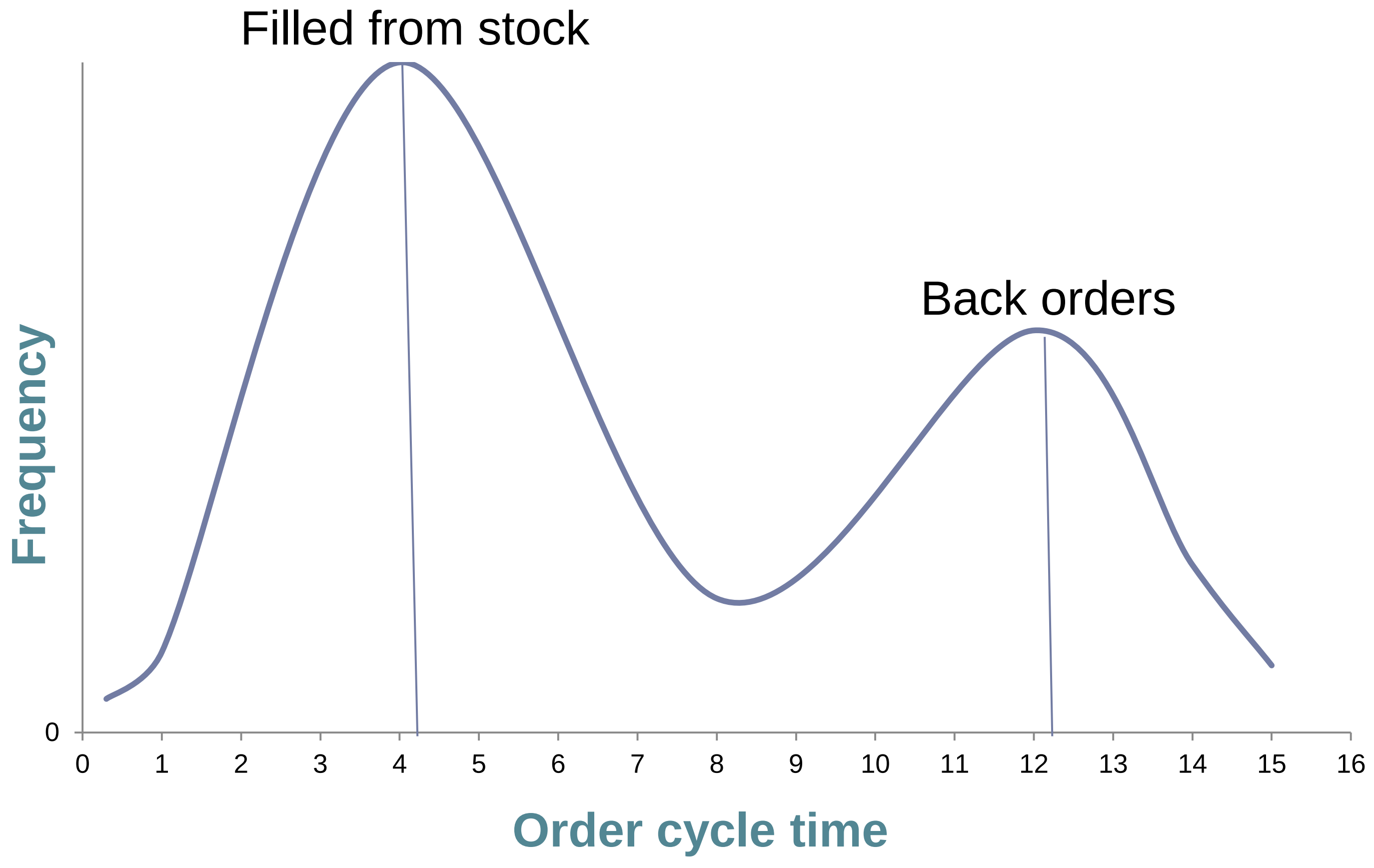
Most Important Customer Service Elements

- On-time delivery
- Order fill rate
- Product condition
- Accurate documentation

