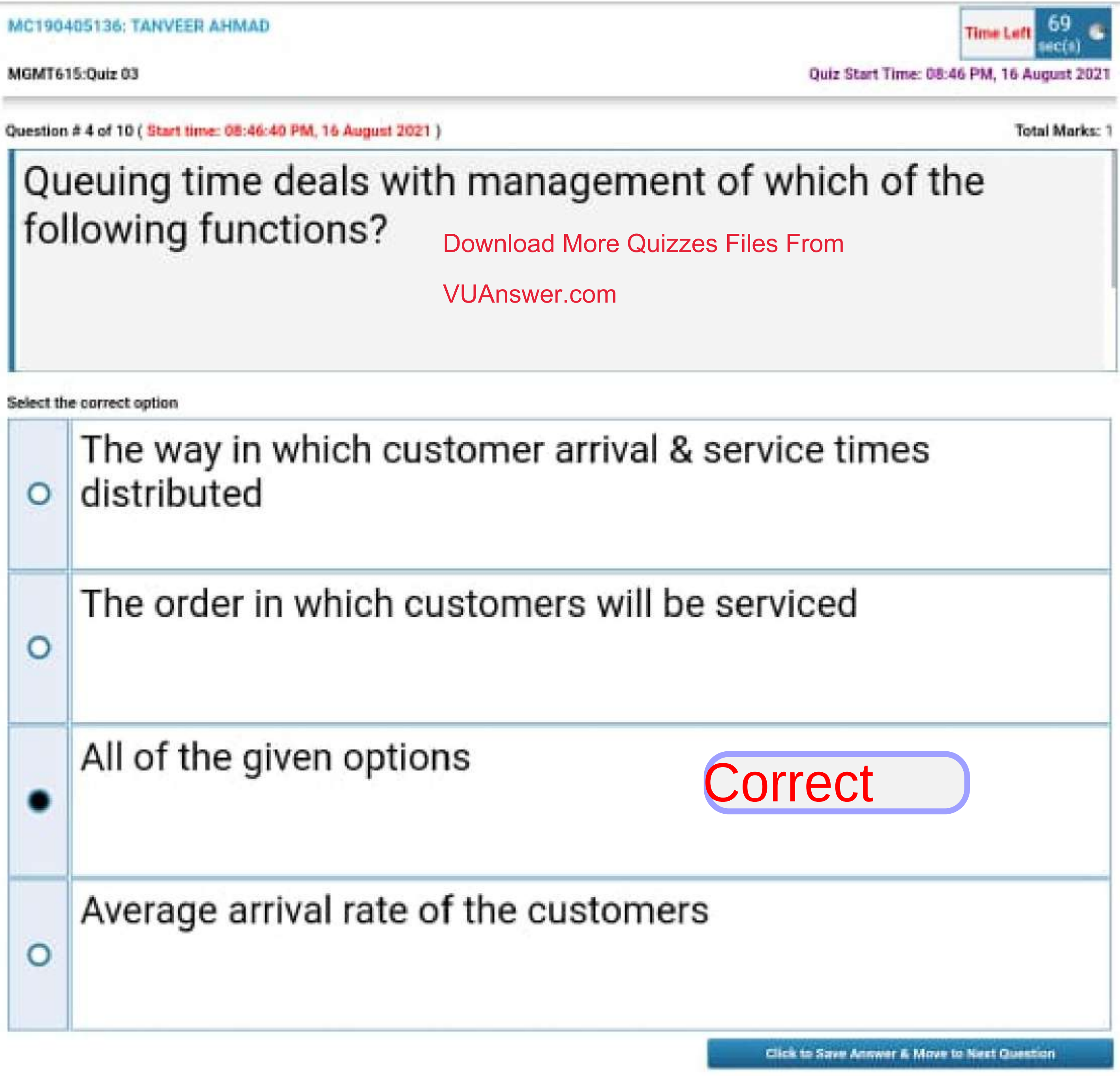

MC190405136: TANVEER AHMAD

MGMT615:Quiz 03

Quiz Start Time: 08:46 PM, 16 August 2021

Question # 4 of 10 ( Start time: 08:46:40 PM, 16 August 2021 )

Total Marks: 1

Queuing time deals with management of which of the following functions?

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Select the correct option

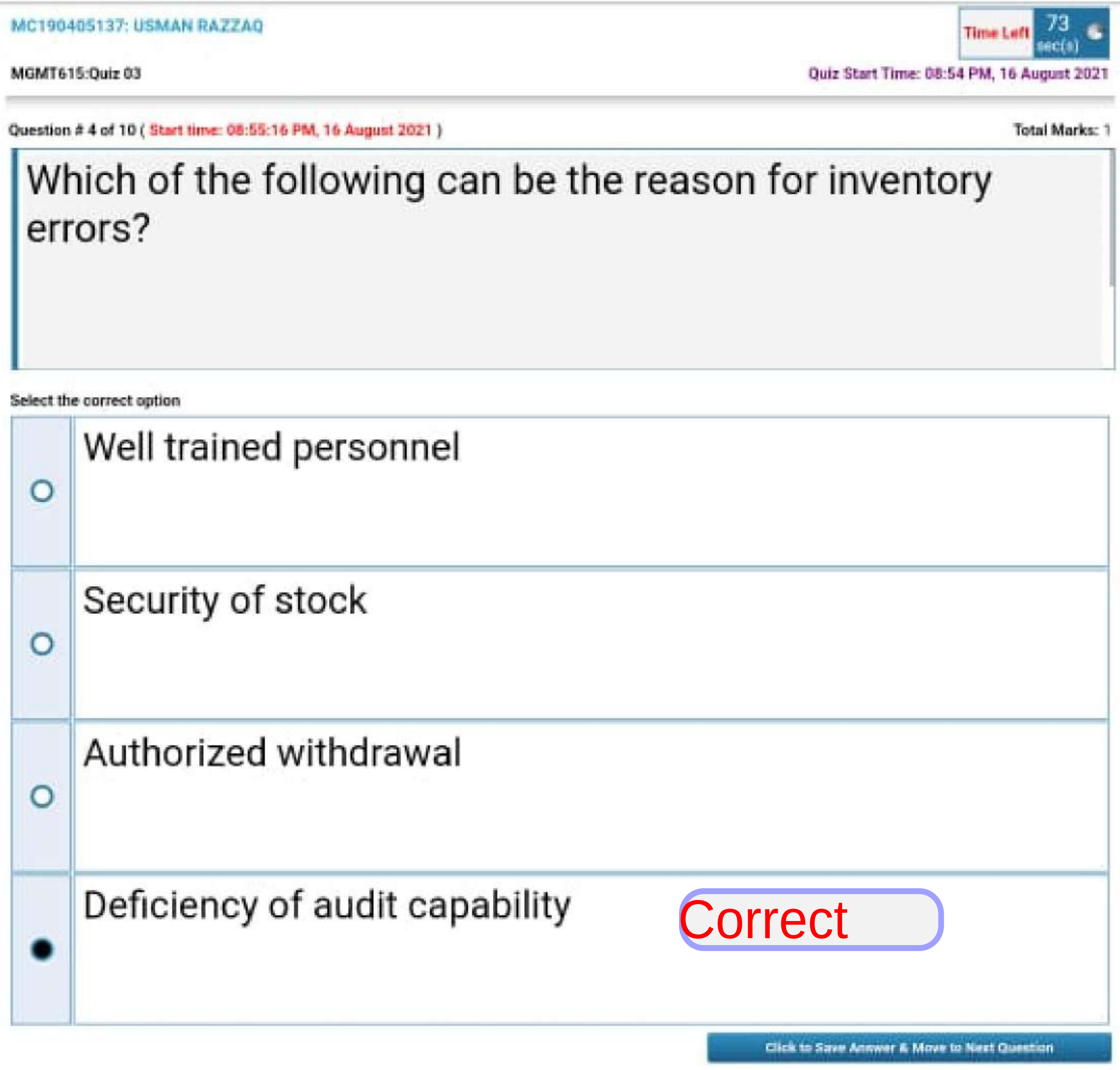
○ The way in which customer arrival & service times distributed

○ The order in which customers will be serviced

● All of the given options

Correct

○ Average arrival rate of the customers



MC190405137: USMAN RAZZAQ

Time Left 73 sec(s)

MGMT615:Quiz 03

Quiz Start Time: 08:54 PM, 16 August 2021

Question # 4 of 10 ( Start time: 08:55:16 PM, 16 August 2021 )

Total Marks: 1

Which of the following can be the reason for inventory errors?

Select the correct option

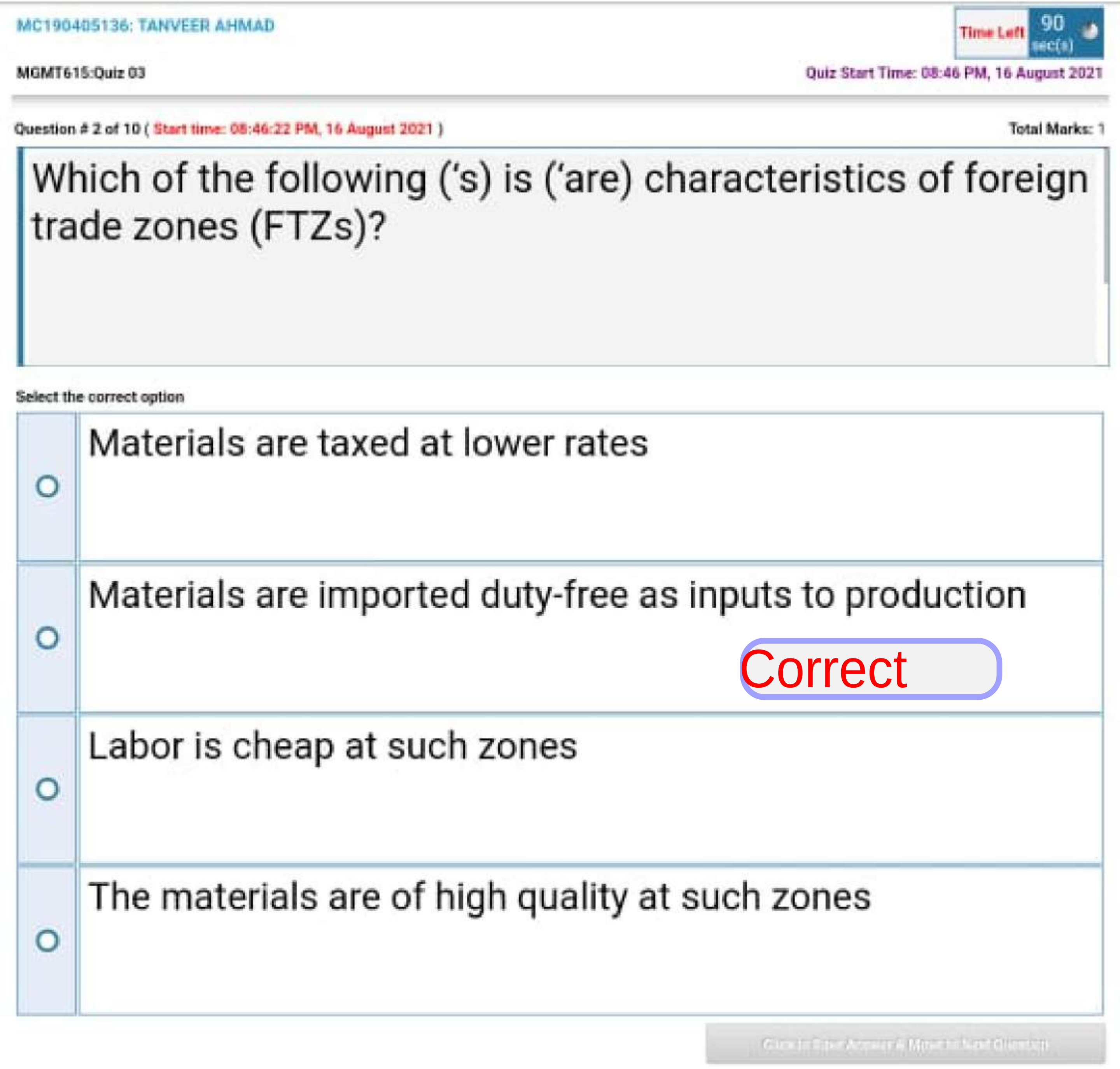
○ Well trained personnel

○ Security of stock

○ Authorized withdrawal

● Deficiency of audit capability

Correct



MC190405136: TANVEER AHMAD

Time Left 90 sec(s)

MGMT615:Quiz 03

Quiz Start Time: 08:46 PM, 16 August 2021

Question # 2 of 10 ( Start time: 08:46:22 PM, 16 August 2021 )

Total Marks: 1

Which of the following ('s) is ('are) characteristics of foreign trade zones (FTZs)?

Select the correct option

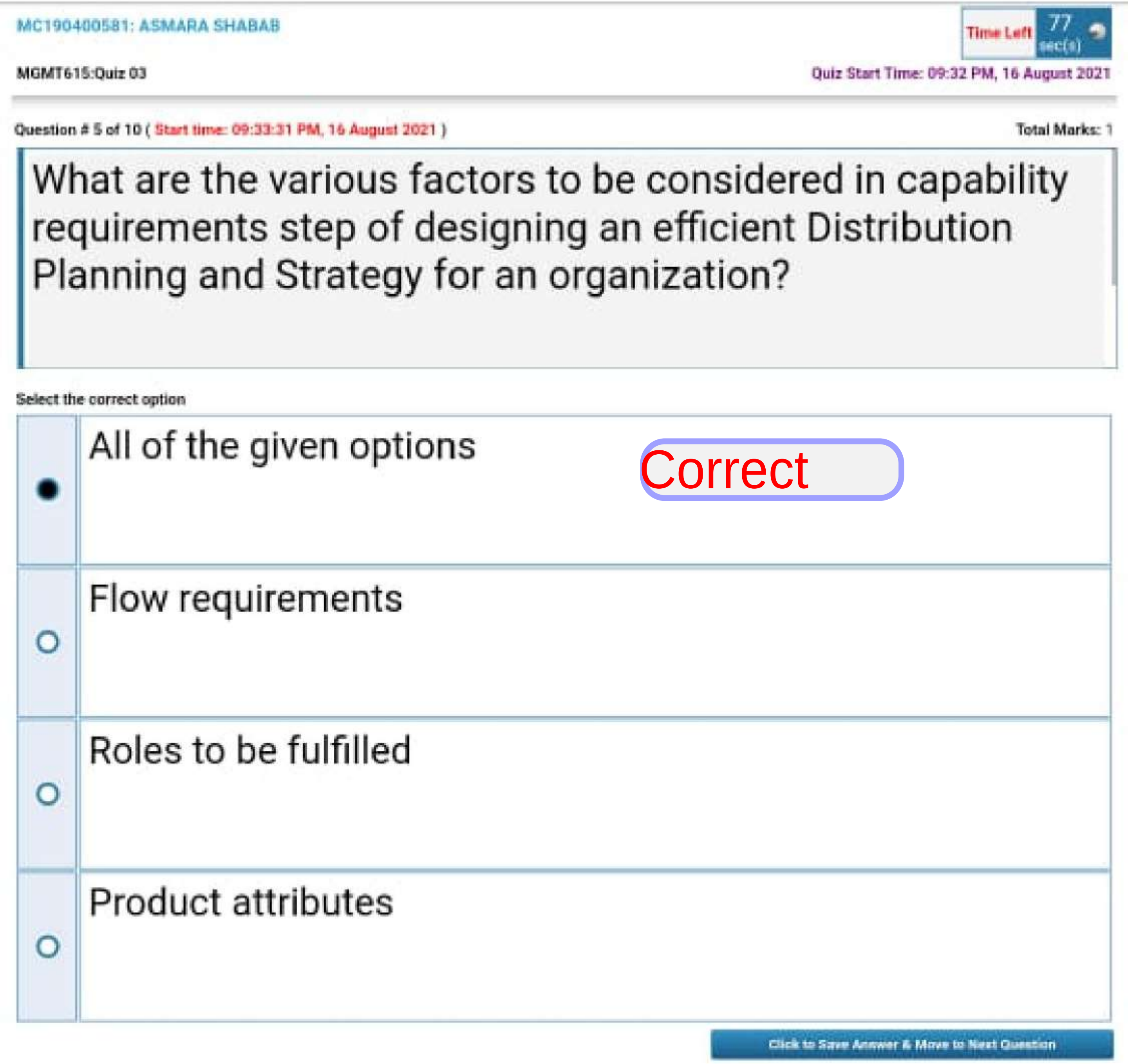
○ Materials are taxed at lower rates

○ Materials are imported duty-free as inputs to production

Correct

○ Labor is cheap at such zones

○ The materials are of high quality at such zones



MC190400581: ASMARA SHABAB

MGMT615:Quiz 03

Quiz Start Time: 09:32 PM, 16 August 2021

Question # 5 of 10 ( Start time: 09:33:31 PM, 16 August 2021 )

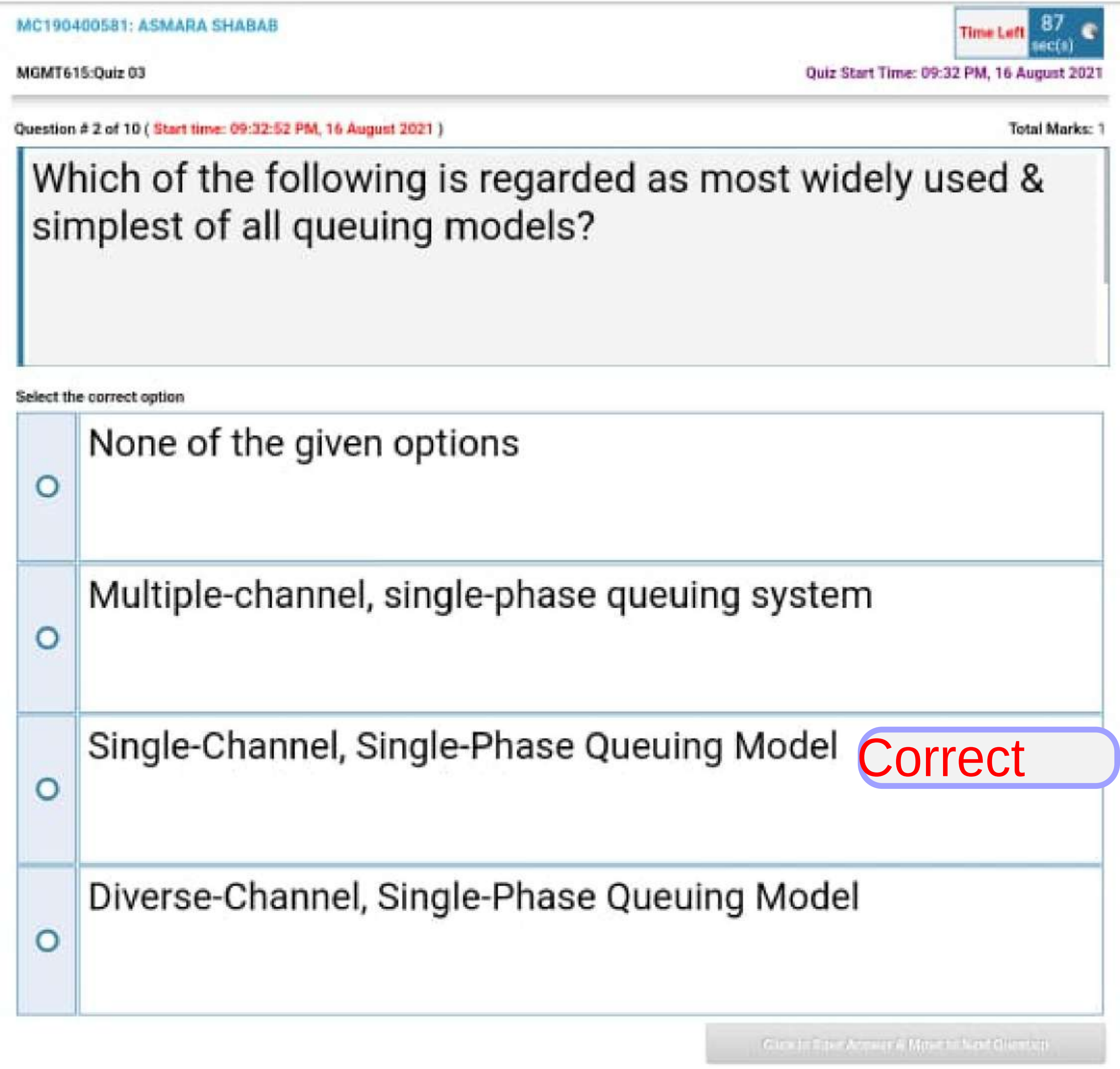
Total Marks: 1

What are the various factors to be considered in capability requirements step of designing an efficient Distribution Planning and Strategy for an organization?