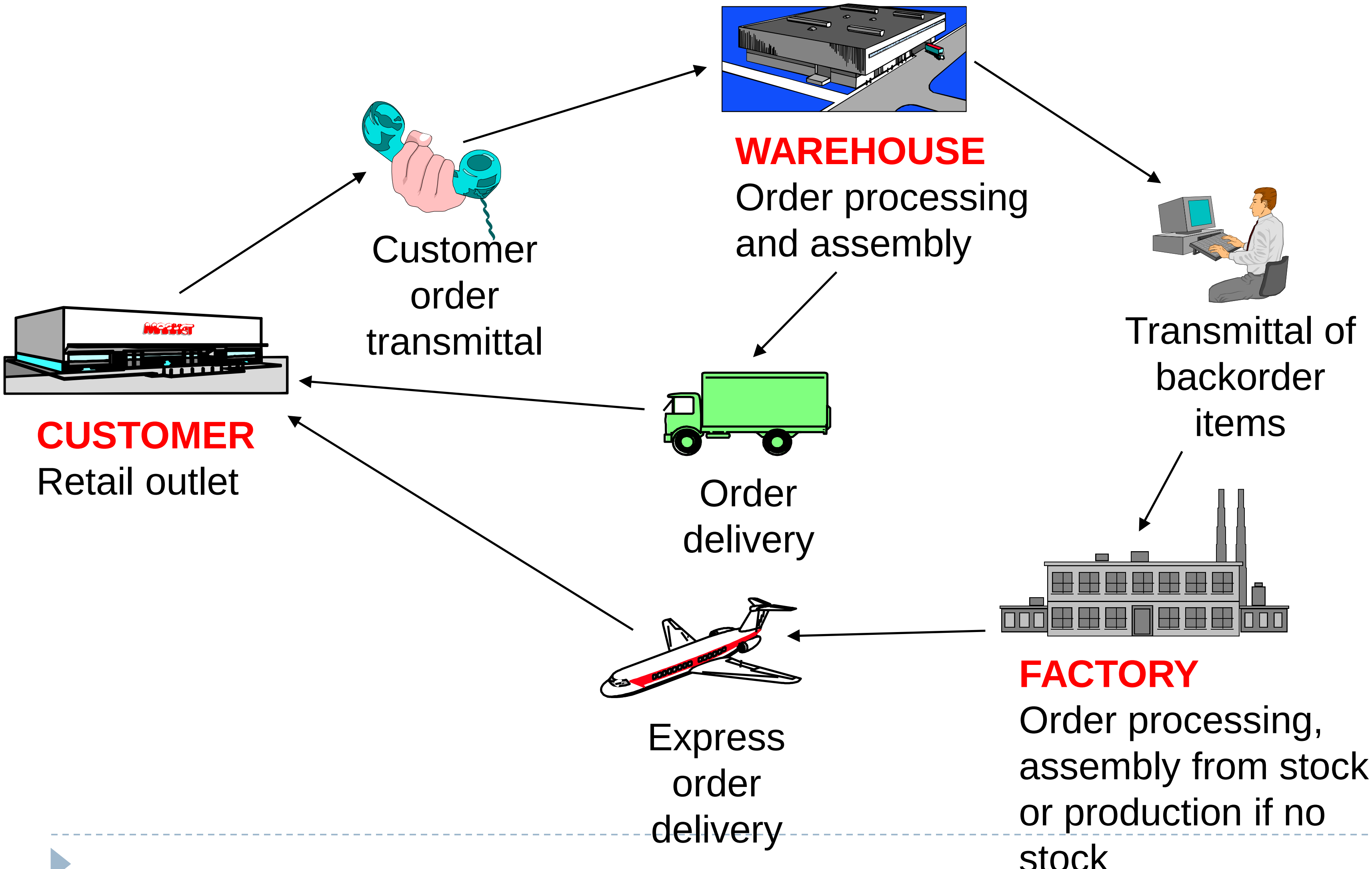
Order Cycle Time

- Order cycle time contains the basic elements of customer service where logistics customer service is defined as:
  - the time elapsed between when a customer order, purchase order, or service request is placed by a customer and when it is received by that customer.
- Order cycle elements
  - Transport time
  - Order transmittal time
  - Order processing and assembly time
  - Production time
  - Stock availability
- Constraints on order cycle time
  - Order processing priorities
  - Order condition standards (e.g., damage and filling accuracy)
  - Order constraints (e.g., size minimum and placement schedule)
- Order cycle time is expressed as a bimodal frequency distribution

Order Cycle Time Frequency Distribution of



Components of a Customer Order Cycle



Importance of Logistics Customer Service

- Service affects sales
- From a GTE/Sylvania study:
  - ...distribution, when it provides the proper levels of service to meet customer needs, can lead directly to increased sales, increased market share, and ultimately to increased profit contribution and growth.
  - Service differences have been shown to account for 5 to 6% variation in supplier sales
- Service affects customer patronage
  - Service plays a critical role in maintaining the customer base:
  - On the average it is approximately 6 times more expensive to develop a new customer than it is to keep a current one.

Service Observations

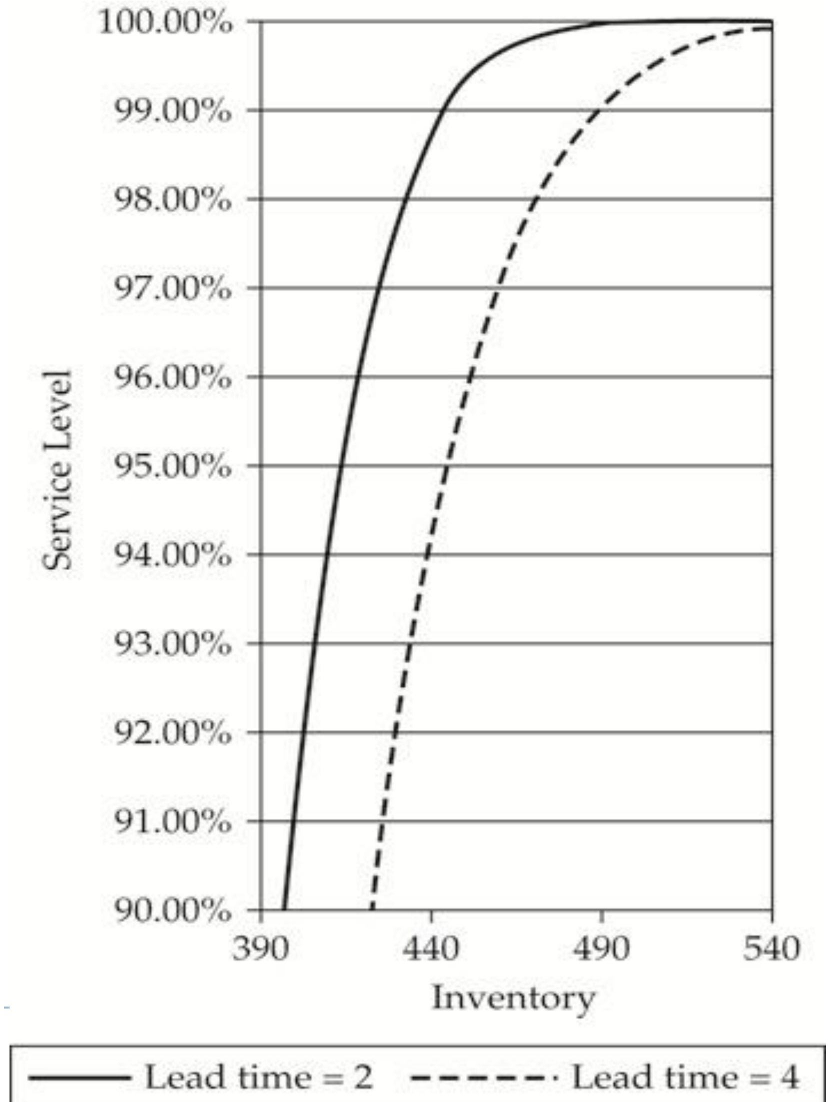
- The dominant customer service elements are logistical in nature
- Late delivery is the most common service complaint and speed of delivery is the most important service element
- The penalty for service failure is primarily reduced patronage, i.e., lost sales
- The logistics customer service effect on sales is difficult to determine

Service Level Optimization

- Optimal inventory policy assumes a specific service level target.
- What is the appropriate level of service?
  - May be determined by the downstream customer
    - Retailer may require the supplier, to maintain a specific service level
    - Supplier will use that target to manage its own inventory
  - Facility may have the flexibility to choose the appropriate level of service

Service Level Optimization

- Service level inventory versus inventory level as a function of lead time



Trade-Offs

- Everything else being equal:
  - the higher the service level, the higher the inventory level.
  - for the same inventory level, the longer the lead time to the facility, the lower the level of service provided by the facility.
  - the lower the inventory level, the higher the impact of a unit of inventory on service level and hence on expected profit

Steps to Follows in Determining the Service Standards

Step 1) Understanding the customer's business

Step 2) Understanding who represents the customer

Step 3) Asking the representatives to express their requirements

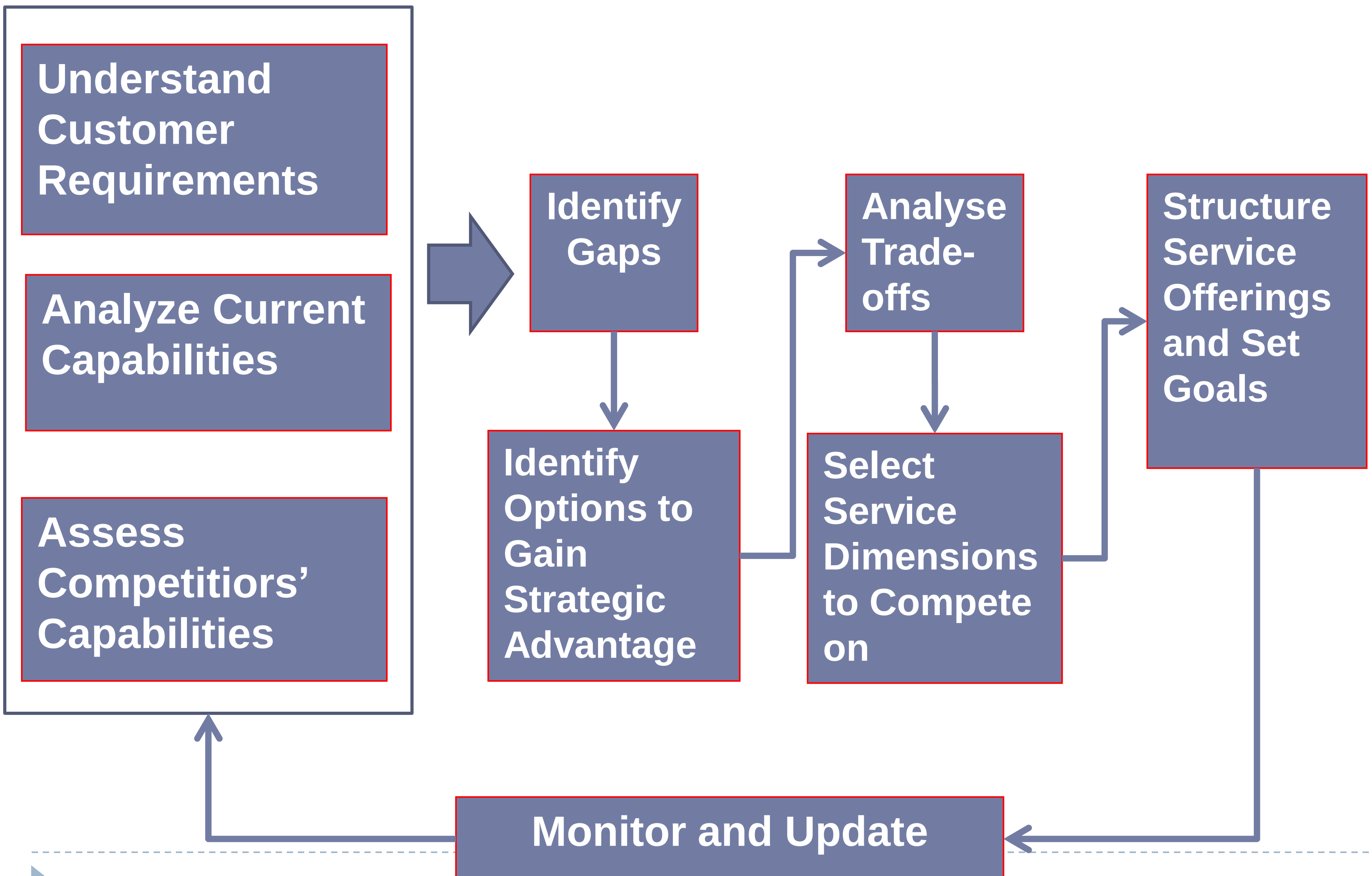
Methods of Identifying Requirements

- Interview approach
- Outside research firms or consultants
- Telephone and mail surveys
- Focus groups
- Using current performance and “noise levels”
- Benchmarking

Understanding Requirements of the Order Fulfillment Process

Ordering process	→ Delivery cycle	→ Order Receipt and follow-up
Ease of order placement and timely information	**Timely, reliable delivery with good communication**	**Accurate, complete undamaged orders with prompt claims handling and accurate invoices**
▪Direct order transmission	▪Order acknowledgement (including quantities to be shipped)	▪Order completeness
▪Product availability information	▪Total order cycle time	▪Accurate invoicing
▪Product Technical information	▪Order cycle consistency	▪Accurate shipping documents
▪Pricing information	▪Delivery on day requested	▪Damage free delivery
▪Credit check information	▪Communication of order status	▪Prompt handling of claims

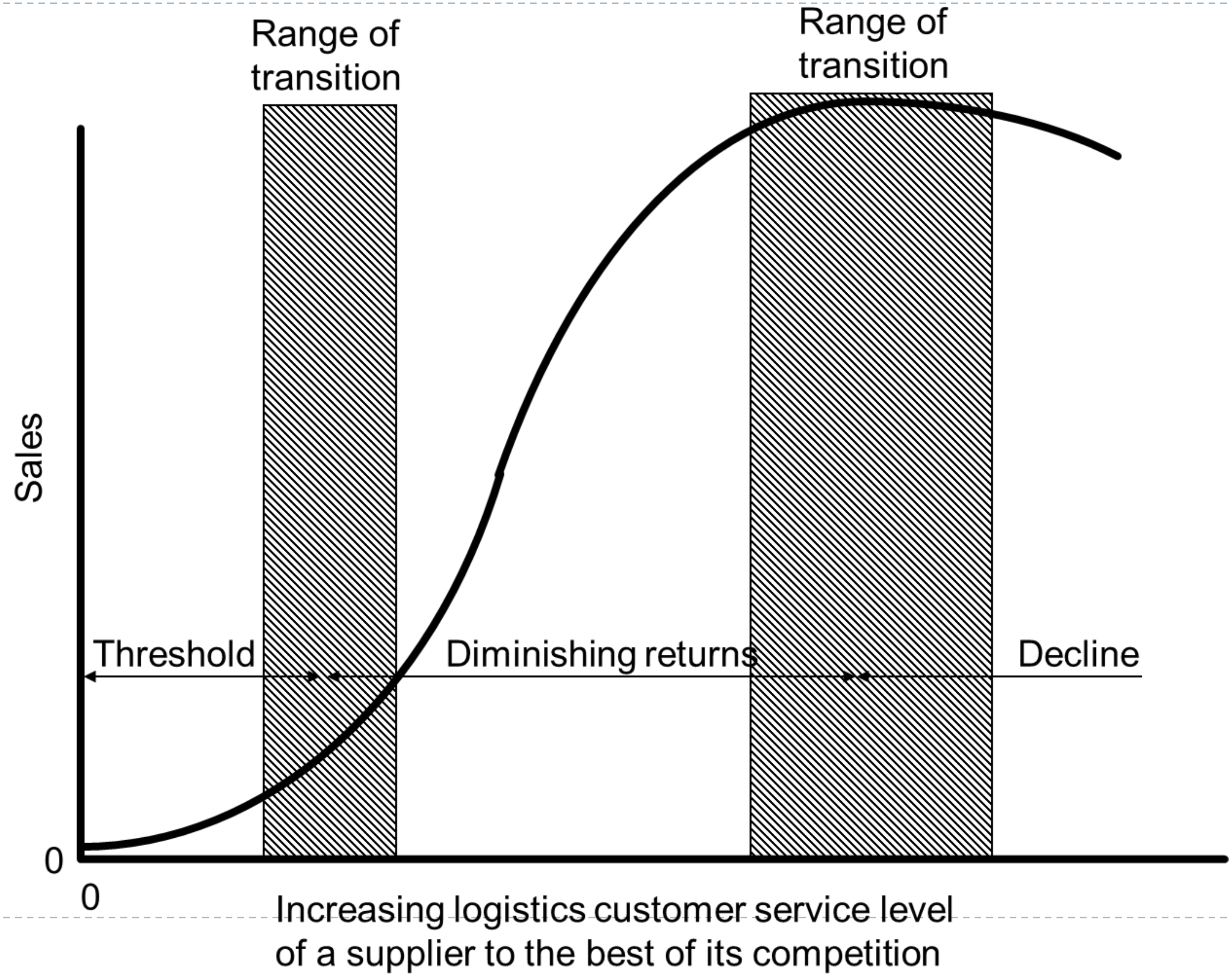
Framework For Developing A Service Strategy