Select the correct option

- ● All of the given options
- ○ Flow requirements
- ○ Roles to be fulfilled
- ○ Product attributes

Correct



MC190400581: ASMARA SHABAB

MGMT615:Quiz 03

Quiz Start Time: 09:32 PM, 16 August 2021

Question # 2 of 10 ( Start time: 09:32:52 PM, 16 August 2021 )

Total Marks: 1

Which of the following is regarded as most widely used & simplest of all queuing models?

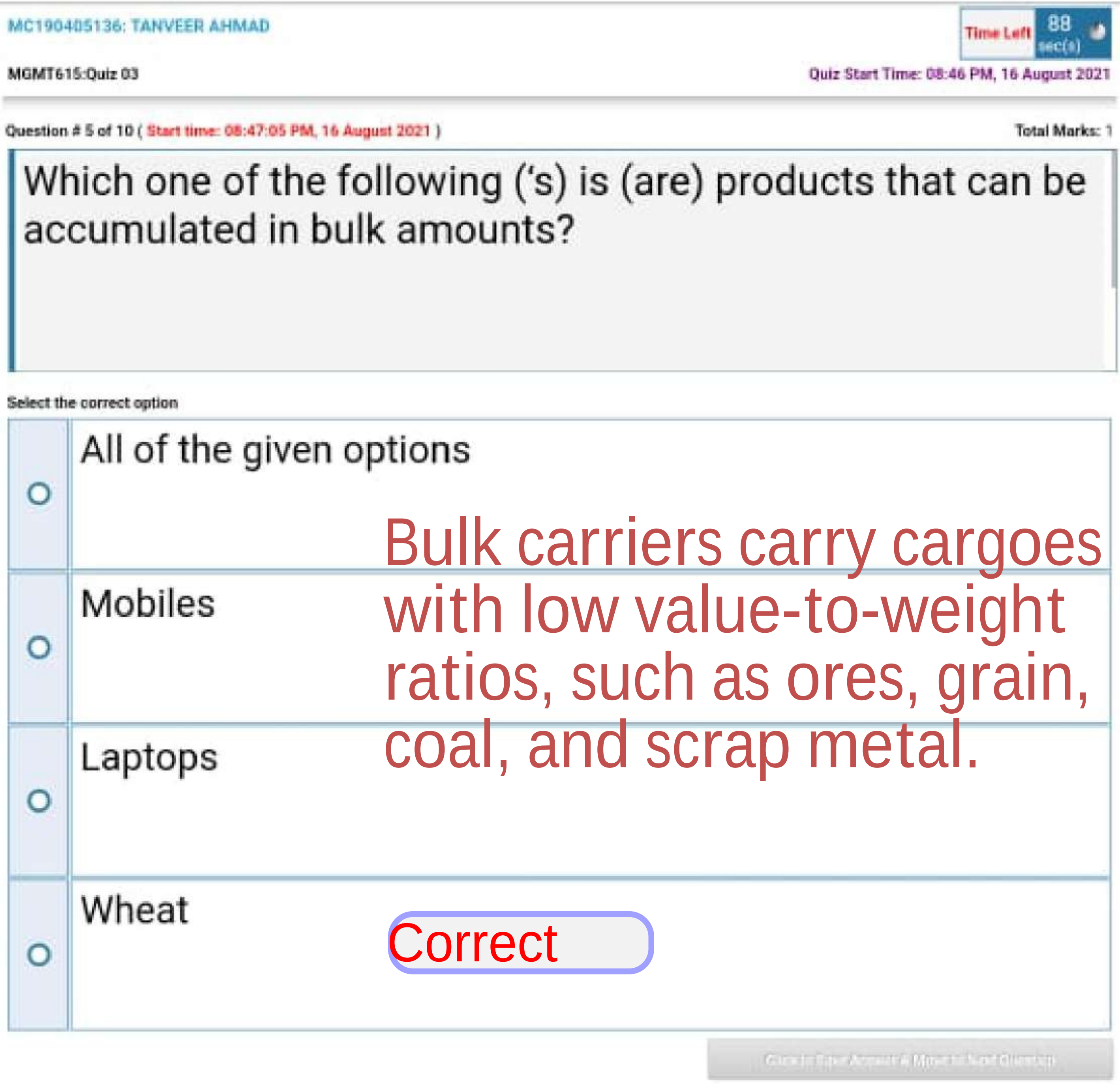
Select the correct option

○ None of the given options

○ Multiple-channel, single-phase queuing system

○ Single-Channel, Single-Phase Queuing Model Correct

○ Diverse-Channel, Single-Phase Queuing Model



MC190405136: TANVEER AHMAD

Time Left 88 sec(s)

MGMT615:Quiz 03

Quiz Start Time: 08:46 PM, 16 August 2021

Question # 5 of 10 ( Start time: 08:47:05 PM, 16 August 2021 )

Total Marks: 1

Which one of the following (‘s) is (are) products that can be accumulated in bulk amounts?

Select the correct option

○ All of the given options

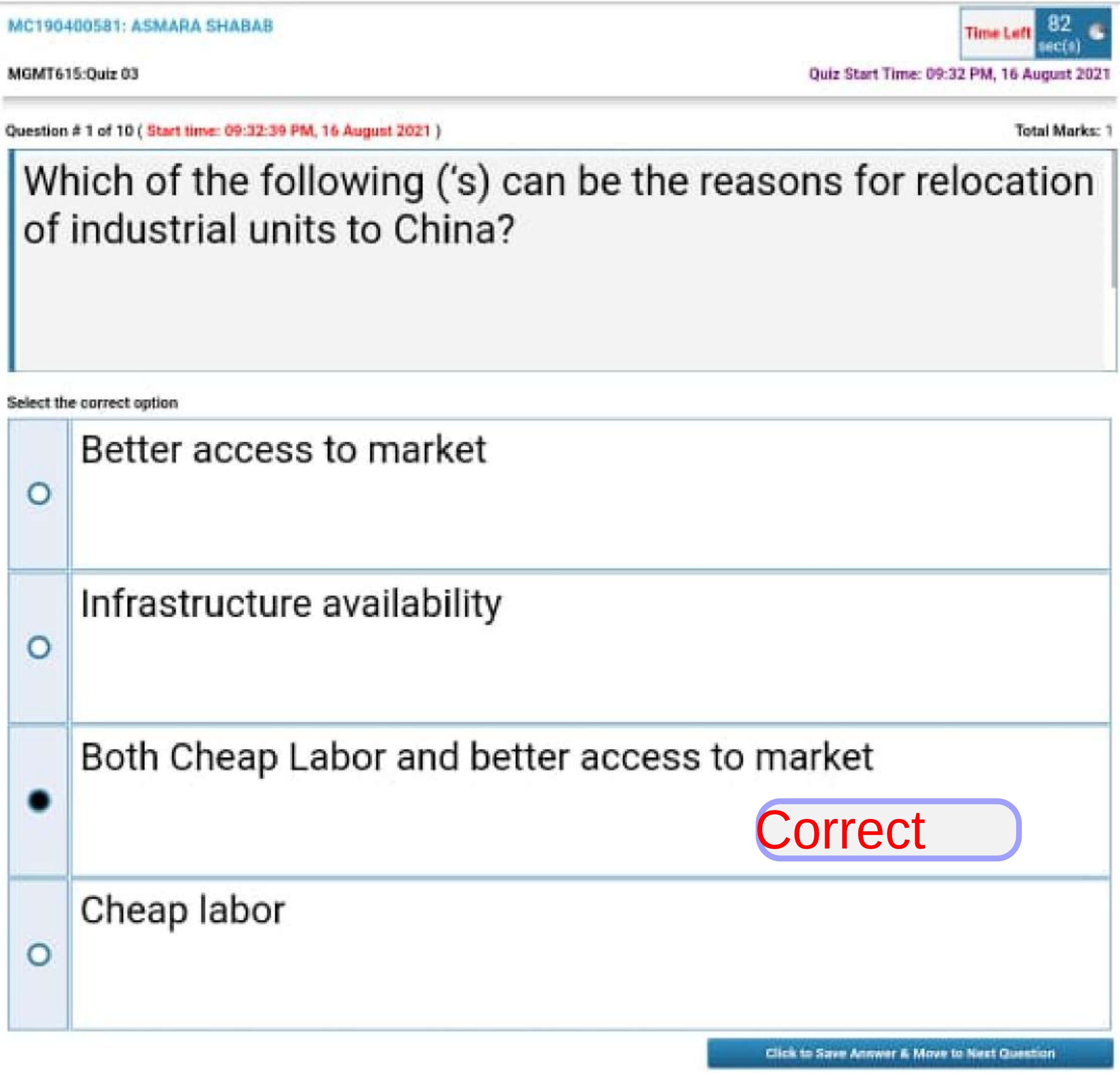
○ Mobiles

○ Laptops

○ Wheat

Bulk carriers carry cargoes with low value-to-weight ratios, such as ores, grain, coal, and scrap metal.

Correct



**MC190400581: ASMARA SHABAB**

MGMT615:Quiz 03

Quiz Start Time: 09:32 PM, 16 August 2021

Question # 1 of 10 ( Start time: 09:32:39 PM, 16 August 2021 )

Total Marks: 1

Which of the following ('s) can be the reasons for relocation of industrial units to China?

Select the correct option

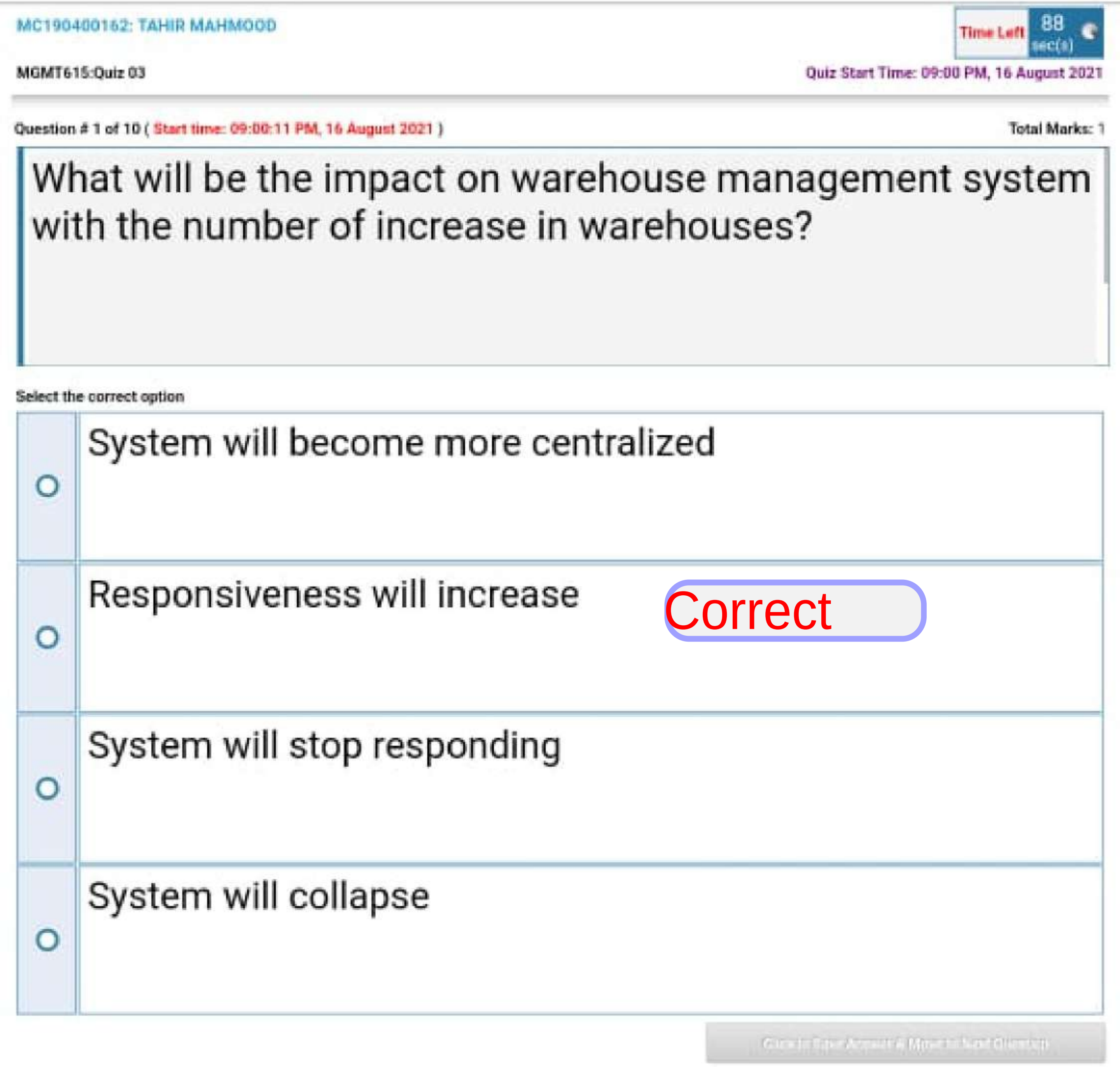
○ Better access to market

○ Infrastructure availability

● Both Cheap Labor and better access to market

Correct

○ Cheap labor



MC190400162: TAHIR MAHMOOD

MGMT615:Quiz 03

Quiz Start Time: 09:00 PM, 16 August 2021

Question # 1 of 10 ( Start time: 09:00:11 PM, 16 August 2021 )

Total Marks: 1

What will be the impact on warehouse management system with the number of increase in warehouses?

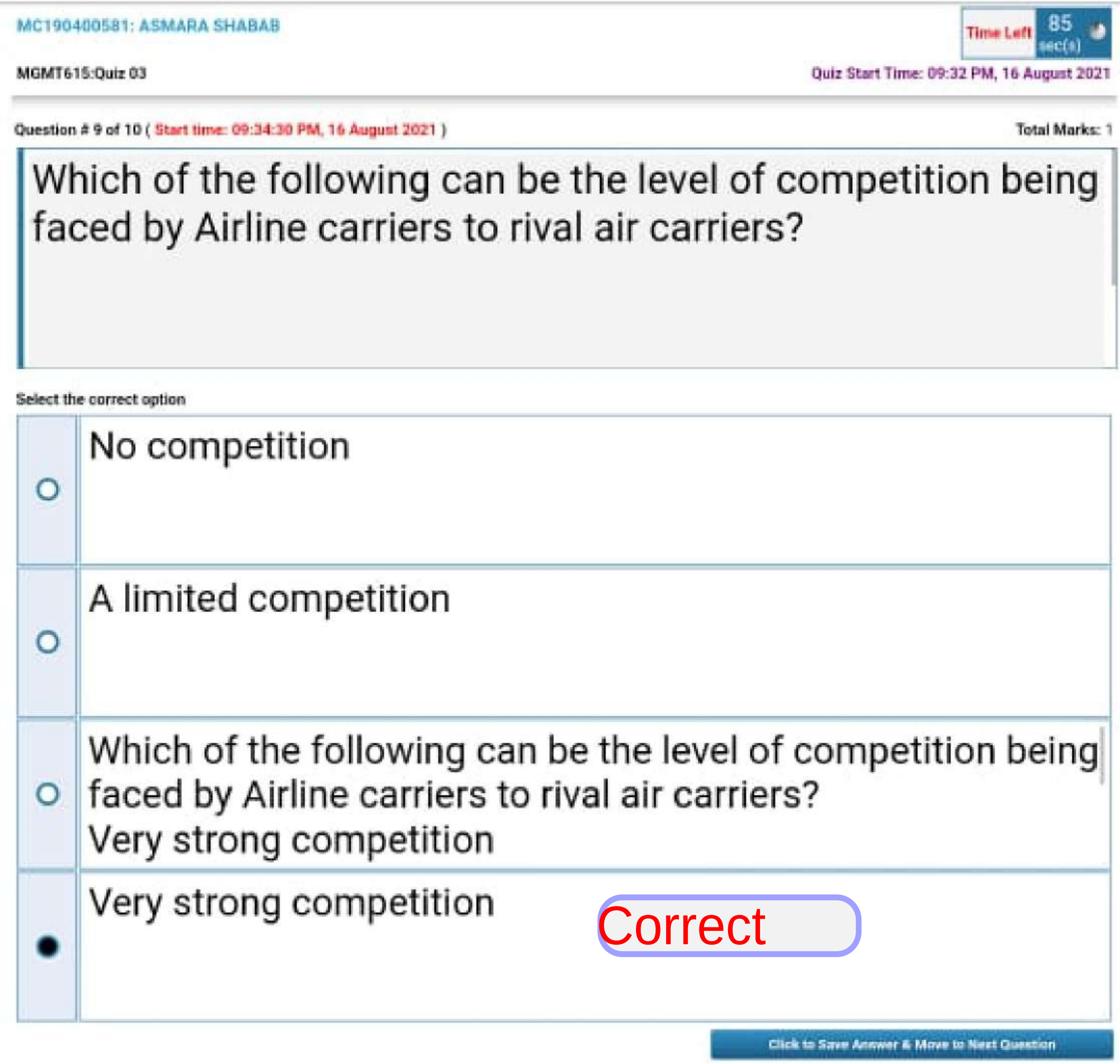
Select the correct option

○ System will become more centralized

○ Responsiveness will increase Correct

○ System will stop responding

○ System will collapse



MC190400581: ASMARA SHABAB

MGMT615:Quiz 03

Quiz Start Time: 09:32 PM, 16 August 2021

Question # 9 of 10 ( Start time: 09:34:30 PM, 16 August 2021 )

Total Marks: 1

Which of the following can be the level of competition being faced by Airline carriers to rival air carriers?

Select the correct option

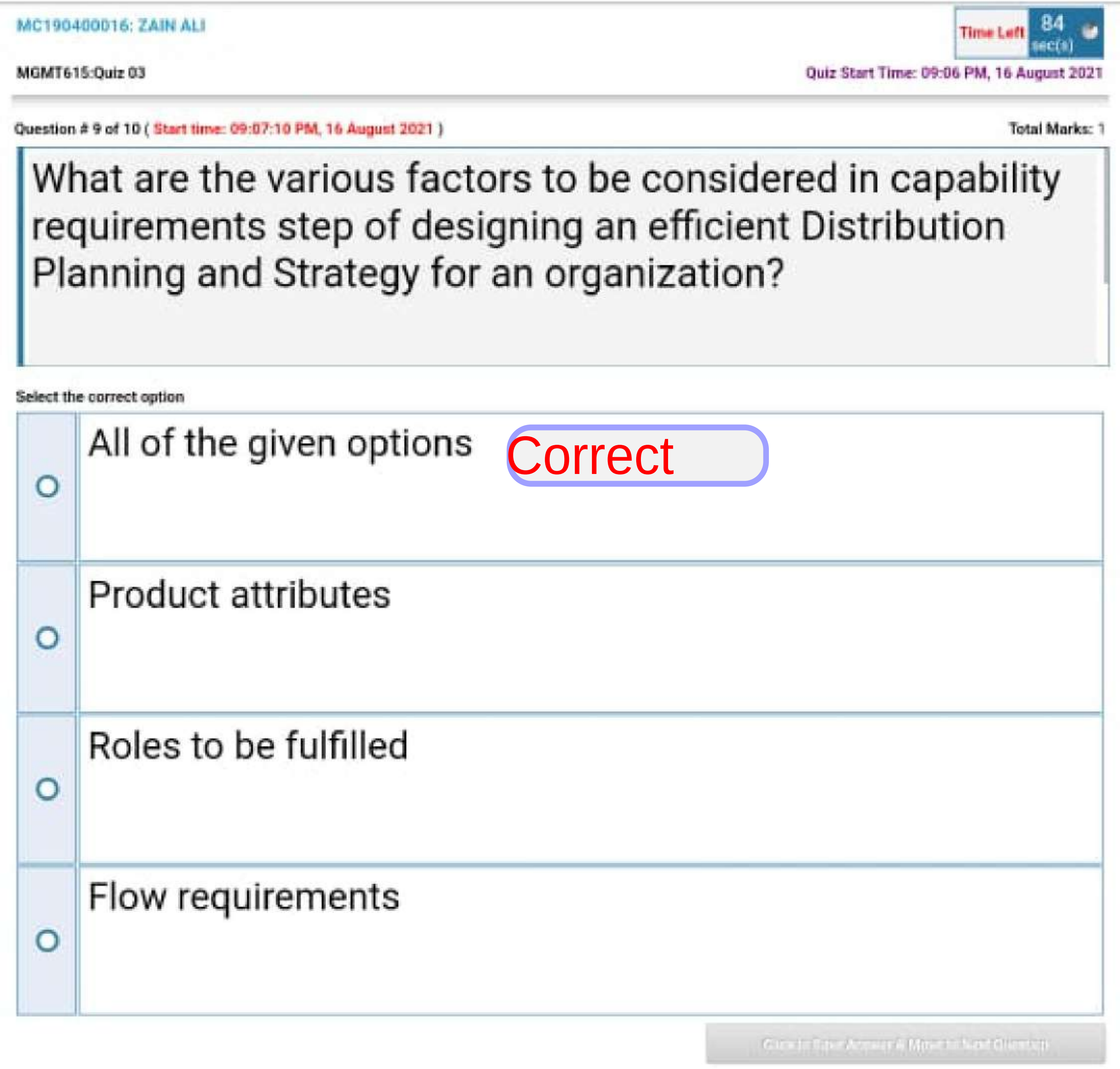
○ No competition

○ A limited competition

○ Which of the following can be the level of competition being faced by Airline carriers to rival air carriers?
Very strong competition

● Very strong competition

Correct



MC190400016: ZAIN ALI

MGMT615:Quiz 03

Quiz Start Time: 09:06 PM, 16 August 2021

Question # 9 of 10 ( Start time: 09:07:10 PM, 16 August 2021 )

Total Marks: 1

What are the various factors to be considered in capability requirements step of designing an efficient Distribution Planning and Strategy for an organization?