Steps to Follows in Determining the Service Standards

- Step 4: Analyse current capabilities
- Step 5: Analyse competitors’ capabilities
- Step 6: Identify gaps
- Step 7: Identify option to gain strategic advantage
- Step 8: Interpreting what the customer wants and is willing to pay for and analyse trade-offs

Sales-Service Relationship



- Step 8: Interpreting what the customer wants and is willing to pay for and analyse trade-off

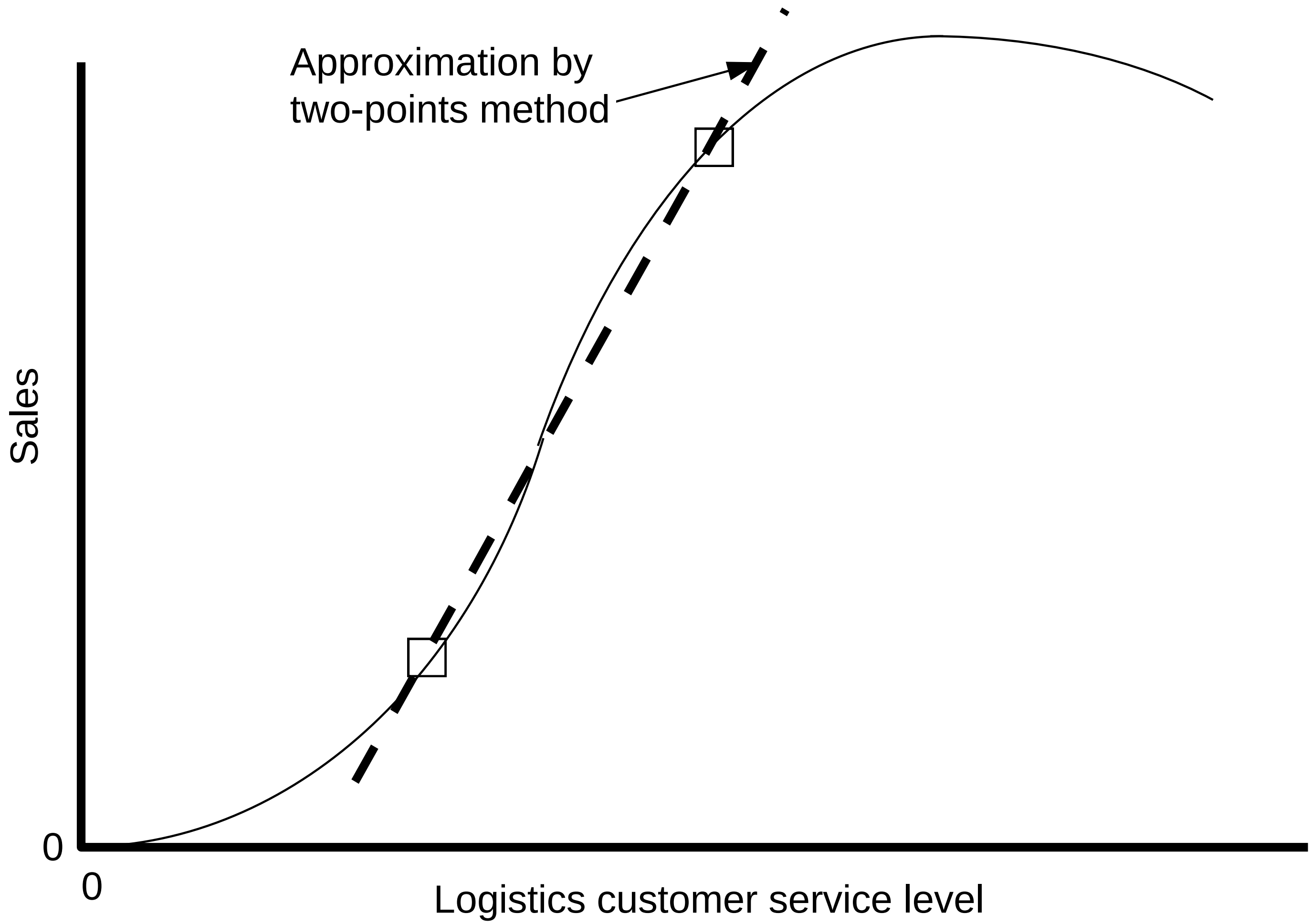
  - A mathematical expression of the level of service provided and the revenue generated

  - It is needed to find the optimal service level

  - A theoretical basis for the relationship

  - Methods for determining the curve in practice
    - Two-points method
    - Before-after experiments
    - Game playing
    - Buyer surveys

Sales-Service Relationship by the Two-Points Method

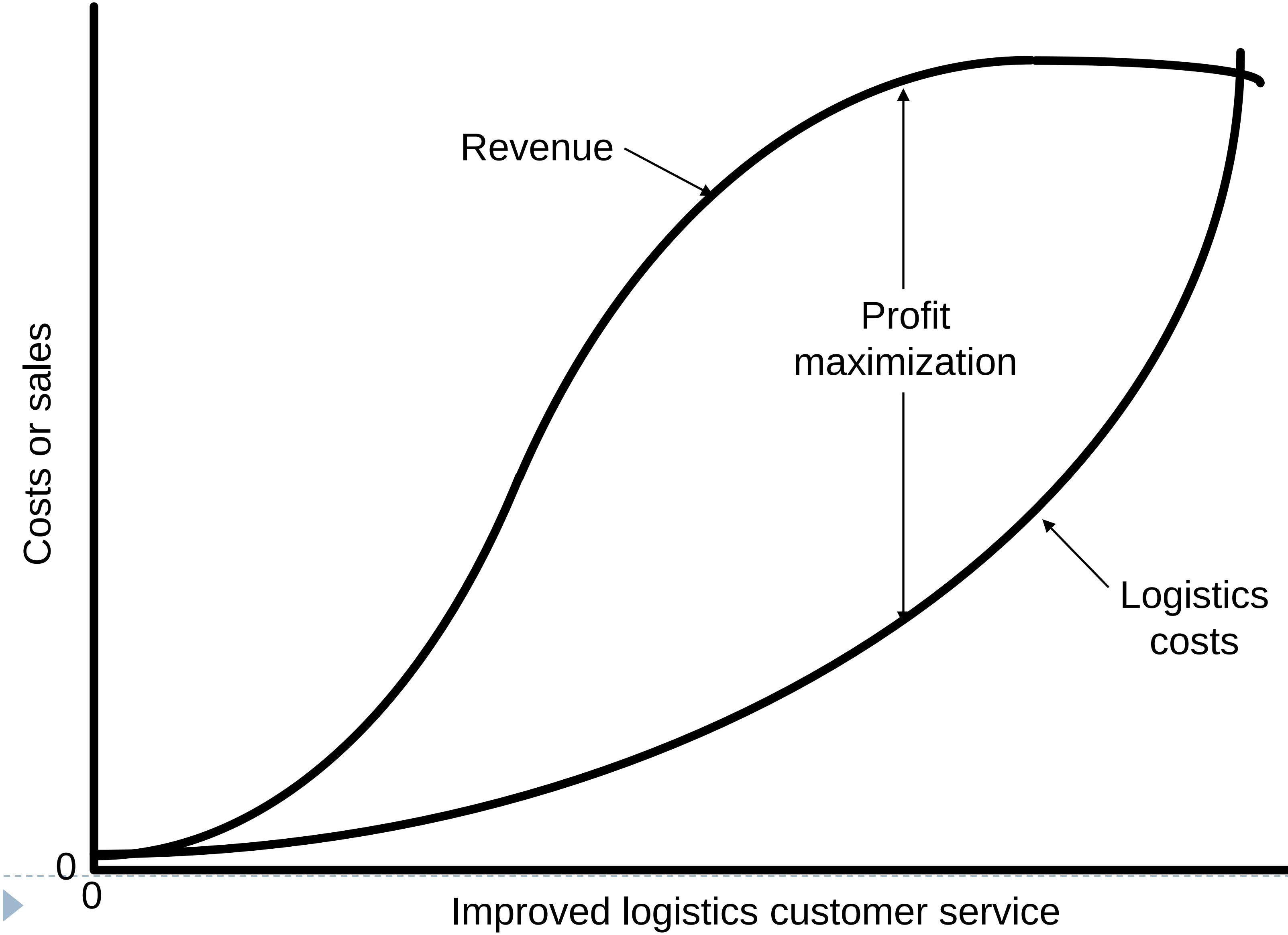


Determining Optimum Service Levels

- Cost vs. Service

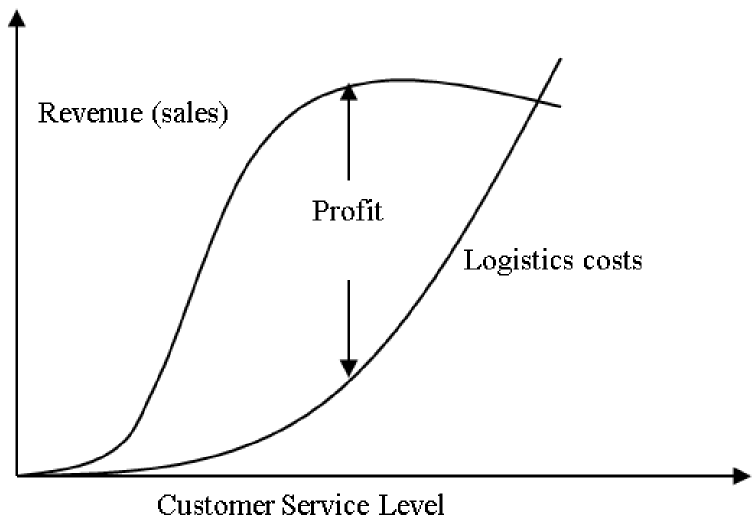
- Theory
- Optimum profit is the point where profit contribution equals marginal cost

Generalized Cost-Revenue Tradeoffs



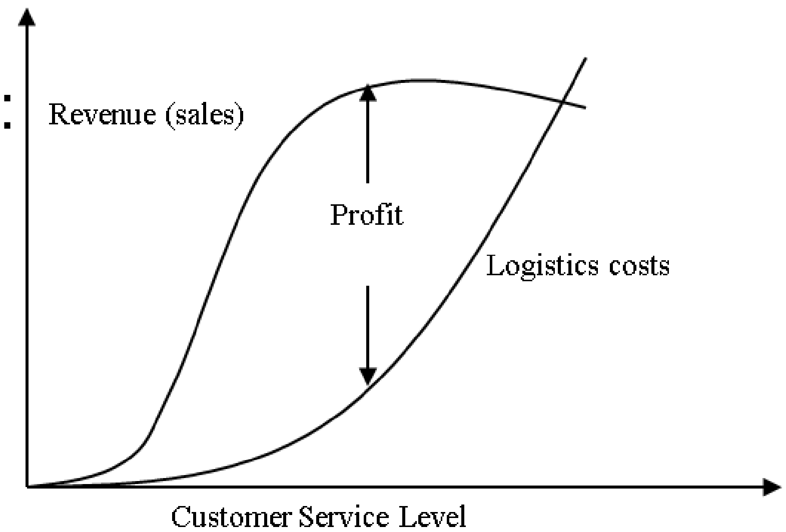
Cost vs. Service Models

- Since the objective of the logistics organization is to maximize profit, we can then attempt to establish an equation for profit, which is a function of customer service level, SL.
- We can approximate the above curves by simple functional equations. If we let R denote revenue, suppose that an approximate equation for revenue as a function of service level is given by the equation:
- $R = K\sqrt{SL}$



Cost vs. Service Models

- Suppose now that since the equation for cost appears parabolic, we relate logistics costs C to service level through the equation:



- $C = k*SL^2$,
  - where k is also a constant.
- Our objective is then to maximize
- $P = R – C$.
- To find the maximum point we can differentiate P with respect to SL and set the result equal to zero.