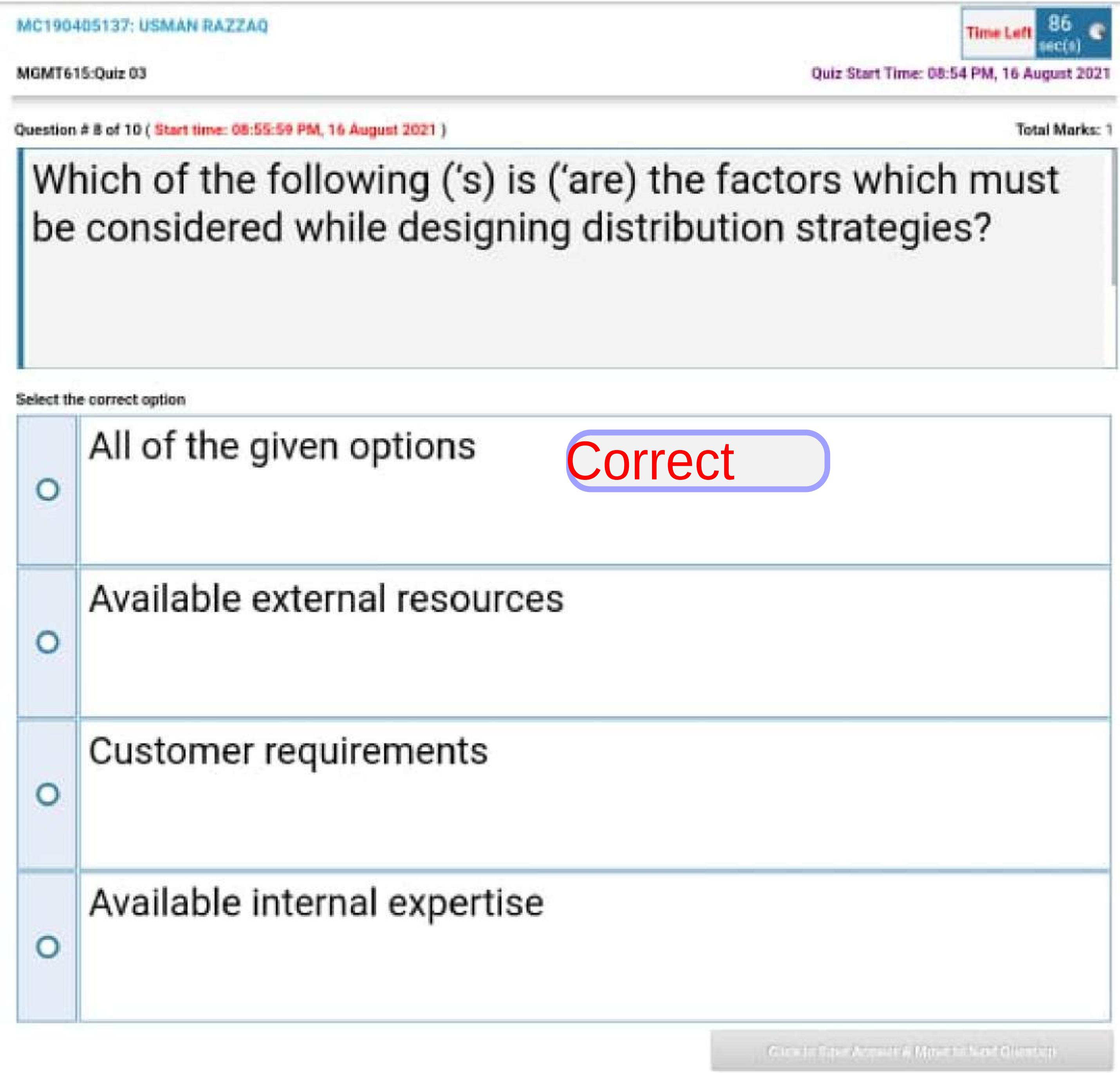
Select the correct option

○ All of the given options Correct

○ Product attributes

○ Roles to be fulfilled

○ Flow requirements



MC190405137: USMAN RAZZAQ

Time Left 86 sec(s)

MGMT615:Quiz 03

Quiz Start Time: 08:54 PM, 16 August 2021

Question # 8 of 10 ( Start time: 08:55:59 PM, 16 August 2021 )

Total Marks: 1

Which of the following ('s) is ('are) the factors which must be considered while designing distribution strategies?

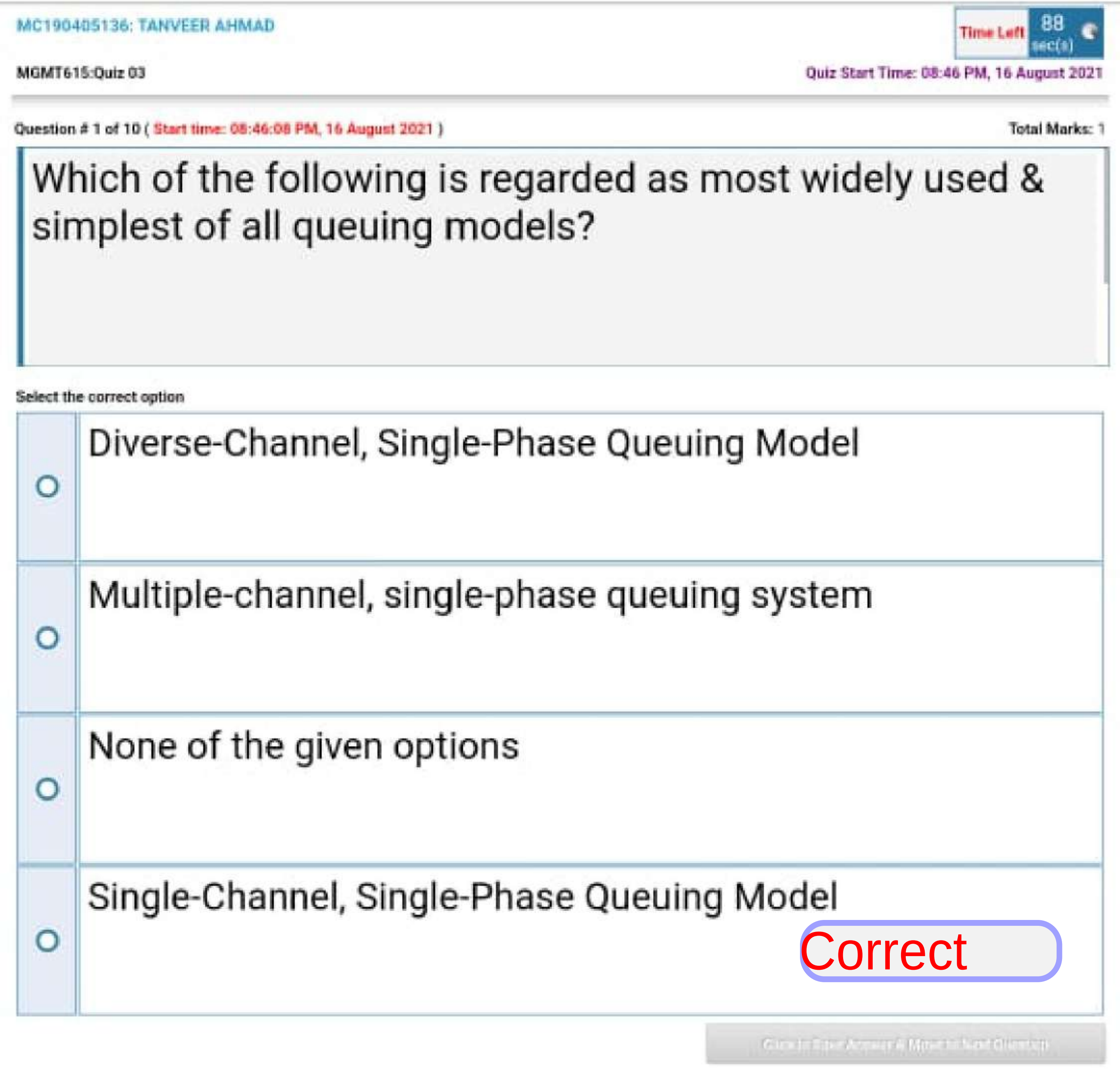
Select the correct option

○ All of the given options Correct

○ Available external resources

○ Customer requirements

○ Available internal expertise



MC190405136: TANVEER AHMAD

MGMT615:Quiz 03

Quiz Start Time: 08:46 PM, 16 August 2021

Question # 1 of 10 ( Start time: 08:46:08 PM, 16 August 2021 )

Total Marks: 1

Which of the following is regarded as most widely used & simplest of all queuing models?

Select the correct option

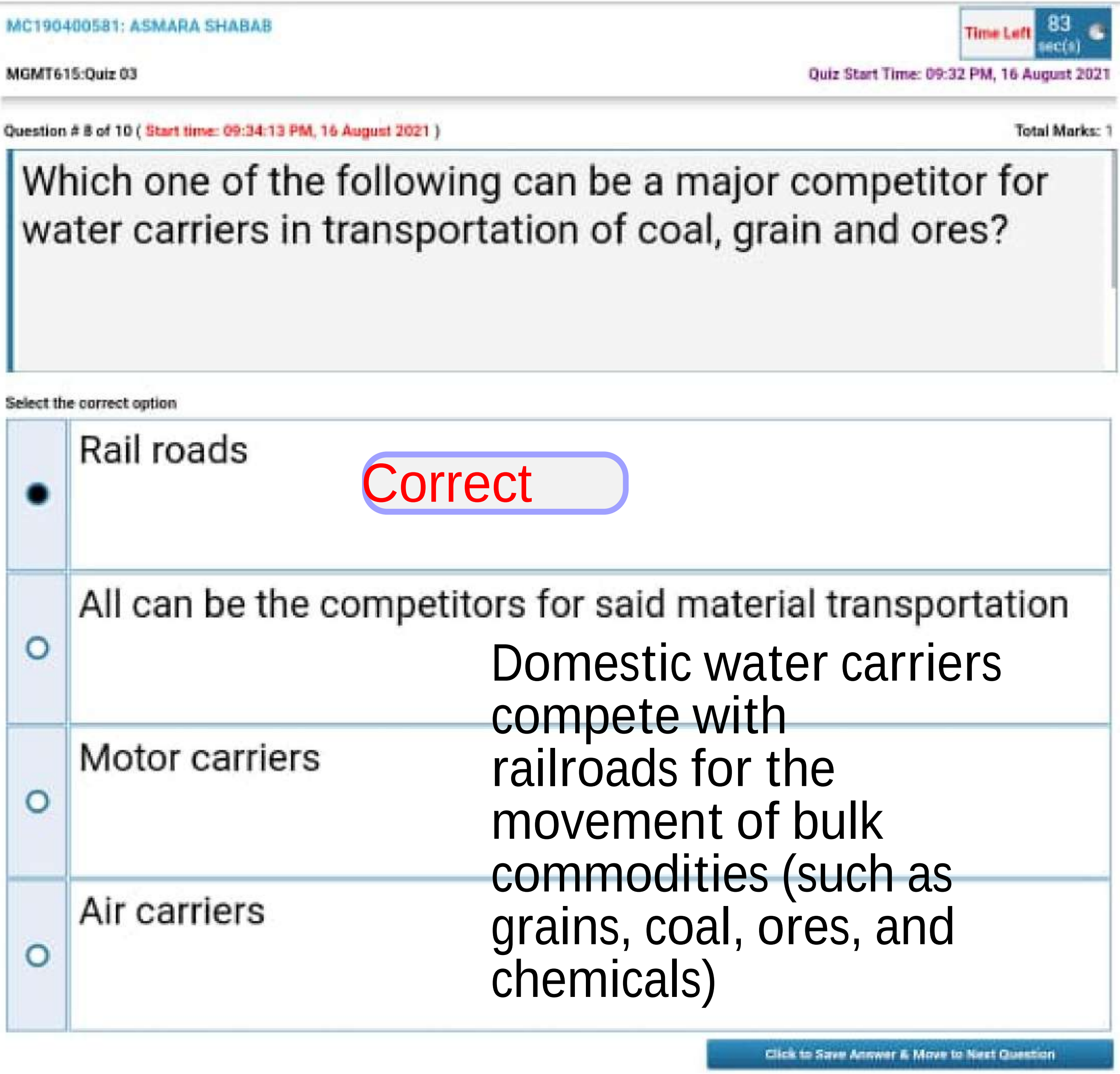
○ Diverse-Channel, Single-Phase Queuing Model

○ Multiple-channel, single-phase queuing system

○ None of the given options

○ Single-Channel, Single-Phase Queuing Model

Correct



MC190400581: ASMARA SHABAB

Time Left 83 sec(s)

MGMT615:Quiz 03

Quiz Start Time: 09:32 PM, 16 August 2021

Question # 8 of 10 ( Start time: 09:34:13 PM, 16 August 2021 )

Total Marks: 1

Which one of the following can be a major competitor for water carriers in transportation of coal, grain and ores?

Select the correct option

● Rail roads

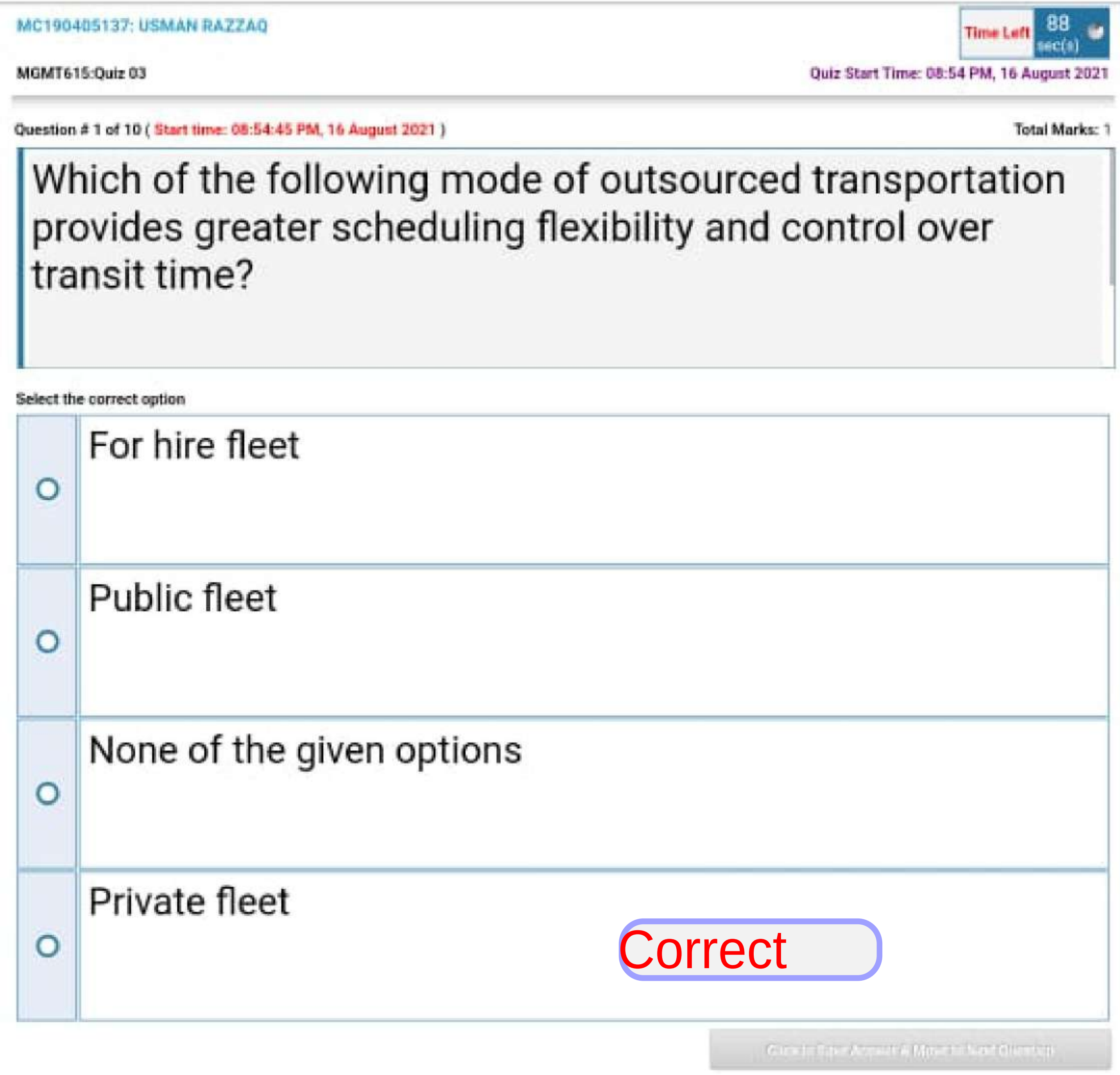
Correct

○ All can be the competitors for said material transportation

○ Motor carriers

○ Air carriers

Domestic water carriers compete with railroads for the movement of bulk commodities (such as grains, coal, ores, and chemicals)



MC190405137: USMAN RAZZAQ

Time Left 88 sec(s)

MGMT615:Quiz 03

Quiz Start Time: 08:54 PM, 16 August 2021

Question # 1 of 10 ( Start time: 08:54:45 PM, 16 August 2021 )

Total Marks: 1

Which of the following mode of outsourced transportation provides greater scheduling flexibility and control over transit time?