EXAMPLE

- In order to find the service level of a company, the revenue and logistics costs related to three different service levels are identified as in the Table.
- If the revenue and cost functions are in the form of following, find the optimum service level.
- $R = K\sqrt{SL}$
- $C = k*SL^2$,

SL	Revenue (1000TL)	Logistics Cost (1000 TL)
0,3	30	3
0,6	42	10
0,8	48	20

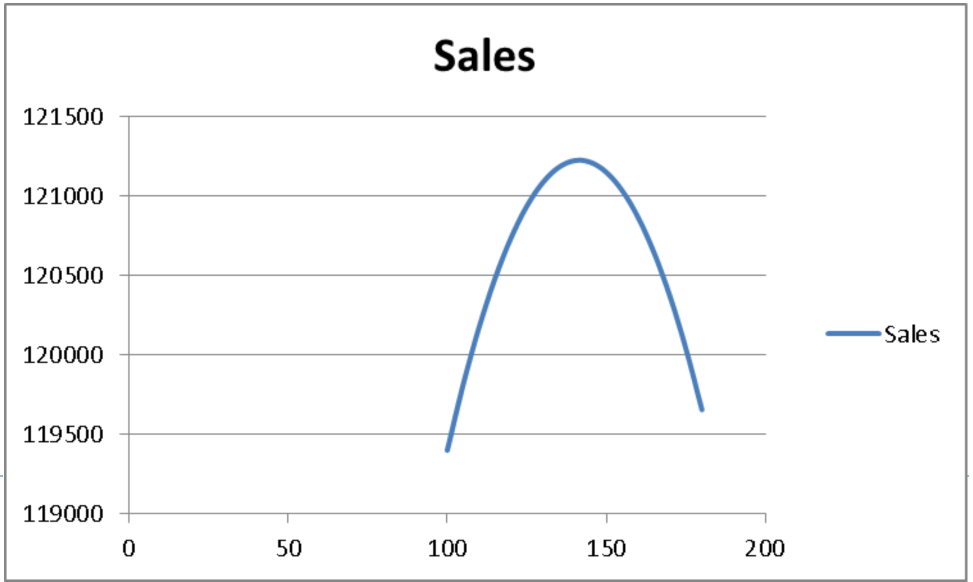
Use Exel Grafics to predict K and k.

Cost vs. Service Models

- **Polynomial Equations**
- **A polynomial** is an equation that has only two variables (X and Y), but may have many terms on the right-hand-side.
  - $Y = a_0 + a_1X + a_2X^2 + \ldots + a_nX^n$
  - When the highest power of X is n, the polynomial is said to be **of order n**..
  - A polynomial of order 2 is xcalled **quadratic equation** $Y = a_0 + a_1X + a_2 X^2$

Cost vs. Service Models

- **Polynomial Equations**
  - Consider the following model for sales (S) as a function of logistics service expenditures (A)
- $S = 100,000 + 300A – 1.06 A^2$
- Let suppose that the objective is to maximize this equation-i.e maximize sales(S).



Cost vs. Service Models

- **Power Equations**
- **Power equations** have one term on the right-hand side-a variable raised to some power.
  - General power equation: $Y=aX^{b}$

- The **learning curve** is an interesting application of power equations. This application stems from the many business situations where it takes time to learn to perform a task-.the onger the task is performed, the better the performance.Output=a(Input)b

Cost vs. Service Models

- Practice
  - For a constant rate,
  - ΔR = trading margin × sales response rate × annual sales
  - ΔC = annual carrying cost × standard product cost × demand standard deviation over replenishment lead-time × Δz
  - Set $\Delta R = \Delta C$ and find Δz corresponding to a specific service level

Cost vs. Service Models
Example - Determining optimum service level

- Given the following data for a particular product
  - Sales response rate = 0.15% change in revenue for a 1% change in the service level (fill rate)
  - Trading margin = $0.75 per case
  - Carrying cost = 25% per year
  - Annual sales through the warehouse = 80,000 case
  - Standard product cost = $10.00
  - Demand standard deviation = 500 cases over LT
  - Lead time = 1 week

Cost vs. Service Models
Example - Determining optimum service level

- Find ΔR
  - $\Delta R = 0.75 \times 0.0015 \times 80{,}000$

    = \$90.00 per year
- Find ΔC
  - $\Delta C = 0.25 \times 10.00 \times 500 \times \Delta z$

    $= 1250\,\Delta z$

- Set $\Delta R = \Delta C$ and solve for Δz, i.e., $90.00/1250 = \Delta z$

  $\Delta z = 0.072$
- For the change in z found in a normal distribution table, the optimal in-stock probability during the lead time (*SL**) is about 92%.