Select the correct option

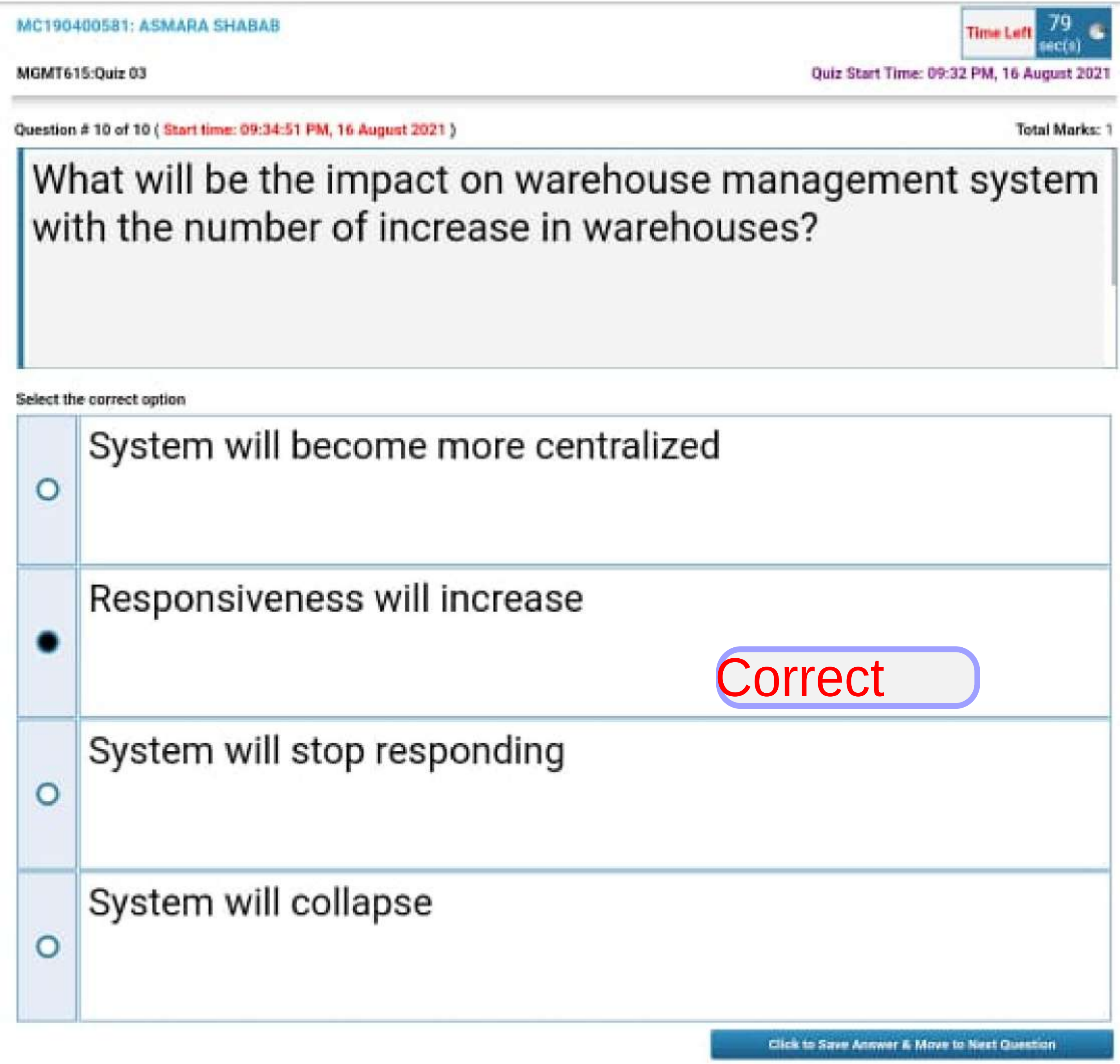
○ For hire fleet

○ Public fleet

○ None of the given options

○ Private fleet

Correct



MC190400581: ASMARA SHABAB

MGMT615:Quiz 03

Quiz Start Time: 09:32 PM, 16 August 2021

Question # 10 of 10 ( Start time: 09:34:51 PM, 16 August 2021 )

Total Marks: 1

What will be the impact on warehouse management system with the number of increase in warehouses?

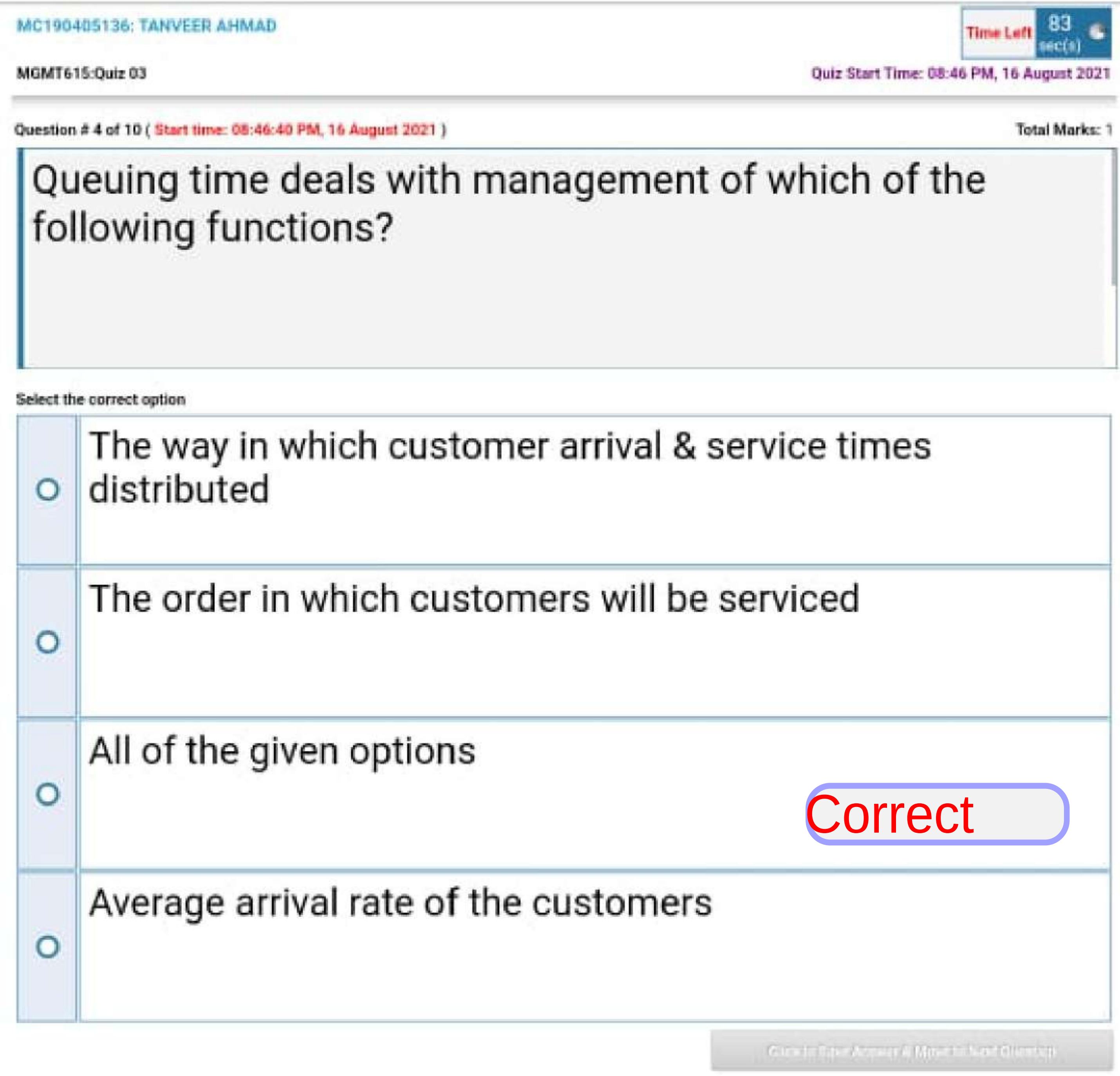
Select the correct option

○ System will become more centralized

● Responsiveness will increase — Correct

○ System will stop responding

○ System will collapse



MC190405136: TANVEER AHMAD

MGMT615:Quiz 03

Quiz Start Time: 08:46 PM, 16 August 2021

Question # 4 of 10 ( Start time: 08:46:40 PM, 16 August 2021 )

Total Marks: 1

Queuing time deals with management of which of the following functions?

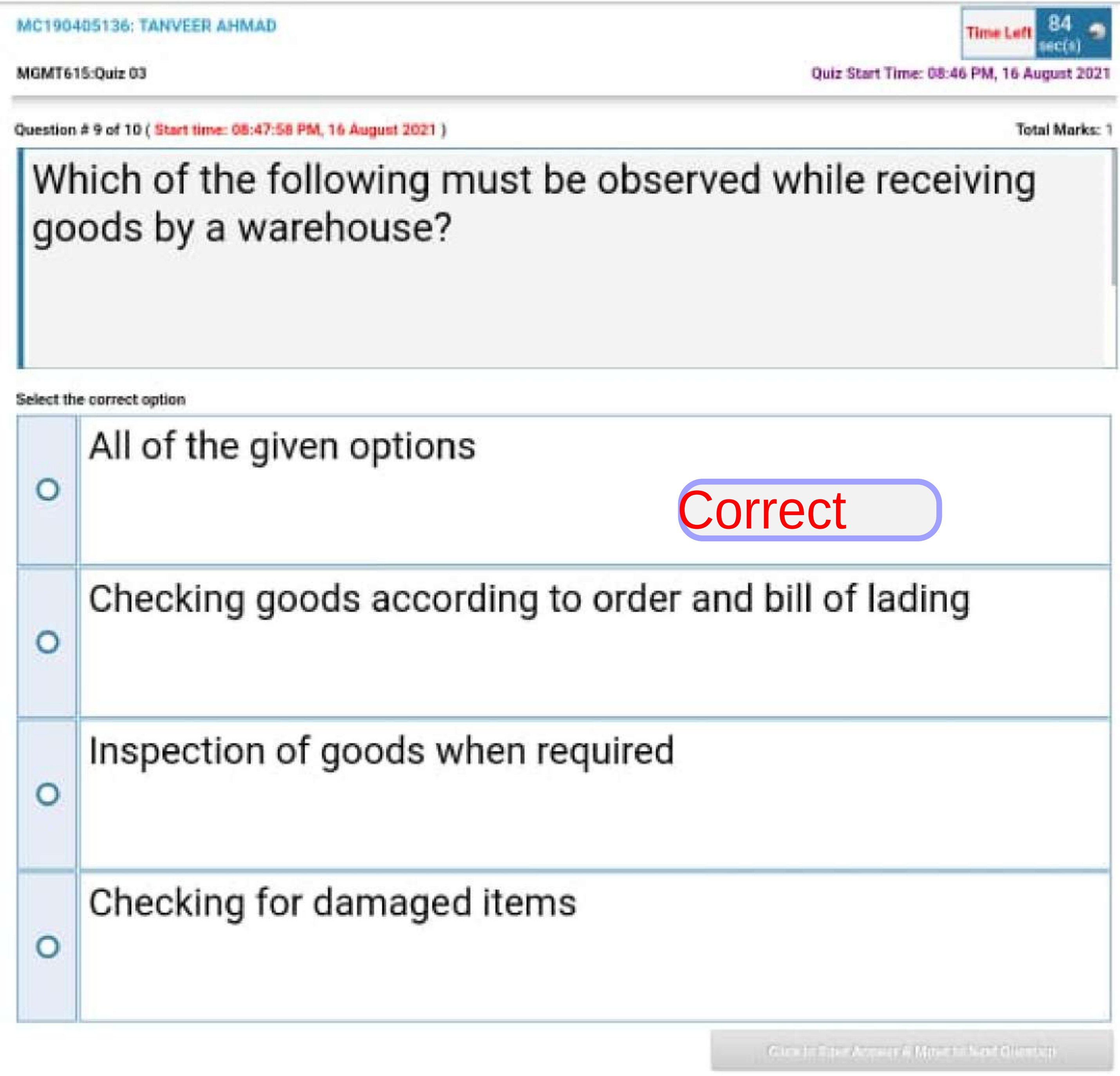
Select the correct option

○ The way in which customer arrival & service times distributed

○ The order in which customers will be serviced

○ All of the given options Correct

○ Average arrival rate of the customers



MC190405136: TANVEER AHMAD

MGMT615:Quiz 03

Quiz Start Time: 08:46 PM, 16 August 2021

Question # 9 of 10 ( Start time: 08:47:58 PM, 16 August 2021 )

Total Marks: 1

Which of the following must be observed while receiving goods by a warehouse?

Select the correct option

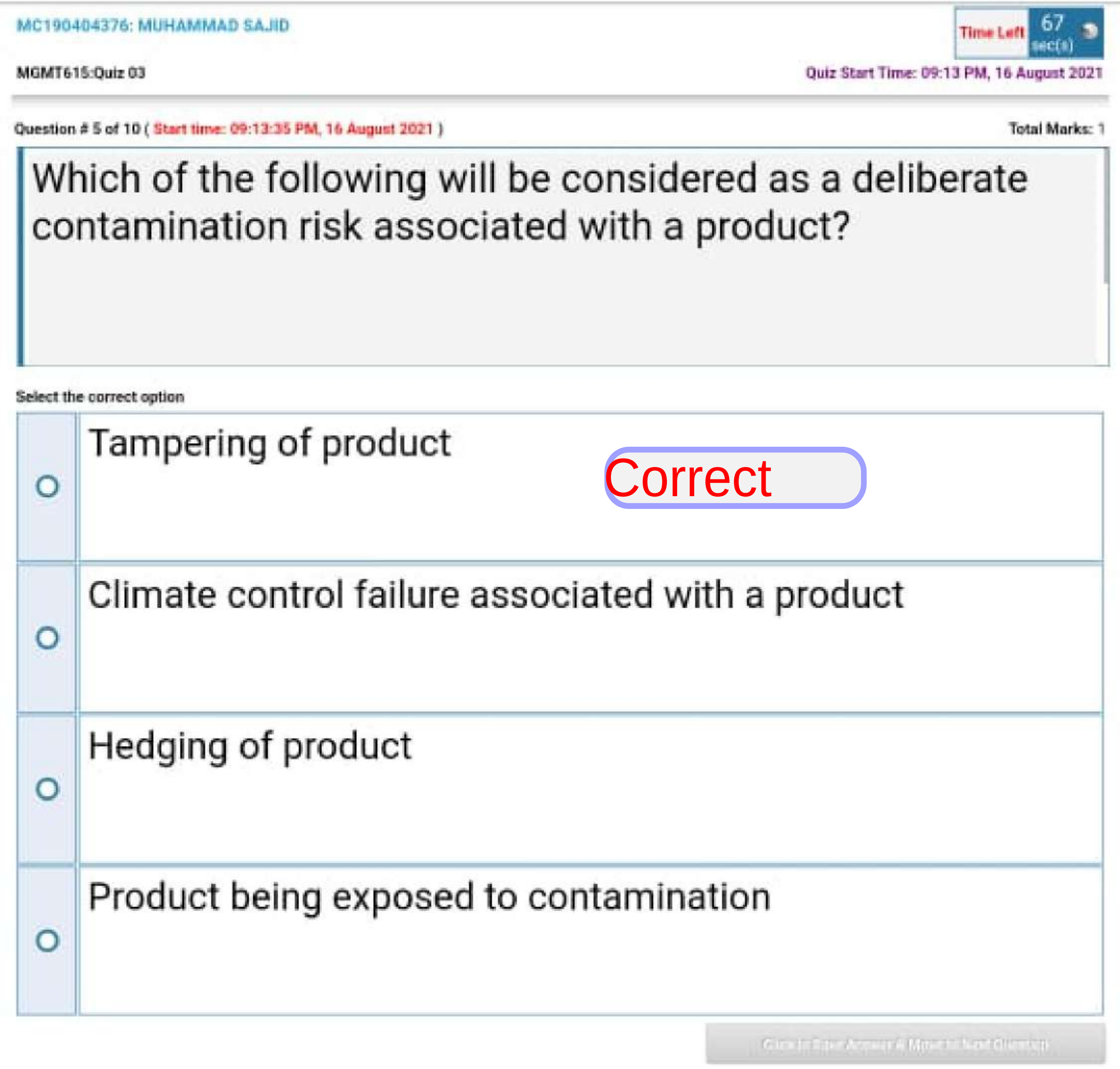
○ All of the given options

Correct

○ Checking goods according to order and bill of lading

○ Inspection of goods when required

○ Checking for damaged items



MC190404376: MUHAMMAD SAJID

Time Left 67 sec(s)

MGMT615:Quiz 03

Quiz Start Time: 09:13 PM, 16 August 2021

Question # 5 of 10 ( Start time: 09:13:35 PM, 16 August 2021 )

Total Marks: 1

Which of the following will be considered as a deliberate contamination risk associated with a product?

Select the correct option

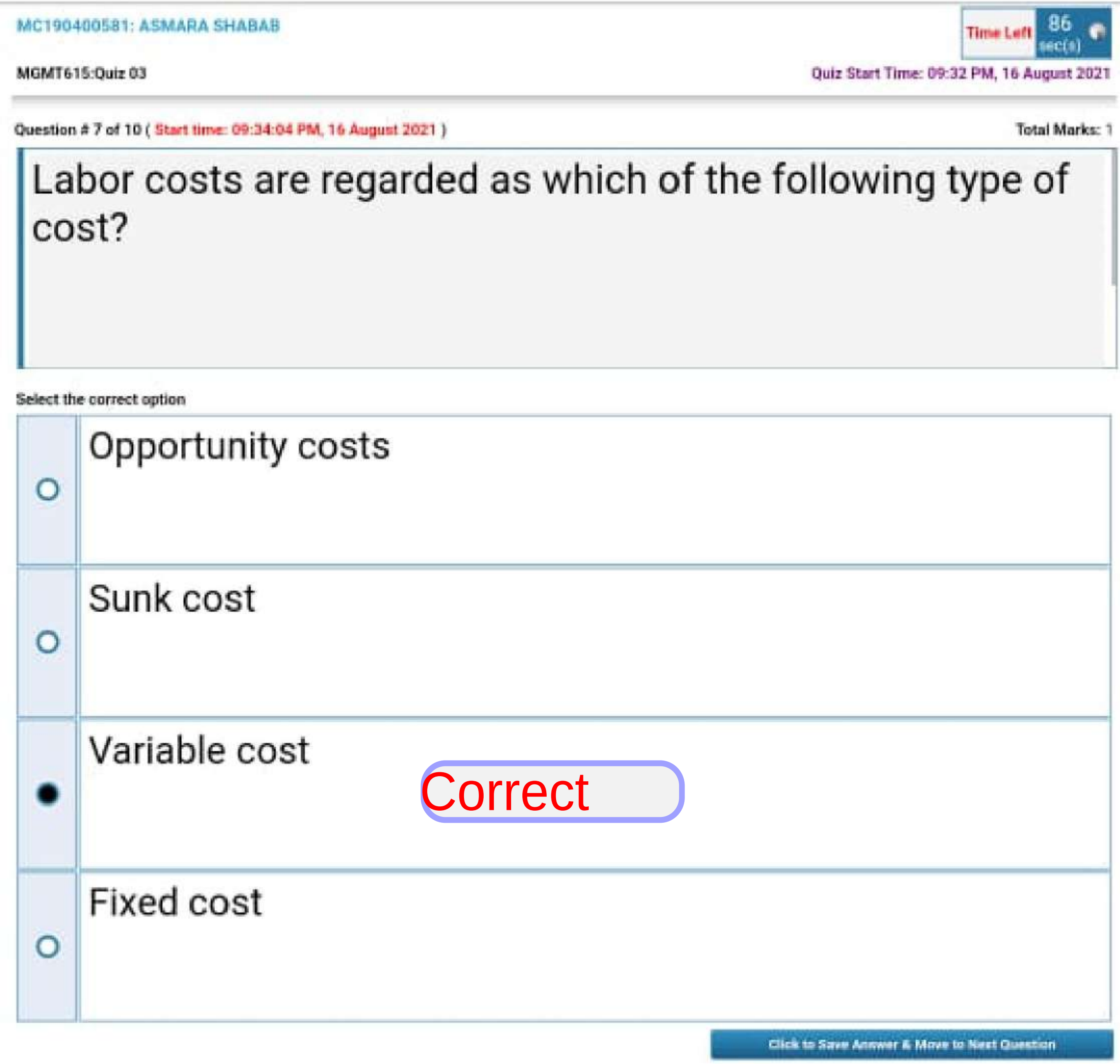
○ Tampering of product

Correct

○ Climate control failure associated with a product

○ Hedging of product

○ Product being exposed to contamination



MC190400581: ASMARA SHABAB

MGMT615:Quiz 03

Quiz Start Time: 09:32 PM, 16 August 2021

Question # 7 of 10 ( Start time: 09:34:04 PM, 16 August 2021 )

Total Marks: 1

Labor costs are regarded as which of the following type of cost?

Select the correct option

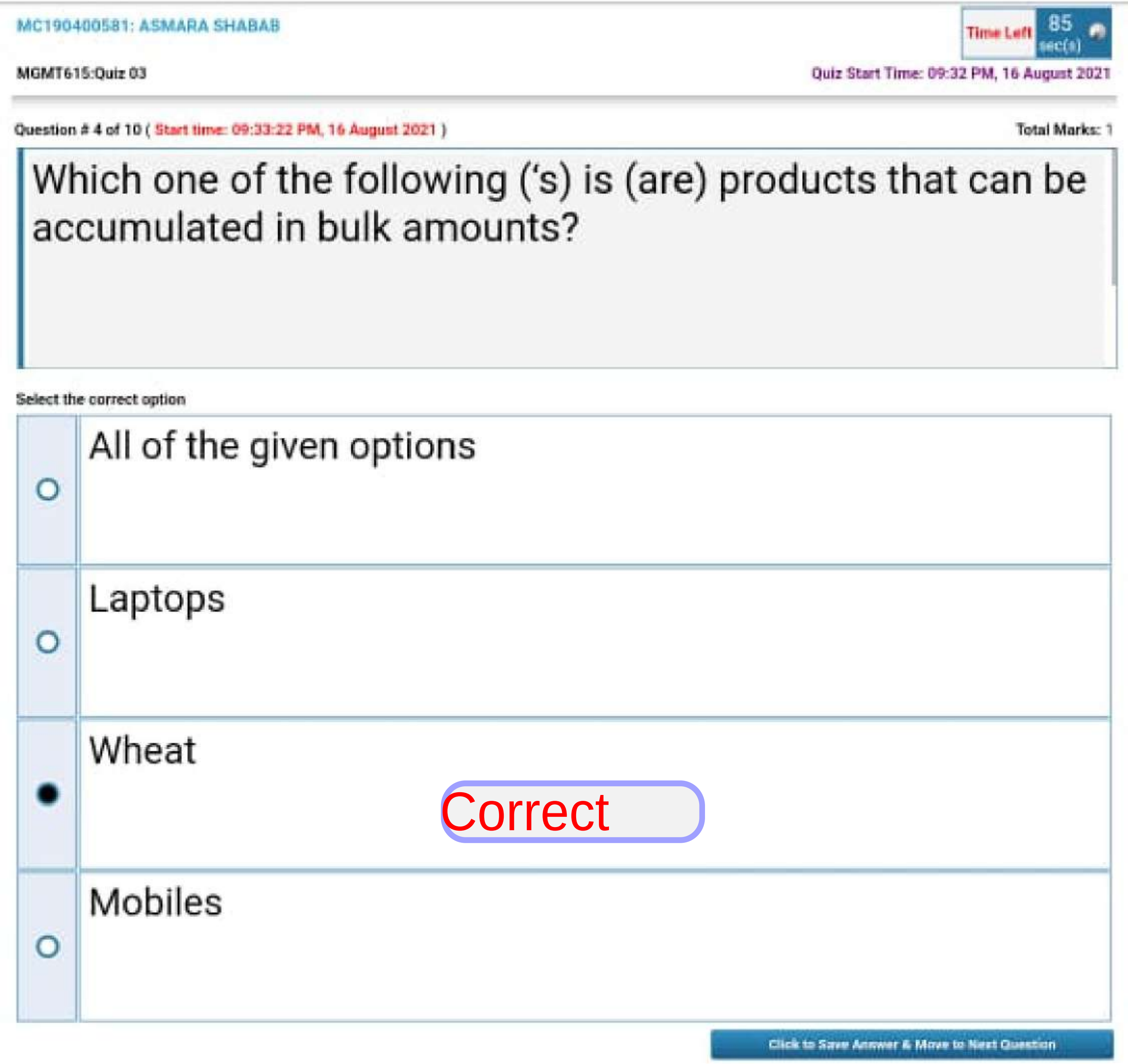
○ Opportunity costs

○ Sunk cost

● Variable cost

Correct

○ Fixed cost



MC190400581: ASMARA SHABAB

MGMT615:Quiz 03

Quiz Start Time: 09:32 PM, 16 August 2021

Question # 4 of 10 ( Start time: 09:33:22 PM, 16 August 2021 )

Total Marks: 1

Which one of the following ('s) is (are) products that can be accumulated in bulk amounts?

Select the correct option

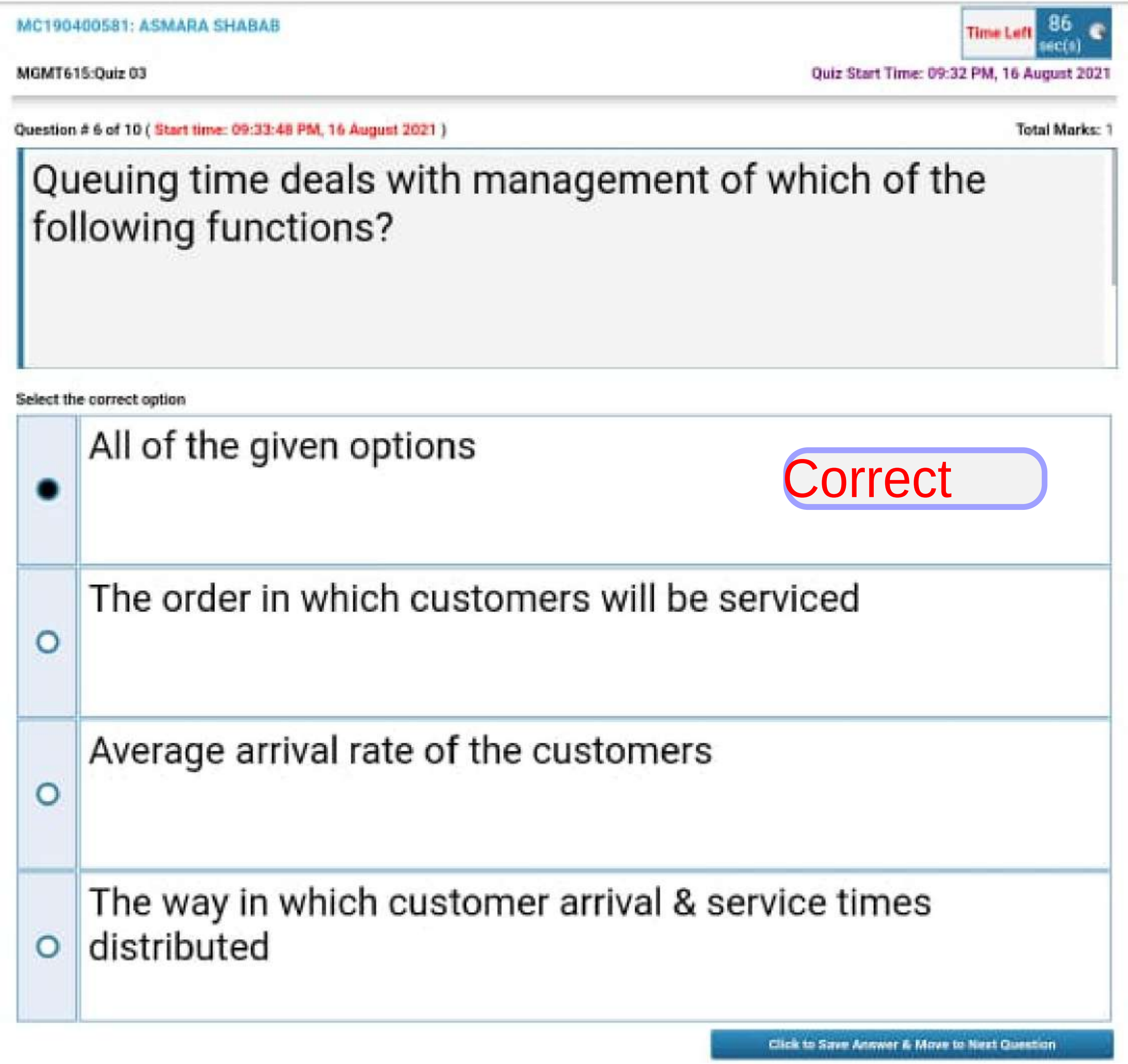
○ All of the given options

○ Laptops

● Wheat

Correct

○ Mobiles



MC190400581: ASMARA SHABAB

Time Left 86 sec(s)

MGMT615:Quiz 03

Quiz Start Time: 09:32 PM, 16 August 2021

Question # 6 of 10 ( Start time: 09:33:48 PM, 16 August 2021 )

Total Marks: 1

Queuing time deals with management of which of the following functions?

Select the correct option

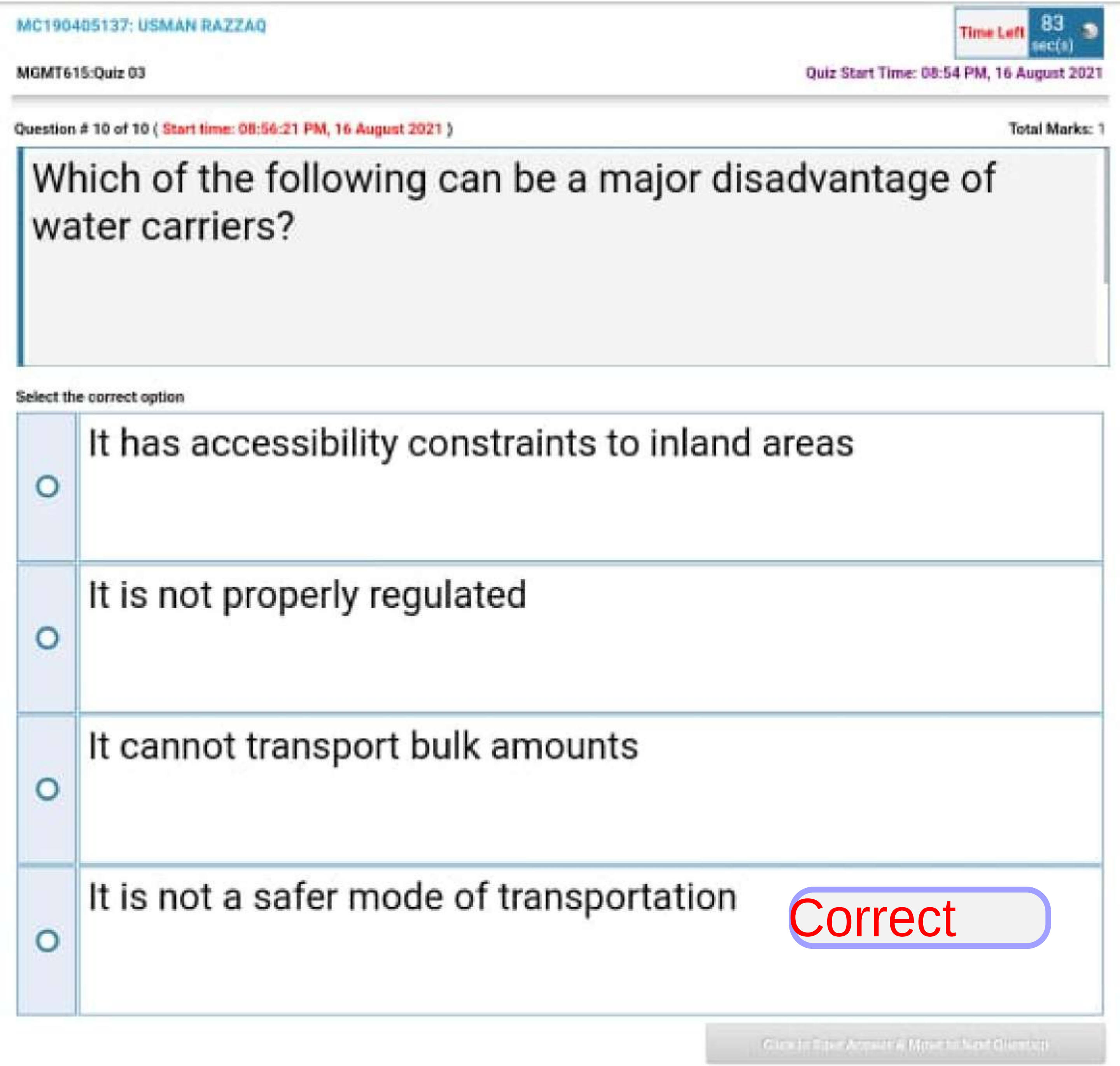
● All of the given options

Correct

○ The order in which customers will be serviced

○ Average arrival rate of the customers

○ The way in which customer arrival & service times distributed



MC190405137: USMAN RAZZAQ

MGMT615:Quiz 03

Quiz Start Time: 08:54 PM, 16 August 2021

Question # 10 of 10 ( Start time: 08:56:21 PM, 16 August 2021 )

Total Marks: 1

Which of the following can be a major disadvantage of water carriers?

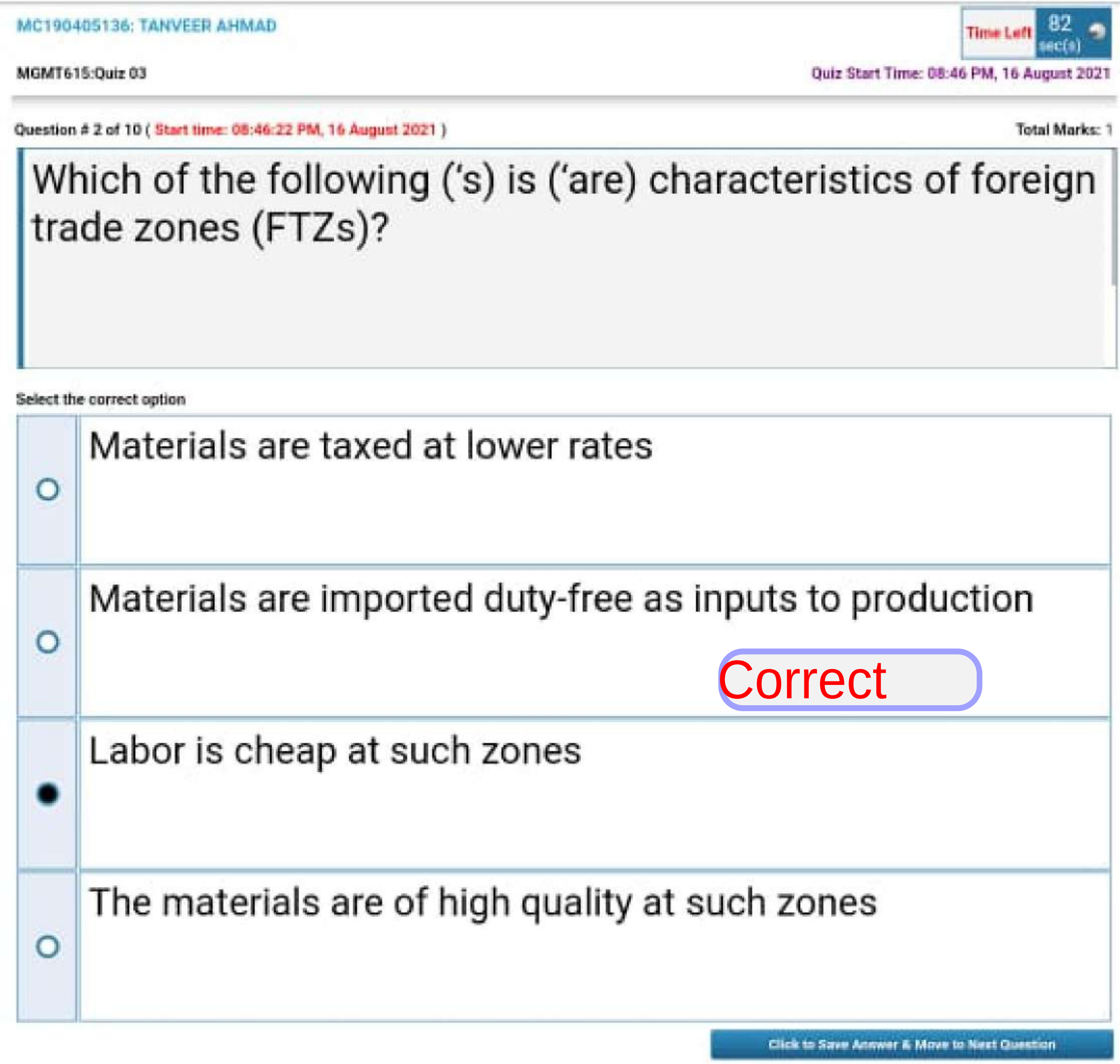
Select the correct option

○ It has accessibility constraints to inland areas

○ It is not properly regulated

○ It cannot transport bulk amounts

○ It is not a safer mode of transportation Correct



MC190405136: TANVEER AHMAD

MGMT615:Quiz 03

Quiz Start Time: 08:46 PM, 16 August 2021

Question # 2 of 10 ( Start time: 08:46:22 PM, 16 August 2021 )

Total Marks: 1

Which of the following ('s) is ('are) characteristics of foreign trade zones (FTZs)?

Select the correct option

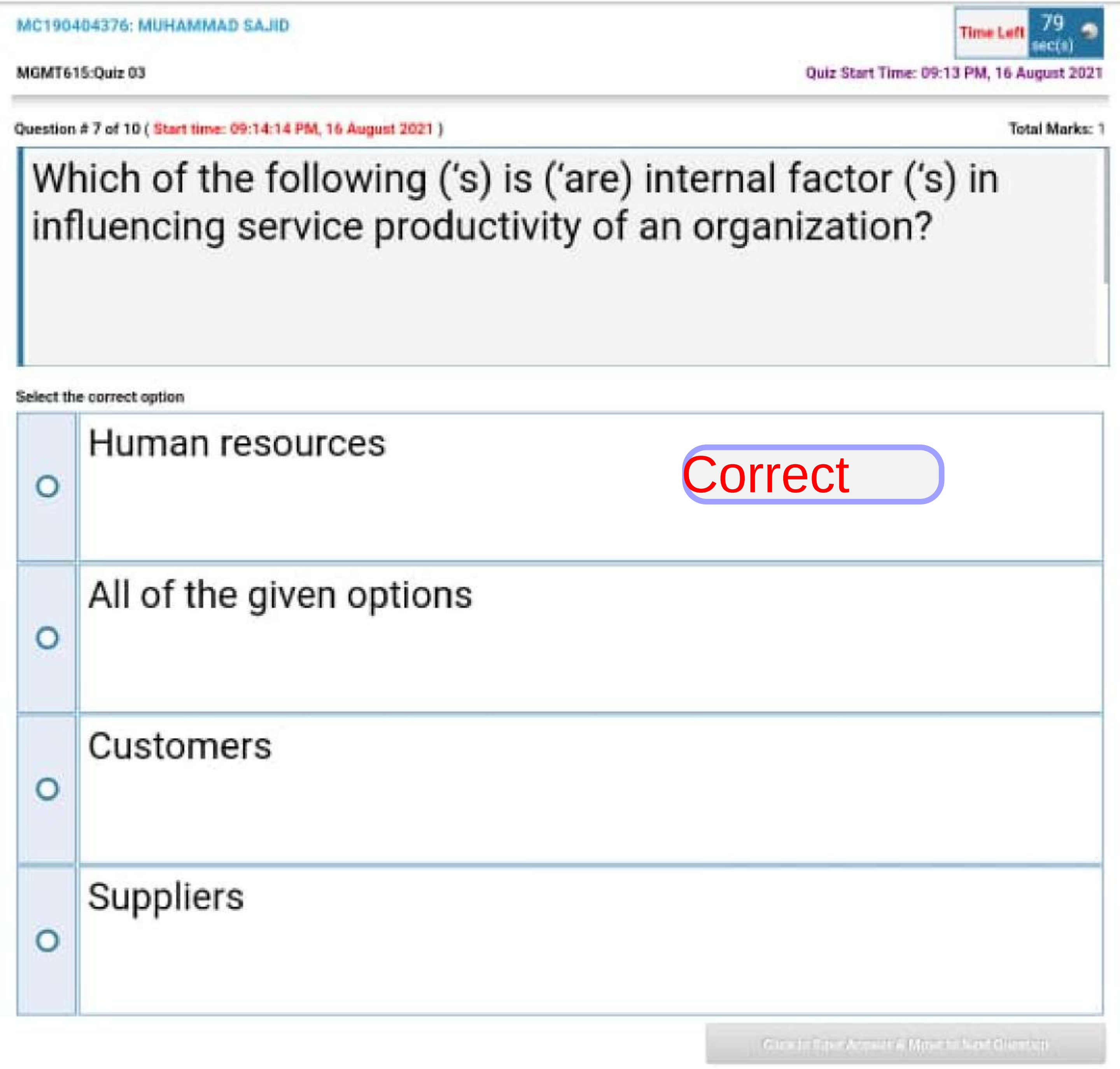
○ Materials are taxed at lower rates

○ Materials are imported duty-free as inputs to production

Correct

● Labor is cheap at such zones

○ The materials are of high quality at such zones



MC190404376: MUHAMMAD SAJID

MGMT615:Quiz 03

Quiz Start Time: 09:13 PM, 16 August 2021

Question # 7 of 10 ( Start time: 09:14:14 PM, 16 August 2021 )

Total Marks: 1

Which of the following ('s) is ('are) internal factor ('s) in influencing service productivity of an organization?