Cost vs. Service Models
Example - Determining optimum service level

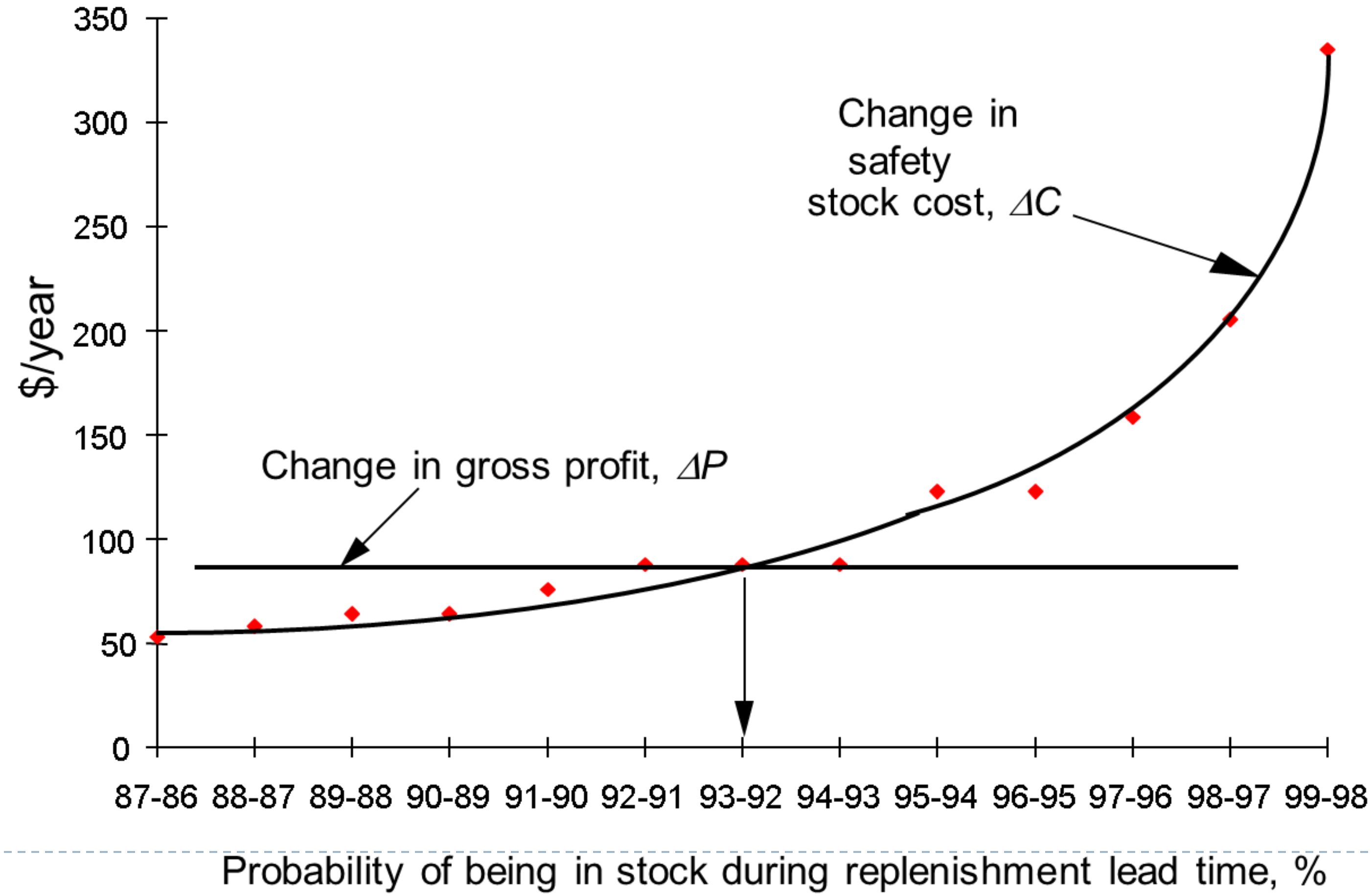
- ΔSL Levels in % for Various Δz Values

ΔSL (%) U L	z_U − z_L	=	Δz
87-86	1.125-1.08	=	0.045
88-87	1.17 -1.125	=	0.045
89-88	1.23 -1.17	=	0.05
90-89	1.28 -1.23	=	0.05
91-90	1.34 -1.28	=	0.06
92-91	1.41 -1.34	=	0.07 ⇐
93-92	**1.48 -1.41**	**=**	**0.07 ⇐**
94-93	1.55 -1.48	=	0.07 ⇐
95-94	1.65 -1.55	=	0.10
96-95	1.75 -1.65	=	0.10
97-96	1.88 -1.75	=	0.13
98-97	2.05 -1.88	=	0.17
99-98	2.33 -2.05	=	0.28

*Developed from entries in a normal distribution table

Cost vs. Service Models
Example - Determining optimum service level

- Graphically Setting the Service Level



Service as a Loss Function

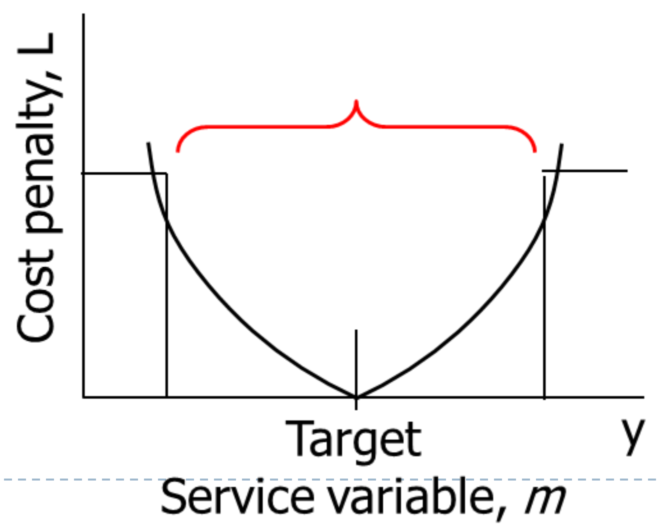
- Genichi Taguchi developed modeling techniques in the area of statistical quality control, one of which can be used to analyze costs of customer service.
  - *m* known and quantifiable target level of customer service
  - *y* denote the measured level of customer service
  - *L* denote the loss (or cost) due to not meeting our desired level

$$L = k(y - m)^2.$$

    - (k is a constant that is a function of the financial importance of the service level measure.)
  - Loss is a quadratic function that penalizes us equally whether we miss m by x units on the high or low side.
  - That is, if we provide too high a level of customer service it requires our costs to increase as significantly as if we provide too low a level.

Optimizing on Service Performance Variability

- Setting service variability according to Taguchi
- A loss function of the form
  - *L* = loss in $
  - *k* = a constant to be determined
  - *y* = value of the service variable
  - *m* = the target value of the service variable



Optimizing on Service Performance Variability

- Setting the allowable deviation from the target service level m is to optimize the sum of penalty cost for not meeting the service target and the cost of producing the service.
  - TC = service penalty cost + service delivery cost

- If the service delivery cost is of the general form
  - DC = A - B(y-m),
  - find the optimum allowed deviation from the service target.

$$TC = k(y-m)^2 + A - B(y-m)$$

$$\frac{dTC}{d(y-m)} = 2k(y-m) + 0 - B = 0$$

$$y - m = \frac{B}{2k}$$

If m is set to 0, y is the optimal deviation allowed from target

Service Variability Example

- Pizzas are to be delivered in 30 minutes (target.) Pizzas delivered more than 10 minutes late incur a penalty of $3 off the pizza bill. Delivery costs are estimated at $2, but ***decline*** at the rate of $0.15 for each minute deviation from target. How much variation should be allowed in the delivery service?

Find k

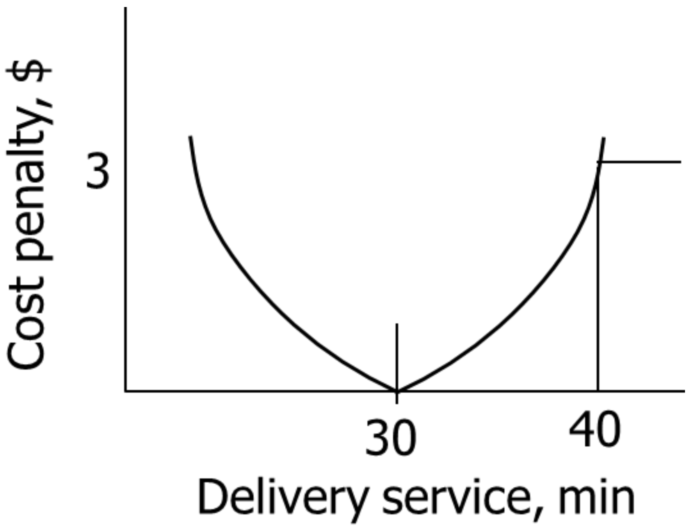
$$L = k(y - m)^2$$

$$3 = k(10 - 0)^2$$

$$k = \frac{3}{10^2} = 0.03$$

and y if m is taken as 0

$$y - 0 = \frac{0.15}{2(0.03)} = 2.5 \text{ minutes}$$



- No more than 2.5 minutes should be allowed from the 30-minute delivery target to minimize cost.