Select the correct option

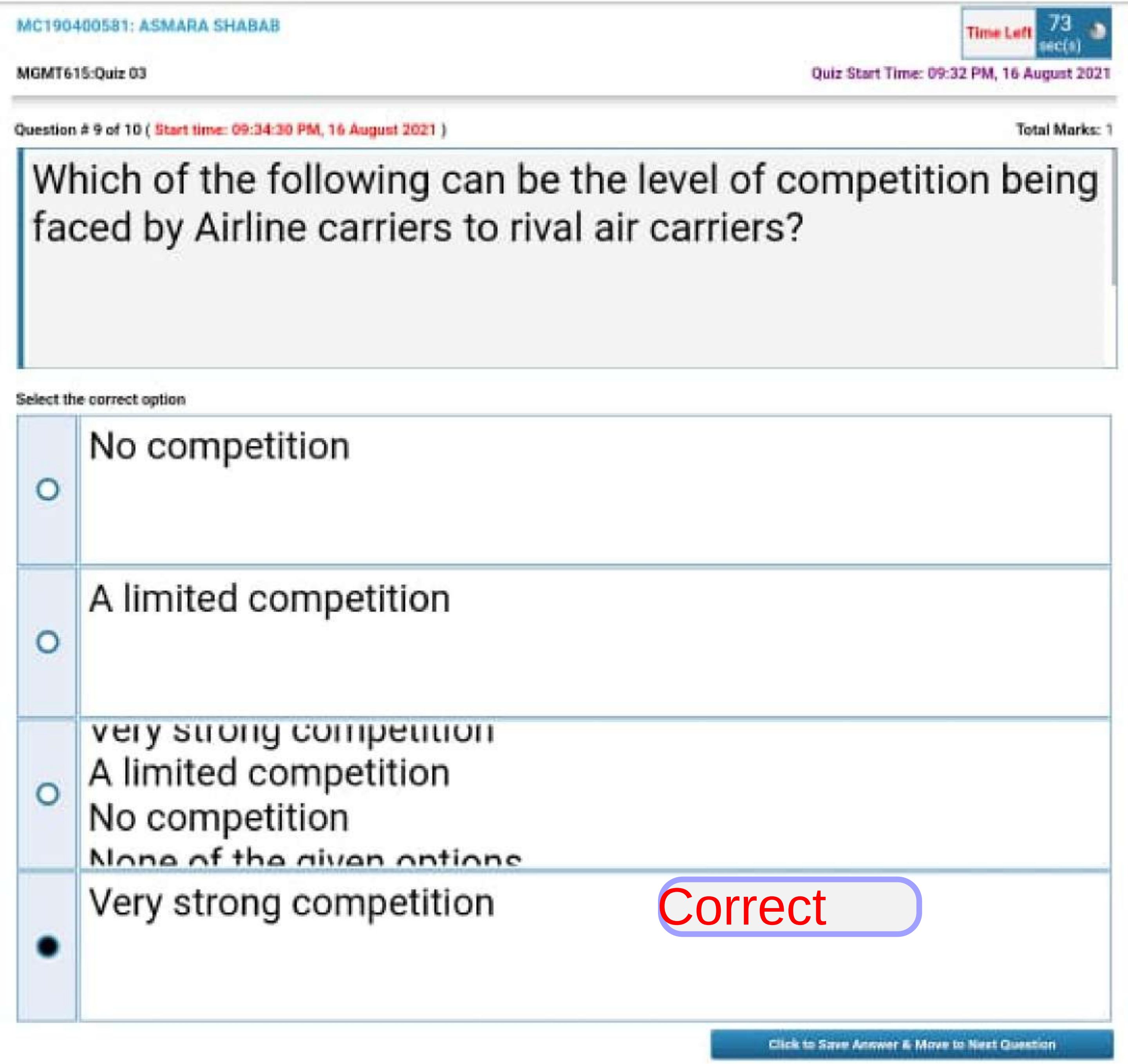
○ Human resources

Correct

○ All of the given options

○ Customers

○ Suppliers



MC190400581: ASMARA SHABAB

MGMT615:Quiz 03

Time Left 73 sec(s)

Quiz Start Time: 09:32 PM, 16 August 2021

Question # 9 of 10 ( Start time: 09:34:30 PM, 16 August 2021 )

Total Marks: 1

Which of the following can be the level of competition being faced by Airline carriers to rival air carriers?

Select the correct option

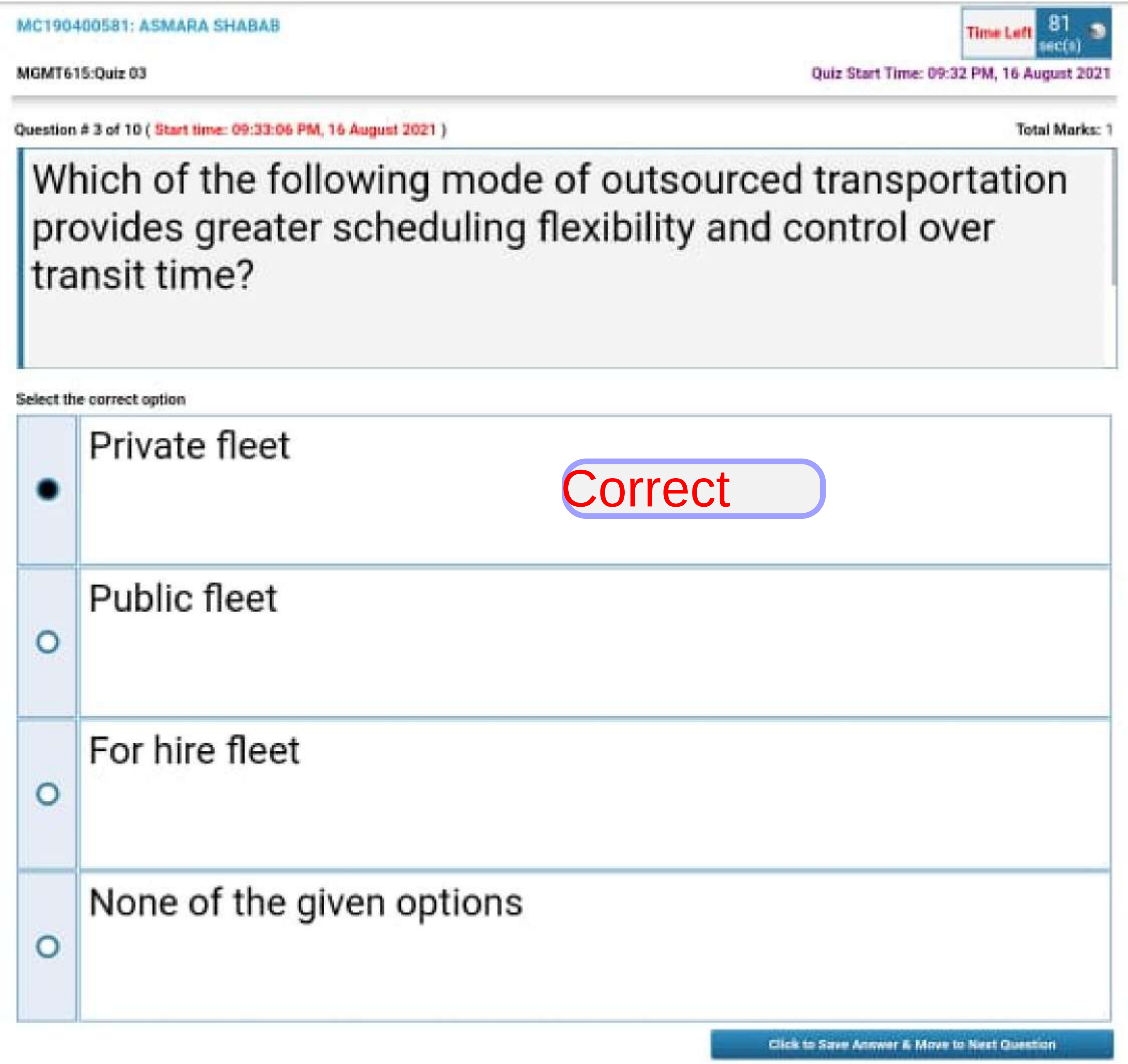
○ No competition

○ A limited competition

○ Very strong competition
A limited competition
No competition
None of the given options

● Very strong competition

Correct



MC190400581: ASMARA SHABAB

MGMT615:Quiz 03

Quiz Start Time: 09:32 PM, 16 August 2021

Question # 3 of 10 ( Start time: 09:33:06 PM, 16 August 2021 )

Total Marks: 1

Which of the following mode of outsourced transportation provides greater scheduling flexibility and control over transit time?

Select the correct option

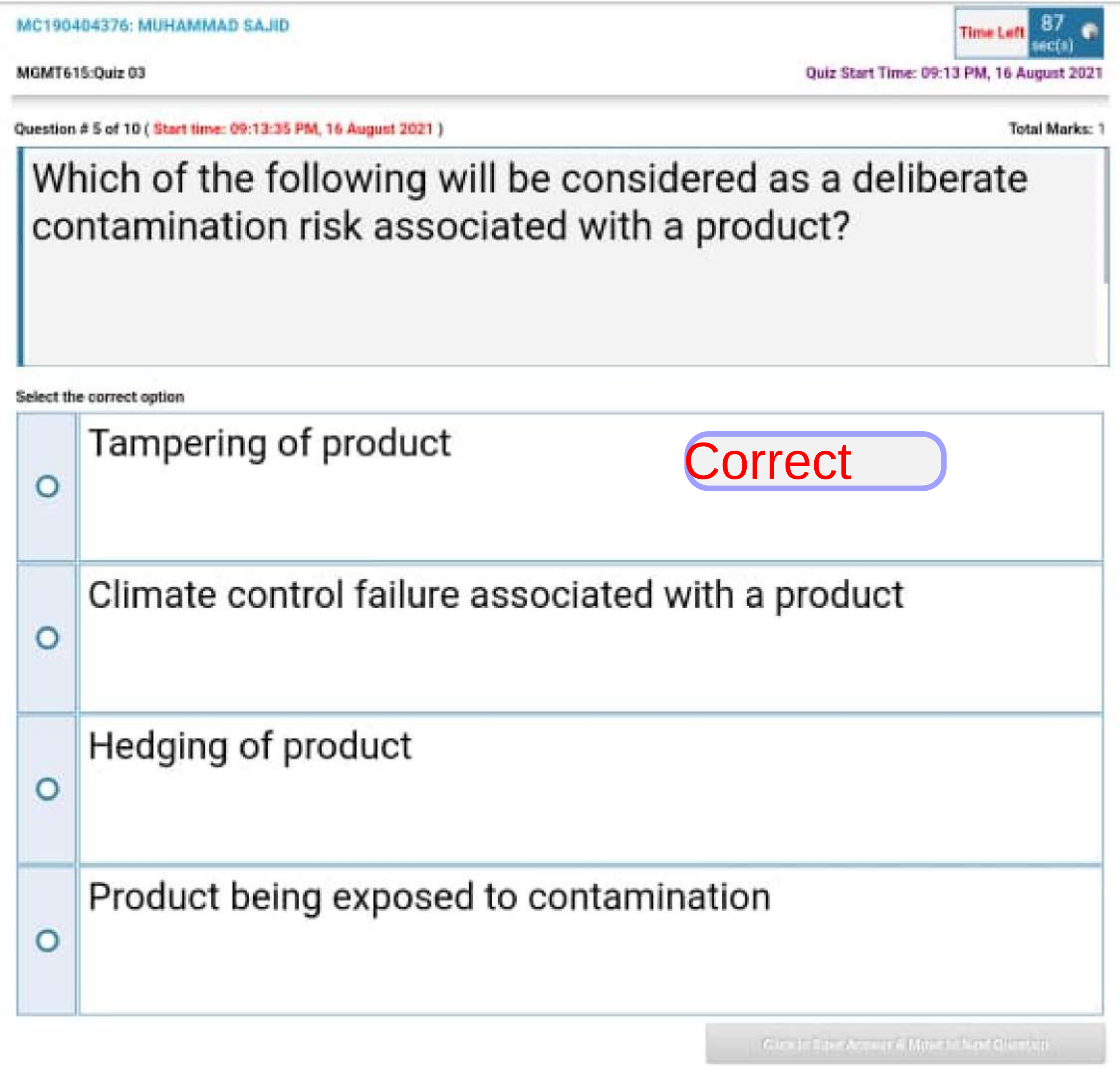
● Private fleet

Correct

○ Public fleet

○ For hire fleet

○ None of the given options



MC190404376: MUHAMMAD SAJID

MGMT615:Quiz 03

Quiz Start Time: 09:13 PM, 16 August 2021

Question # 5 of 10 ( Start time: 09:13:35 PM, 16 August 2021 )

Total Marks: 1

Which of the following will be considered as a deliberate contamination risk associated with a product?

Select the correct option

○ Tampering of product

Correct

○ Climate control failure associated with a product

○ Hedging of product

○ Product being exposed to contamination

# MGMT615 – TRANSPORTATION & LOGISTICS MANAGEMENT
## LECTURE 1 - 11 QUIZ # 1 FILE
## Dec 2021

1. Which of the following (‘s) is (‘are) the benefits of collaborative logistics?

   a. Dynamic creation, measurement, and evolution of collaborative partnerships
   b. Co-buyer and co-supplier relationships
   **c. All of the given options (PPTS Page no 343 and 344)**
   d. Flexibility and security

2. Logistical integration depends on what?

   a. Social factors
   **b. Product nature (PPT Page no 194)**
   c. Economic factors
   d. Size of the organizations

3. Which of the followings is an operational objective that is about establishing a trade-off between safety stock inventory or use of high - cost premium transportation?

   a. Movement consolidation
   **b. Minimum variance (PPT Page no 215)**
   c. Rapid response
   d. Minimum inventory

4. Which of the following can be the result of inaccurate order processing information?

   a. Postponement
   **b. Higher logistics cost (PPT Page no 201)**
   c. Increased lead time
   d. Wrong inventory positioning

5. Which one of the following is NOT a key decision area of logistics management?

   **a. Recruitment and selection (PPT Page no 168)**
   b. Material handling
   c. Packaging
   d. Warehousing

6. Which of the following statement is TRUE about inventory?

   a. It is part of owner's equity on balance sheet
   b. It is a liability on balance sheet and variable expense on income statement
   **c. It is an asset on balance sheet and variable expense on income statement (PPT Page no 235)**
   d. It is a liability on balance sheet and fixed expense on income statement

7. What is the intensity of the magnitude of variance for finished goods and inventory delivery?

   a. No variance
   **b. High (PPT Page no 234)**
   c. Low
   d. Moderate

8. The customers which have high cost to serve and higher sales fall in which of the following segment in CRM?

   **a. Cost Engineer (PPT Page no 268 and Page no 26 Handouts)**
   b. Protect segment
   c. Danger segment
   d. Build Segment

9. Which of the following comprises the number of various entities that are available for the provision of same distribution function in a distribution channel?

   a. Channel Width
   **b. Channel length (PPT Page no 142)**
   c. Channel Map
   d. Channel Breadth

10. Time and variance related to order processing are function of what?

    a. Workload
    b. Degree of automation
    c. Policies related to order approval
    **d. All of the above options (PPT Page no 218)**

11. Which of the followings is an operational objective that is concerned with a firm's ability to satisfy customer service requirements in timely manner?

    a. Movement consolidation
    **b. Rapid response (PPT Page no 215)**
    c. Minimum variance
    d. Minimum inventory

12. Which of the following is the first step while implementing the Customer Relationship Management (CRM) process within a business environment?

    **a. Segment the Customer Base by Profitability (PPT Page no 237)**
    b. Identify the Product/Service Package for Each Customer Segment
    c. Develop and Execute the Best Processes
    d. Measure Performance and Continuously Improve

13. Which of the following factor('s) are more important in evolution of logistics management?

    a. Emerging information technology
    **b. All of the given functions (PPT Page no 190)**
    c. Economic necessity
    d. Quantification of reduced inventory costs through logistics

14. Collaboration within a supply chain that involves the relationship between buyer and supplier is termed as which of the following?

    a. Triangular Collaboration
    b. Straight Collaboration
    c. Horizontal Collaboration
    **d. Vertical Collaboration (PPT Page no 339)**

15. Providing best service to the customers segments of supplier organization thus resulting in increased profits for them is goal of which of following?

    a. Logistic Management
    **b. Customer Relationship Management (PPT Page no 95)**
    c. Supply Chain Management
    d. Production Management

16. Which of the following does not require direct line of sight to read a tag and information on the tag is updatable?

    a. Bar Code
    **b. RFID (PPT Page no 409)**

17. Which of the followings is an operational objective that involves reducing inventory deployment like zero inventory and maximizing rate of inventory usage over time?

    a. Movement consolidation
    b. Rapid response
    c. Minimum variance
    **d. Minimum inventory (PPT Page no 217)**

18. Which of the following is the economic utility(s) that add value to customers?

    **a. All of the above utilities (Page no 17 Handouts)**
    b. Form utility
    c. Place utility
    d. Possession utility

19. Logistics competency can be achieved by coordinating all of the following EXCEPT:

    a. Warehousing
    b. Information
    c. Material handling
    **d. Training and development (PPT Page no 178)**

20. Logistical alliances were built around the competencies of specialized service firms. What was the objective behind these alliances?

    a. None of the above options
    b. To link employees to different supply chain partners
    **c. To link buyers and sellers (PPT Page no 194)**
    d. To link different departments of a firm

21. In which situation, traditional cost accounting is very effective?

    a. where the output is correlated with the price
    **b. where the output is correlated with the allocation base (PPT Page no 295)**
    c. where the output is not correlated with the allocation base
    d. where the output is not correlated with the price

22. Which of the following customer actions affects firm's cost?

    a. How much customer order
    b. How customers order
    c. What customers order
    **d. All of the above options (PPT Page no 254)**

23. Logistical competency requires integration of which of the following functions?

    a. Information & Transportation
    b. Inventory & warehousing
    c. Material handling & packaging
    **d. All of the given options (PPT Page no 164)**

24. Performance management of logistical system is concerned with which of the followings?

    **a. All of the above options (PPT Page no 195)**
    b. Availability of inventory
    c. Operational capability
    d. Quality of efforts

25. Logistics management includes the design and administration of system to control the flow of which of the following?

    a. Work-in-process
    **b. All of the given options (PPT Page no 172)**
    c. Finished inventory
    d. Material

26. In customer focused marketing, basic customer service is measured in terms of which of the following?

    a. Availability of product and services
    b. Performance of product and services
    **c. All of the above options (PPT Page no 226)**
    d. Reliability of product and services

27. Which of the following ('s) is ('are) type of 3PL logistics?

    a. Warehouse/distribution-based
    **b. All of the given options (PPT Page no 350)**
    c. Transportation-based
    d. Forwarder-based

28. Which of the following is a demand for which internal demand of parts is based on the demand of the final product in which the parts are used?

    a. Independent Demand
    **b. Dependent Demand (PPT Page no 391)**
    c. Cyclic Demand
    d. Seasonal demand

29. In which of the following transportation costs will be lower?

    a. Automation
    b. Mass production
    c. Standardization
    **d. Customization (PPT Page no 325)**

30. Which one of the following is the overall objective of Logistic Management?

    **a. To achieve a targeted level of customer service at the lowest possible total cost (PPT Page no 160)**
    b. To achieve zero defect production capacity
    c. To achieve a cross functional orchestration of logistical activity within and beyond one firm
    d. To integrate different value chains within a production system

31. The products which are ready for shipment are regarded as which type of inventory?

    a. Raw material
    b. Maintenance, repair & operating
    **c. Finished Goods (PPT Page no 410)**
    d. Work in process

32. Which of the following party logistic constitute a firm that is required to possess its own freight, cargo and good being transported from one point to another point?

    a. 3PL
    b. 4PL
    c. 2PL
    **d. 1PL [Google]**

33. Which of the followings is/are operational objective(s) to be carried out by the firm to determine logistical performance?

    **a. All of the above options (PPTS Page no 199)**
    b. Quality attribute
    c. Rapid response
    d. Movement consolidation

34. A costing approach that deals with defining activities and assigning costs to every identified activity and resources are allocated according to their actual consumption is called as:

    a. Traditional Costing
    b. Overhead costing
    c. None of the given options
    **d. Activity Based Costing (From Google)**

35. Which of the followings alternative(s) is/are available for danger zone customers?

   a. **All of the above (PPT Page no 265)**
   b. Switch the customer to an alternative distribution channel
   c. Charge the customer the actual cost of doing business
   d. Change customer interaction with firm so the customer can move to another segment

36. In ABC inventory system, which of the following items are given the highest priority while keeping their larger safety stocks.

   a. B items
   b. All of the given options
   **c. A items (PPT Page no 404)**
   d. C items

37. The objective to evaluate the CRM program after implementation is to determine what?

   a. customer needs and set target performance levels
   b. varying the product quality or service levels for each customer segment
   c. how to "package" the value-adding products and services for each customer segment
   d. **If the different customer segments are satisfied (Page no 25 Handouts)**

38. The request for the return of a product after it has been reported with defects that may put danger to consumer health or can provoke a legal action against the company is termed as:

**a. Product Recall (From Google)**
b. Scrap
c. Product Remanufacturing
d. Reverse Logistics

39. Which of the following is the third step while implementing the Customer Relationship Management (CRM) process within a business environment?

a. Segment the Customer Base by Profitability
b. Identify the Product/Service Package for Each Customer Segment
**c. Develop and Execute the Best Processes (PPT Page no 240)**
d. Measure Performance and Continuously Improve

40. Which of the following factor('s) is ('are) important while considering transportation operations?

a. Cost
b. Consistency
c. Speed
**d. All of the given options (PPT Page no 189)**

41. How many eras of globalization have evolved so far?

a. Five
b. Seven
c. Nine
**d. Three (PPT Page no 361)**

42. Walmart is famous for:

**a. Best distribution and transportation channels (PPT Page no 237)**
b. Better quality products
c. Best manufacturers in market
d. Efficient staff management

43. What was the major reason behind the absence of cross functional integration, during the evolution of marketing?

**a. Unavailability of computers and quantitative techniques (PPT Page no 177)**
b. Unavailability of skilled employees
c. Unavailability of major theoretical concepts
d. Unavailability of infrastructure

44. Forecasting and order management are two areas of logistical work that depends on what?

**a. Information (PPT Page no 200)**
b. Warehousing
c. Procurement
d. Material handling

45. Which of the following terms measures the mission of a logistical system?

a. Fixed cost and inventory costs
b. Inventory turnover and profits
**c. Total cost and performance (PPT Page no 181)**
d. Fixed and variable costs

46. Which of the following statement is(are) true for CRM?

a. Objective of CRM is to improve the profitability of the organization
b. CRM is the art and science of strategically positioning customers
**c. All of the above statements (PPT Page no 252)**
d. Objective of CRM is to enhance its relationships with its customer base.

47. Which of the following is a picture of the current channels used to reach end user segments?

a. Channel length
b. Channel Width
**c. Channel Map (PPT Page no 291)**
d. Channel Breadth

48. Contemporary logistics involves which type of integration of the core competencies of an enterprise?

a. External
b. Internal
**c. Both internal and external (PPT Page no 180)**
d. Neither internal nor external

49. Which of the following is the second step while implementing the Customer Relationship Management (CRM) process within a business environment?

a. Segment the Customer Base by Profitability
**b. Identify the Product/Service Package for Each Customer Segment (PPT Page no 257)**
c. Develop and Execute the Best Processes
d. Measure Performance and Continuously Improve

50. Basic logistical service is measured in which of the following terms?

a. Service reliability
b. Availability
**c. All of the given options (PPT Page no 172)**
d. Operational performance

51. In ABC inventory system, which of the following items account for the remaining 40% of total items and 5% of total inventory cost?

a. B items
b. All of the given options
c. A items
**d. C items (PPT Page no 420)**

52. Identify the effect of assuring consistency in transportation on safety stock from below given options?

a. Consistency in transportation and safety stock levels have no relation with each other
**b. It will lead to a decrease in level of inventory safety stock (PPT Page no 39)**
c. There will be no effect on safety stock
d. It will lead to an increase in level of inventory safety stock.

53. Which of the followings is/are primary operational area(s) of logistic management?

a. Manufacturing support
b. Physical distribution
**c. All of the above options (PPT Page no 197)**
d. Procurement

54. Which one of the following is NOT an operational objective to be achieved by the firm to determine logistical performance?

a. Rapid response
b. Movement consolidation
c. Life cycle support
**d. Demand creation (PPT Page no 198)**

55. Which of the following term represents inventory usage over time?

a. Inventory safety stock
**b. Turn velocity (PPT Page no 217)**
c. Inventory turnover
d. Economic order quantity

56. Which one of the following is NOT a key decision area of logistics management?

a. Packaging
b. Warehousing
c. Material handling
**d. Recruitment and selection (PPT Page no 168)**

57**.** Which of the following (‘s) represents the purpose (‘s) of reverse logistics?

a. Enable proper disposal of products
b. Capturing value
**c. All of the following (Read Reverse Logistics Page no 147 Handouts)**
d. Reuse of products or materials

58. Which one of the following involves the quality attributes of logistics?

**a. Service reliability (PPT Page no 188)**
b. None of the given options
c. Availability
d. Operational performance

59. A carriage company that deals in the transportation of its own goods is called as:

**a. Private Carriage [Google]**
b. Common Carriage
c. None of the given options
d. Contract Carriage

60. A type of Carriage Company in which the rights, duties and liabilities for both the carrier and cosigner are properly defined and followed is called as which of the following?

a. Private Carriage
b. Common Carriage
c. None of the given options
d. **Contract Carriage [Google]**

# MGMT 615 MCQS FILE

1. Which of the following can be the level of competition being faced by Airline carriers to rival air carriers?

    a. No competition
    b. A limited competition
    c. Which of the following can be the level of competition being faced by Airline carriers to rival air carriers? Very strong competition
    **d. Very strong competition**

2. Which of the following ('s) is ('are) the factors which must be considered while designing distribution strategies?

    **a. All of the given options (PPT Page no 1031)**
    b. Available external resources
    c. Customer requirements
    d. Available internal expertise

3. Which will be the impact on warehouse management system with the number of increase in warehouses?

    **a. System will become more centralized**
    b. Responsiveness will increase
    c. System will stop responding
    d. System will collapse

4. What are the various factors to be considered in capability requirements step of designing an efficient Distribution Planning and Strategy for an organization?

    **a. All of the given options (PPT Page no 1033)**
    b. Product attributes
    c. Roles to be fulfilled
    d. Flow requirements

5. Which of the following can be reason for inventory errors?

    a. Well trained personnel
    b. Security of stock
    c. Authorized withdrawal
    **d. Deficiency of audit capability**

6. Queuing time deals with management of which of the following functions?

   a. The way in which customer arrival & service times distributed
   b. The order in which customers will be serviced
   **c. All of the given options (PPT Page no 1189, 1190)**
   d. Average arrival rate of the customers

7. Which of the following (‘s) is (‘are) characteristics of foreign trade zones (FTZs)?

   a. Materials are taxed at lower rates
   **b. Materials are imported duty-free as inputs to production (PPT Page no 927)**
   c. Labor is cheap at such zones
   d. The materials are of high quality at such zones

8. Which of the following is regarded as most widely used & simplest of all queuing models?

   a. None of the given options
   b. Multiple-channel, single-phase queuing system
   **c. Single- Channel, Single-Phase Queuing System (PPT Page no 1213)**
   d. Diverse-Channel, Single-Phase Queuing System

9. Which one of the following can be a major competitor for water carriers in transportation of coal, grain and ores?

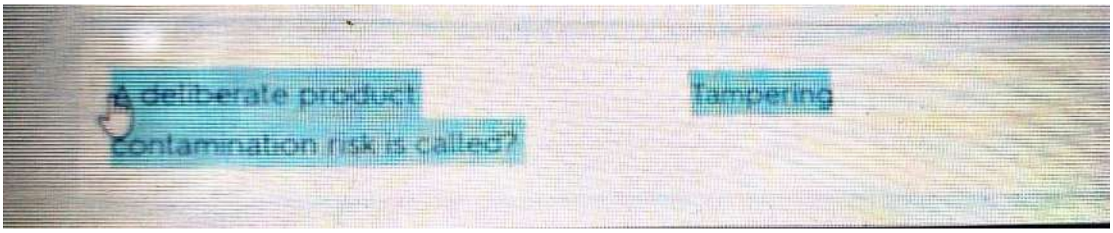
   **a. Rail roads (Page no 106 Handouts)**
   b. All can be the competitors for said material transportation
   c. Motor carriers
   d. Air carriers

10. Which one of the following (‘s) is (are) products that can be accumulated in bulk amounts?

   **a. All of the given options**
   b. Mobiles
   c. Laptops
   d. Wheat

11. Which of the following will be considered as a deliberate contamination risk associated with a product?

   **a. Tampering of product (From Google)**
   b. Climate control failure associated with a product
   c. Hedging of product
   d. Product being exposed to contamination



A deliberate product contamination risk is called?

Tampering

12. Which of the following mode of outsourced transportation provides greater scheduling flexibility and control over transit time?

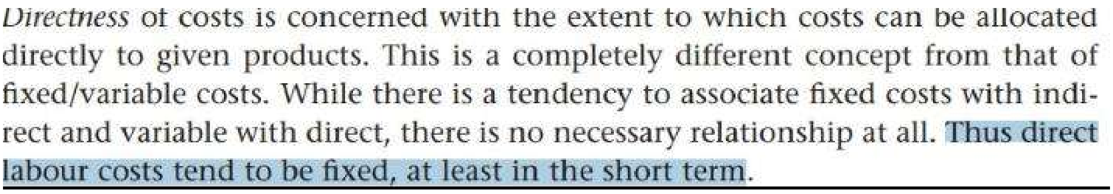
    **a. Private fleet (PPT Page no 866)**
    b. Public fleet
    c. For hire fleet
    d. None of the given options

13. Which of the following ('s) is ('are) internal factor ('s) in influencing service productivity of an organization?

    **a. Human resources**
    b. All of the given options
    c. Customers
    d. Suppliers

14. Labor costs are regarded as which of the following type of cost?

    a. Opportunity costs
    b. Sunk cost
    c. Variable cost
    **d. Fixed cost (From Google)**



*Directness* of costs is concerned with the extent to which costs can be allocated directly to given products. This is a completely different concept from that of fixed/variable costs. While there is a tendency to associate fixed costs with indirect and variable with direct, there is no necessary relationship at all. Thus direct labour costs tend to be fixed, at least in the short term.

15. Which of the following can be a major disadvantage of water carriers?

    **a. It has accessibility constraints to inland areas**
    b. It is not properly regulated
    c. It cannot transport bulk amounts
    d. It is not a safer mode of transportation

**Reference:**
**As water carrier cannot go inland.**

16. Which of the following must be observed while receiving goods by a warehouse?

    a. **All of the given options (From Google)**
    b. Checking goods according to order and bill of lading
    c. Inspection of goods when required
    d. Checking for damaged items

What should be checked when receiving a stock delivery?

**A receiving record details the exact time and date of delivery, the invoice number and remarks signed by the person who has accepted the goods.**

1. Check quantity in delivery. ...
2. Check condition on delivery. ...
3. Check quantity and quality after delivery. ...
4. Store the stock securely. ...
5. Deal with damaged or missing stock after delivery.

17. Tolls and fuel mileage taxes are considered as which of the following charges in public transportation promotion system?

    a. Relative Use
    b. Absolute Charge
    c. Existence charge
    d. **Unit Charge (PPT Page no 635)**

18. Logistical integration depends on what?

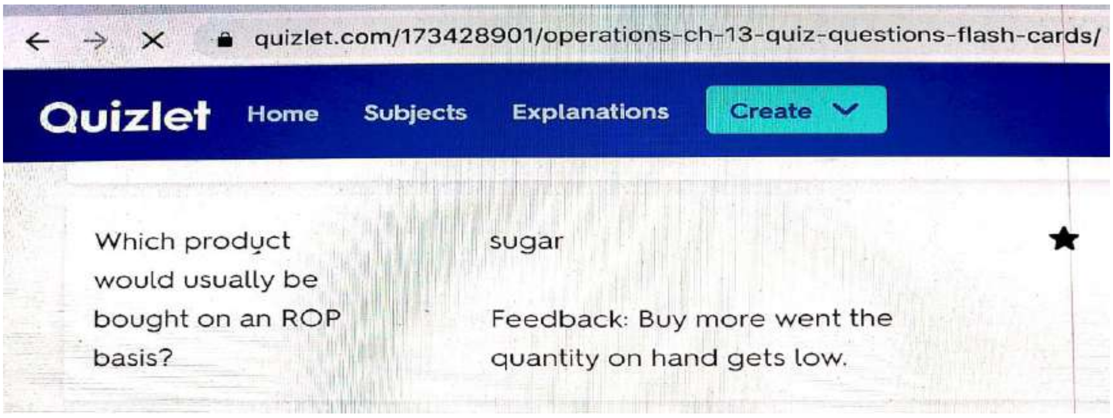
    a. Social factors
    b. **Product nature (PPT Page no 194)**
    c. Economic factors
    d. Size of the organizations

19. Which of the following does not require direct line of sight to read a tag and information on the tag is updatable?

    a. Bar Code
    b. **RFID (PPT Page no 409)**

20. Which of the following represents the product for which it is appropriate to be purchased on the ROP basis?

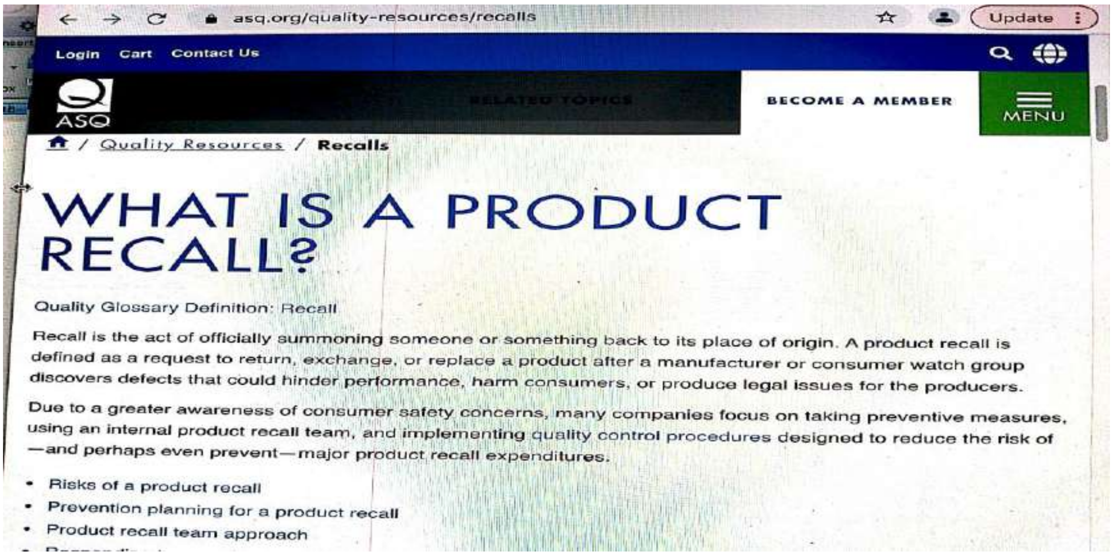
    a. Text books
    **b. Sugar (From Google)**



| | |
|---|---|
| Which product would usually be bought on an ROP basis? | sugar<br>Feedback: Buy more went the quantity on hand gets low. |

21. The request for the return of a product after it has been reported with defects that may put danger to consumer health or can provoke a legal action against the company is termed as:

    **a. Product Recall (From Google)**
    b. Scrap
    c. Product Remanufacturing
    d. Reverse Logistics



WHAT IS A PRODUCT RECALL?

Quality Glossary Definition: Recall

Recall is the act of officially summoning someone or something back to its place of origin. A product recall is defined as a request to return, exchange, or replace a product after a manufacturer or consumer watch group discovers defects that could hinder performance, harm consumers, or produce legal issues for the producers.

Due to a greater awareness of consumer safety concerns, many companies focus on taking preventive measures, using an internal product recall team, and implementing quality control procedures designed to reduce the risk of —and perhaps even prevent—major product recall expenditures.

- Risks of a product recall
- Prevention planning for a product recall
- Product recall team approach

22. Which one of the following is the overall objective of Logistic Management?

    **a. To achieve a targeted level of customer service at the lowest possible total cost (PPT Page no 160)**
    b. To achieve zero defect production capacity
    c. To achieve a cross functional orchestration of logistical activity within and beyond one firm
    d. To integrate different value chains within a production system

23. Which of the followings is/are operational objective(s) to be carried out by the firm to determine logistical performance?

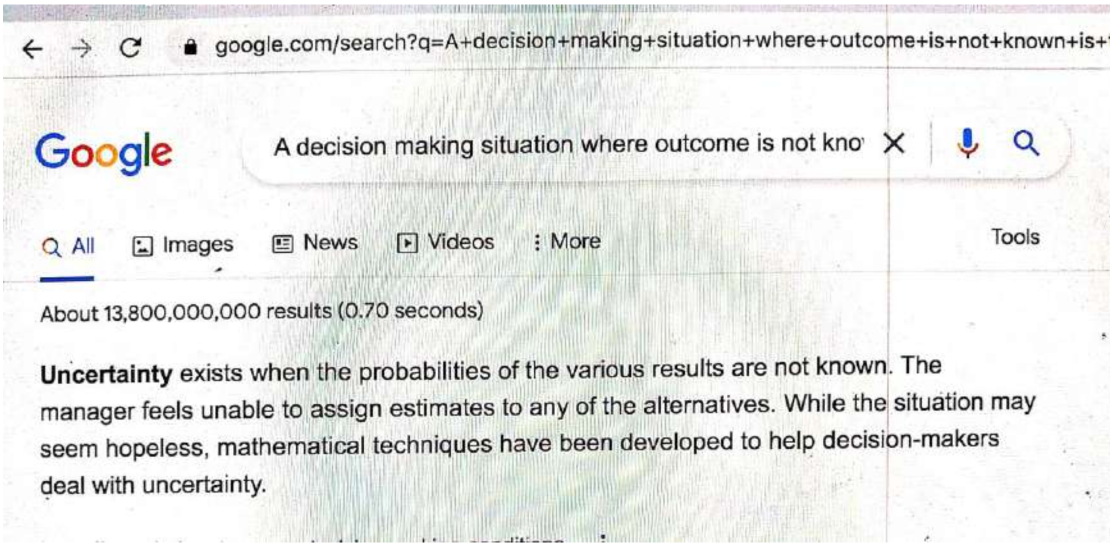
    **a. All of the above options (PPTS Page no 199)**
    b. Quality attribute
    c. Rapid response
    d. Movement consolidation

24. Which of the following is a picture of the current channels used to reach end user segments?

    a. Channel length
    b. Channel Width
    **c. Channel Map (PPT Page no 291)**
    d. Channel Breadth

25. A decision making situation where outcome is not known is termed as:

    **a. Uncertainty (From Google)**
    b. Loss
    c. Probability
    d. Certainty



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**Uncertainty** exists when the probabilities of the various results are not known. The manager feels unable to assign estimates to any of the alternatives. While the situation may seem hopeless, mathematical techniques have been developed to help decision-makers deal with uncertainty.