Service as a Constraint

- Practitioners often find these constants, such as k and K, difficult to quantify, since we don't know exactly how customers will react to poor service. For this reason we often find *constraints* on service levels implemented in practice, e.g., the firm targets a level of no more than 2% stockouts per period or specifies 99% of orders are received within 1 week of order placement. This gives alternatives when creating an optimization model with respect to system costs or profits:
  - Either we create a term in our objective function that captures cost as a function of service level, or
  - We create constraints that require our decision variables to satisfy a certain minimum level of service.

Optimal Cycle Service Level

Seasonal Items with a Single Order in a Season

- We focus on attention on seasonal products such as ski jackets;
  - All leftover items must be disposed of at the end of the season

p	=	**sale price**
s	=	**outlet or salvage price**
c	=	**purchase price**
O^*	=	**optimal order size**
CSL^*	=	**optimal cycle service level = probability (demand ≤ O^*)**

C_o: Cost of overstoking by one unit, $C_o = c - s$

C_u: Cost of understocking by one unit, $C_u = p - c$

Estimating Optimal Level of Product Availability
Buyers' Estimate of Demand Distribution at L.L. Bean

Demand [100s]	Probabability	Probability of demand being this much or less	Probability of demand being greater than this much
4	.01	.01	.99
5	.02	.03	.97
6	.04	.07	.93
7	.08	.15	.85
8	.09	.24	.76
9	.11	.35	.65
10	.16	.51	.49
11	.20	.71	.29
12	.11	.82	.18
13	.10	.92	.08
14	.04	.96	.04
15	.02	.98	.02
16	.01	.99	.01
17	.01	1.00	.00

Expected Demand = 1,026 Parkas

Estimating Optimal Level of Product Availability

Cost of Over- and Understocking at L.L Bean

Cost per parka = *c* = $45

Sale price per parka = *p* = $100

Discount price per parka = $50

Holding and transportation cost = $10

Salvage value = *s* = $50-$10 = $40

- **Profit from selling parka = C_u = p-c = $100-$45 = $55**
- **Cost of overstocking = C_o = c-s = $45+$10-$50 = $5**

Estimating Optimal Level of Product Availability

Profit from Ordering the Expected Demand at L.L. Bean

Order Quantity = 1000 Parkas (Expected Demand = 1,026)					
Probability	**Demand**	**Sold**	**Overstocked**	**Understocked**	**Profit**
0.01	400	400	600	0	$ 19,000
0.02	500	500	500	0	$ 25,000
0.04	600	600	400	0	$ 31,000
0.08	700	700	300	0	$ 37,000
0.09	800	800	200	0	$ 43,000
0.11	900	900	100	0	$ 49,000
0.16	1,000	1,000	0	0	$ 55,000
0.20	1,100	1,000	0	100	$ 55,000
0.11	1,200	1,000	0	200	$ 55,000
0.10	1,300	1,000	0	300	$ 55,000
0.04	1,400	1,000	0	400	$ 55,000
0.02	1,500	1,000	0	500	$ 55,000
0.01	1,600	1,000	0	600	$ 55,000
0.01	1,700	1,000	0	700	$ 55,000
Expected:	1,026	915	85	111	**$ 49,900**

Estimating Optimal Level of Product Availability

- Expected Marginal Contribution of Increasing Order Size by 100 units

If we order 1,000, the CSL=probability(demand ≤ 1,000) = 0.51

Additional 100 units sell with probability 1-CSL = 0.49.
We earn margin C_u=p-c = $55 / unit.

Additional 100 units do not sell with probability CSL = 0.51.
We lose C_o= c-s = $5 per unit.

Expected marginal contribution of an additional 100 units =

0.49 x 100 x $55 - 0.51 x 100 x $5 = $2,440

Estimating Optimal Level of Product Availability

Expected Marginal Contributions as Availability is Increased

Additional 100s	Expected Marginal Benefit	Expected Marginal Cost	Expected Marginal Contribution
11th	5500×.49 = 2695	500×.51 = 255	2695-255 = 2440
12th	5500×.29 = 1595	500×.71 = 355	1595-355 = 1240
13th	5500×.18 = 990	500×.82 = 410	990-410 = 580
14th	5500×.08 = 440	500×.92 = 460	440-460 = -20
15th	5500×.04 = 220	500×.96 = 480	220-480 = -260
16th	5500×.02 = 110	500×.98 = 490	110-490 = -380
17th	5500×.01 = 55	500×.99 = 495	55-495 = -440

Optimal Order Quantity = 1,300 Parkas
Expected Profit = $ 54,160
Service level = 92%

Estimating Optimal Level of Product Availability
Seasonal Items with a Single Order in a Season

At the optimal cycle service level CSL^* and order size O^*:
Expected marginal profit from raising the order size by one unit to $O^* + 1 \leq 0$

Expected Marginal Revenue = probability the unit sells $\times C_u$ $= (1-CSL^*) \times C_u$
Expected Marginal Cost = probability the unit does not sell C_o $= CSL^* \times C_o$

Therefore: $(1-CSL^*) \times C_u - CSL^* \times C_o = 0$

Optimal Cycle Service Level: $CSL^* = C_u / (C_u + C_o) = (p-c) / (p-s)$

Critical fractile

$$O^* = F^{-1}(CLS^*, \mu, \sigma) = NORMINV(CSL^*, \mu, \sigma)$$

Evaluating Expected Profits, Overstock, and Understock

$$\text{Expected profits} = (p\text{-}s)\mu\, NORMDIST((O - \mu)/\sigma, 0, 1, 1)$$
$$- (p\text{-}s)\sigma\, NORMDIST((O - \mu)/\sigma, 0, 1, 0)$$
$$- O(c\text{-}s)\, NORMDIST(O, \mu, \sigma, 1)$$
$$+ O\,(p\text{-}c)\,[1 - NORMDIST(O, \mu, \sigma, 1)]$$

$$\text{Expected overstock} = (O - \mu) NORMDIST((O - \mu)/\sigma, 0, 1, 1)$$
$$+ \sigma\, NORMDIST((O - \mu)/\sigma, 0, 1, 0)$$

$$\text{Expected understock} = (\mu - O)[1 - NORMDIST((O - \mu)/\sigma, 0, 1, 1)]$$
$$+ \sigma\, NORMDIST((O - \mu)/\sigma, 0, 1, 0)$$

Product Availability for Continuous Distributions: Example

Motown studios is deciding on the number of copies of a CD to have manufactured. The manufacturer currently charges $2 for each CD. Motown sells each CD for $12 and currently places only one order for the CD before its release. Unsold CDs must be trashed. Demand for the CD has been forecast to be normally distributed with a mean of 30,000 and a standard deviation of 15,000.

How many CDs should Motown order?