26. Walmart is famous for:

    a. **Best distribution and transportation channels (PPT Page no 237)**
    b. Better quality products
    c. Best manufacturers in market
    d. Efficient staff management

27. In ABC inventory system, which of the following items are given the highest priority while keeping their larger safety stocks.

    a. B items
    b. All of the given options
    c. **A items (PPT Page no 404)**
    d. C items

28. Time and variance related to order processing are function of what?

    a. Workload
    b. Degree of automation
    c. Policies related to order approval
    d. **All of the above options (PPT Page no 218)**

29. Which of the following factor('s) is ('are) important while considering transportation operations?

    a. Cost
    b. Consistency
    c. Speed
    d. **All of the given options (PPT Page no 189)**

30. Logistical competency requires integration of which of the following functions?

    a. Information & Transportation
    b. Inventory & warehousing
    c. Material handling & packaging
    d. **All of the given options (PPT Page no 164)**

31. Basic logistical service is measured in which terms?

    a. Availability
    b. Operational performance
    c. Service reliability
    d. **All of the above (PPT Page no 172)**

32. Which of the following is the <u>first</u> step while implementing the Customer Relationship Management (CRM) process within a business environment?

    a. **Segment the Customer Base by Profitability (PPT Page no 237)**
    b. Identify the Product/Service Package for Each Customer Segment
    c. Develop and Execute the Best Processes
    d. Measure Performance and Continuously Improve

33. Which of the following is the <u>third</u> step while implementing the Customer Relationship Management (CRM) process within a business environment?

    a. Segment the Customer Base by Profitability
    b. Identify the Product/Service Package for Each Customer Segment
    c. **Develop and Execute the Best Processes (PPT Page no 240)**
    d. Measure Performance and Continuously Improve

34. The customers falling in which of the following 'segment' are considered <u>least</u> profitable for the shipper?

    a. Build Segment
    b. Protect segment
    c. **Danger Zone segment (Page no 12 Handouts)**
    d. Cost Engineer

35. The customers falling in which of the following 'segment' are considered <u>most</u> profitable for the shipper?

    a. Build Segment
    b. **Protect segment (Page no 11 Handouts)**
    c. Danger Zone segment
    d. Cost Engineer

36. Which of the following (‘s) is (‘are) economic benefits of transportation?

    a. Enhanced competition
    b. Evaluation in land value
    **c. All of the given options (Not sure)**
    **d. Production on large scale (Not sure)**

37. Which of the following vehicle have cargo and power unit combined in one vehicle?

    a. Open Top vehicles
    **b. City straight trucks (PPT Page no 724)**
    c. High cube
    d. Line-haul Vehicles

38. Which of the following is a demand for which internal demand of parts is based on the demand of the final product in which the parts are used?

    a. Independent Demand
    **b. Dependent Demand (PPT Page no 391)**
    c. Cyclic Demand
    d. Seasonal demand

39. Which of the following terms measures the mission of a logistical system?

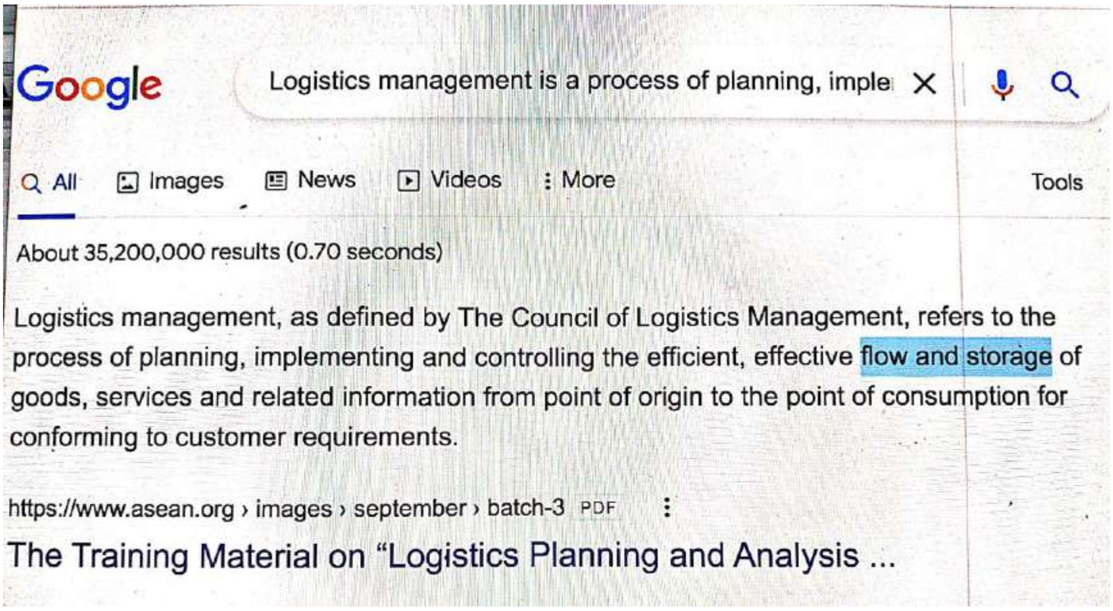
    a. Fixed cost and inventory costs
    b. Inventory turnover and profits
    **c. Total cost and performance (PPT Page no 181)**
    d. Fixed and variable costs

40. Which of the following (‘s) represents the purpose (‘s) of reverse logistics?

    a. Enable proper disposal of products
    b. Capturing value
    **c. All of the following (Read Reverse Logistics Page no 147 Handouts)?**
    d. Reuse of products or materials

41. Logistics management is a process of planning, implementing and controlling the efficient and effective:

    **a. Flow and storage (From Google)**
    b. Sales and marketing
    c. Usage and Consumption
    d. Design and development



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Logistics management, as defined by The Council of Logistics Management, refers to the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from point of origin to the point of consumption for conforming to customer requirements.

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The Training Material on "Logistics Planning and Analysis ...

42. Which one of the following is NOT an operational objective to be achieved by the firm to determine logistical performance?

    a. Rapid response
    b. Movement consolidation
    c. Life cycle support
    **d. Demand creation (PPT Page no 198)**

43. Driver's license and auto registration fees are considered as which of the following charges in public transportation promotion system?

    a. Absolute Charge
    b. Unit Charge
    **c. Existence charge (PPT Page no 634)**
    d. Relative Use

44. In customer focused marketing, basic customer service is measured in terms of which of the following?

    a. Availability of product and services
    b. Performance of product and services
    **c. All of the above options (PPT Page no 226)**
    d. Reliability of product and services

45. What was the major reason behind the absence of cross functional integration, during the evolution of marketing?

    **a. Unavailability of computers and quantitative techniques (PPT Page no 177)**
    b. Unavailability of skilled employees
    c. Unavailability of major theoretical concepts
    d. Unavailability of infrastructure

46. Which of the followings alternatives is NOT available for danger zone customers?

    a. Charge the customer the actual cost of doing business
    b. **Make a bulk dispatch to such customer (Order Management and Customer Service Page no 12 Handouts) (PPT Page no 251)**
    c. Switch the customer to an alternative distribution channel
    d. Change customer interaction with firm so the customer can move to another segment

47. An approach of transportation control which focuses on developing contracts with carriers for a tailored set of transportation services at rates that fairly compensate the carriers.

    a. Adversarial Approach
    b. **Collaborative Approach (PPT Page no 883)**
    c. Cost volume Approach
    d. Financial Approach

48. The inbound transportation is being controlled by which of the following entity?

    a. **Purchase Department (PPT Page no 858)**
    b. Logistics Department
    c. Marketing Department
    d. Quality control Department

49. Which of the following has shortest transit time for delivery of commodities?

    a. Motor carriers
    b. Water carriers
    c. Rail roads
    d. **Air carriers (PPT Page no 366)**

50. Which of the following will be an impact of imposing high tariffs on imports?

    a. **It will encourage companies to produce locally**
    b. It will facilitate foreign companies to increase their existence in host country
    c. It will encourage to increased imports
    d. It will not have any impact on imports

51. Dr. Kasra Ferdows identified how many types of locations for businesses?

    a. 5
    **b. 6 (PPT Page no 906)**
    c. 8
    d. 10

52. A firm which competes on cost advantage basis is likely to select which of the following options?

    a. A location in a privileged prime market.
    b. A location in a prestigious market
    c. A location that can give competitive advantage over its rivals.
    **d. A location that assures minimum cost**

53. Which of the following ('s) can be reasons for relocation of industrial units to China?

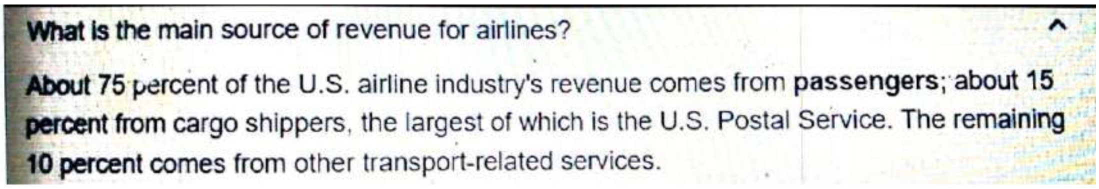
    a. Better access to market
    **b. Both Cheap Labor and better access to market (PPT Page no 930)**
    c. Cheap labor
    d. Infrastructure availability

54. Which of the following is a type of location facility that is characterized by a firm using government incentives, low exchange risk &tariff barriers to reduce taxes & logistics costs?

    **a. Server factory (PPT Page no 908)**
    b. Source factory
    c. Outpost factory
    d. Contributor factory

55. Which one of the following is ('are) the main source ('s) of revenue for airline industry?

    a. The aviation services revenue
    b. The baggage shipments
    **c. The passenger travel (From Google)**
    d. The freight shipments



**What is the main source of revenue for airlines?**

**About** 75 percent of the U.S. airline industry's revenue comes from **passengers**; about 15 percent from cargo shippers, the largest of which is the U.S. Postal Service. The remaining 10 percent comes from other transport-related services.

56. Which of the following is a type of location where the firm is source of innovation & competitive advantage of the organization?

    a. Source factory
    b. Contributor factory
    c. Server factory
    d. **Lead factory (PPT Page no 911)**

57. Which of the following denotes a subset of different edges being connected in a graph with all the vertices joined together with least possible total edge weight and cycles?

    a. **Minimum spanning tree (Read PPT Page no 1004 to 1007)**
    b. Tree graph
    c. Dollar tree
    d. Decision tree

58. Which one of following holds TRUE regarding products which have higher rates of innovation?

    a. The products are low in demand
    b. **The products cannot be accumulated**
    c. Buyers don't like such kinds of products
    d. The products can be accumulated

59. Which of the following can NOT be a facilitating factor that allows companies to locate themselves at different places around the globe?

    a. Faster transportation
    b. **Strict trade and tariff policies (PPT Page no 900)**
    c. Technology
    d. Increased globalization

60. Which of the following ('s) can be the facilitating factors that allow companies to locate themselves at different places around the globe?

    a. **All of the given options (PPT Page no 900)**
    b. Faster transportation
    c. Increased globalization
    d. Technology

61. A type of Rail Car service that comprise of a  freight car with a flat bottom, fixed sides, and no top used primarily for hauling bulk commodities.

    a. Hopper car
    b. Covered hopper
    c. Boxcar
    d. **Gondola (PPT Page no 791)**

62. A type of Rail Car service that comprise of a Standardized roofed freight car with sliding doors on the side used for general commodities.

    a. Hopper car
    b. Covered hopper
    c. **Boxcar (PPT Page no 785)**
    d. Flatcar

63. Which type of commodity is usually transported through water mode?

    a. **Basic raw materials (PPT Page no 846)**
    b. High valued small volume items
    c. Commodities which needs to be delivered quickly
    d. None of the given options

# LOGISTICS MANAGEMENT: AN INTRODUCTION

## LEARNING OBJECTIVES

- Understand the role and importance of logistics in private and public organizations.

- Discuss the impact of logistics on the economy and how effective logistics management contributes to the vitality of the economy.

- Understand the value-added roles of logistics on both a macro and micro level.

- Explain the relationships between logistics and other functional areas such as manufacturing, marketing, and finance.

- Discuss the importance of management activities in the logistics function.

- Analyze logistics systems from several different perspectives to meet different objectives.

- Determine the total costs and understand the cost tradeoffs in a logistics system.

## OVERVIEW

### Introduction

Logistics is misunderstood and often overlooked with the excitement surrounding supply chain management and all of the related technology that has been developed to support the supply chain. The glamour associated with the e-supply chain, e-tailing, e-business, and so on, seems to overshadow the importance of logistics in an organization and the need for efficient and effective logistics support in a supply chain.

The concepts of supply chain management and logistics must be compared or, more appropriately, related to each other. Supply chain management has been defined using a pipeline analogy with the start of the pipeline representing the initial supplier and the end of the pipeline representing the ultimate customer. Another perspective is that of a network of logistics systems and related activities of all the organizations that are part of a supply chain.

### What is Logistics?

The term logistics has become much more widely recognized by the general public in the last 20 years. Television, radio, and print advertising have lauded the importance of logistics. Another factor contributing to the recognition of logistics has been increased customer sensitivity to not only product quality but also to the associated service quality.

Even with increased recognition of the term logistics, however, there is still confusion about its definition. Some of the confusion can be traced to the fact that a number of terms are used by individuals when they refer to what has been described as logistics.

For example, consider the following list of terms:
- Logistics management
- Business logistics management
- Integrated logistics management
- Materials management
- Physical distribution management
- Marketing logistics
- Industrial logistics
- Distribution

The logistics concept began to appear in the business-related literature in the 1960s under the label of physical distribution, which had a focus on the outbound side of the logistics system. During the 1960s, military logistics began to focus on engineering dimensions of logistics—reliability, maintainability, configuration management, life cycle management, and so on—with increased emphasis on modeling and quantitative analysis.

Logistics management is the most widely accepted term and encompasses logistics not only in the private business sector but also in the public/government and nonprofit sectors. For the 21st century, logistics should be viewed as part of organizational management and has four parts: business, military, event, and service logistics. Each of these subdivisions has some common characteristics and requirements such as forecasting, scheduling, and transportation.

- Business logistics: That part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, service, and related information from point of use or consumption in order to meet customer requirements.

- Military logistics: The design and integration of all aspects of support for the operational capability of the military forces (deployed or in garrison) and their equipment to ensure readiness, reliability, and efficiency.

- Event logistics: The network of activities, facilities, and personnel required to organize, schedule, and deploy the resources for an event to take place and to efficiently withdraw after the event.

- Service logistics: The acquisition, scheduling, and management of the facilities/ assets, personnel, and materials to support and sustain a service operation or business.

The general definition of logistics that encompasses all four of these dimensions is “Logistics is the process of anticipating customer needs and wants; acquiring the capital, materials, people, technologies, and information necessary to meet those needs and wants; optimizing the goods or service-producing network to fulfill customer requests; and utilizing the network to fulfill customer requests in a timely manner.

For the purposes of this text, the definition offered by the Council of Supply Chain Management Professionals is the most appropriate. It states that logistics is “The art and science of management, engineering, and technical activities concerned with requirements, design, and supplying and maintaining resources to support objectives, plants, and operations.

### Value-Added Roles of Logistics

Five principle types of economic utility add value to a product or service. Included are form, time, place, quantity, and possession. Generally, production activities are credited with providing form utility; logistics activities with time, place, and quantity utilities; and marketing activities with possession utility. Each will be discussed briefly.

Form Utility: Form utility refers to the value added to goods through a manufacturing or assembly process.

Place Utility: Logistics provides place utility by moving goods from production surplus points to points where demand exists.

Quantity Utility: Today’s business environment demands that products not only be delivered on time to the correct destination but also be delivered in the proper quantities.

Possession Utility: Possession utility is primarily created through the basic marketing activities related to the promotion of products and services.

### Logistical Activities

The responsibility of the logistics manager includes a number of activities. The number and importance of these activities to the business varies according to the particular emphasis placed on the logistics function.

- Transportation involves the physical movement or flow of raw materials or finished goods and involves the transportation agencies that provide service to the firm.

- Storage involves two closely related activities: inventory management and warehousing. A direct relationship exists between transportation and the level of inventory and number of warehouses required. It is important to examine the trade-offs related to the various alternatives in order to optimize the overall logistics system.

- Packaging involves the necessary packaging needed to move the product to the market safely and securely. Logistics managers must analyze the tradeoffs between the type of transportation selected and its packaging requirements.

- Materials Handling is important to efficient warehouse operation and concerns the mechanical equipment for short-distance movement of goods through the warehouse.

- Inventory Control includes assuring appropriate levels of materials are available and certifying inventory accuracy.

- Order Fulfillment consists of the activities involved with completing customer orders. Order fulfillment concerns the total lead time from when the order is placed to actual delivery in satisfactory condition.

- Forecasting involves the prediction of inventory requirement and materials and parts essential to effective inventory control.

- Production Planning concerns the determination of the number of units necessary to provide market coverage. The integration of production planning into logistics has become increasingly popular in large companies to effectively forecast and control inventory.

- Procurement concerns the availability for production of needed parts, components, and materials in the right quantity, at the right time, at the right place, and at the right cost including within the logistics area if it more effectively coordinates and lowers costs for the firm.

- Customer Service levels play an important part in logistics by ensuring the customer gets the right product, at the right time and place. Logistics decisions about product availability and inventory lead time are critical to customer service.

- Facility Location is concerned with optimizing the time and place relationships between plants and markets, or between supply points and plants. Site location impacts transportation rates and service, customer service, inventory requirements, and possible other areas.

- Other activities: Parts and service support is concerned with maintaining an adequate channel to anticipated repair needs. Salvage and scrap disposal deals with reverse logistics systems and channels in order to effectively and efficiently dispose of containers and other scrap at the end of the distribution channel.

### Logistics in the Economy: A Macro Perspective

The overall, absolute cost of logistics on a macro basis will increase with growth in the economy. In other words, if more goods and services are produced, logistics costs will increase. To determine the efficiency of the logistics system, total logistics costs need to be measured in relationship to gross domestic product (GDP), which is a widely accepted barometer used to gauge the rate of growth in the economy.

Some additional understanding of logistics costs can be gained by examining the three major cost categories included in this cost—warehousing and inventory costs, transportation costs, and other logistics costs.

The declining trend for logistics cost relative to GDP is very important to recognize.

In addition to the managerial focus on managing inventory and transportation more efficiently, the total logistics system has received increased attention.

## Logistics in the Firm: The Micro Dimension

Another dimension of logistics is the micro perspective that examines the relationships between logistics and other functional areas in an organization—marketing, manufacturing/operations, finance and accounting, and others. Logistics, by its nature, focuses on processes that cut across traditional functional boundaries, particularly in today's environment with its emphasis on the supply chain. Consequently, logistics interfaces in many important ways with other functional areas.

Logistics Interfaces with Operations/Manufacturing: Length of the production run is a classic interface area between logistics and manufacturing management. Other operational areas of interface include the effects of product seasonal demand, supply-side interfaces, protective packaging, and foreign and third-party alternative sources of production inputs.

Logistics Interfaces with Marketing: Logistics is often referred to as the other half of marketing and plays an important role through the physical movement and storage of goods in selling a product. Interfaces with marketing are discussed in terms of price, product, promotion, and place elements of the marketing mix. Logistics pricing decisions concern carrier pricing, matching discount schedules to transportation rates, and volume relationships affecting the ability to move and store products.

Price: From a logistics perspective, adjusting quantity prices to conform to shipment sizes appropriate for transportation organizations might be quite important.

Product: Another decision frequently made in the marketing area concerns products, particularly their physical attributes.  These changes impact container size and hence container utilization and storage space requirements.

Promotion: Firms often spend millions of dollars on national advertising campaigns and other promotional practices to improve sales. An organization making a promotional effort to stimulate sales should inform its logistics manager so that sufficient quantities of inventory will be available for distribution to the customer. Marketing can either "push" the product through the distribution channel to the customer or "pull" it through.

Place: The place decision refers to the distribution channels decision, and thus involves both transactional and physical distribution channel decisions.

Recent Trends: Perhaps the most significant trend is that marketers have begun to recognize customer service as the interface activity between marketing and logistics and have promoted customer service as a key element of the marketing mix.

While manufacturing and marketing are probably the two most important internal, functional interfaces for logistics in a product-oriented organization, there are other important interfaces. The finance and accounting areas have become increasingly important during the last decade.

## Logistics in the Firm: Factors Affecting the Cost and Importance of Logistics

This section deals with specific factors relating to the cost and importance of logistics. Emphasizing some of the competitive, product, and spatial relationships of logistics can help explain the strategic role of an organization's logistics activities.

Competitive Relationships: Frequently, competition is narrowly interpreted only in terms of price competition. While price is certainly important, in many markets, customer service can be a very important form of competition.

Order Cycle: A well-accepted principle of logistics management is that order cycle length directly affects inventory levels. Stated another way, the shorter the order cycle, the less inventory required to be held by the customer. Order cycle can be defined as the time that elapses from when a customer places an order until the order is received.

Substitutability: Substitutability very often affects the importance of customer service.

Inventory Effect: By increasing inventory costs (either by increasing the inventory level or by increasing reorder points), organizations can usually reduce the cost of lost sales. In other words, an inverse relationship exists between the cost of lost sales and inventory cost.

Transportation Effect: Organizations can usually trade off increased transportation costs against decreased lost sales costs.

## Product Relationships

A number of product-related factors affect the cost and importance of logistics. Among the more significant of these are dollar value, density, susceptibility to damage, and the need for special handling.

Dollar Value: The value of a product typically affects warehousing, inventory, and transportation costs.

Density: Another factor that affects logistics cost is density, which refers to the weight/space ratio of the product.

Susceptibility to Damage: The third product factor affecting logistics cost is susceptibility to damage. The greater the risk of damage to a product, the higher the transportation and warehousing cost.

Special Handling Requirements: Some products might require specifically designed equipment, refrigeration, heating, or strapping, which entail higher costs.

## Spatial Relationships

A final topic that is extremely significant to logistics is spatial relationships, the location of fixed points in the logistics system with respect to demand and supply points. Spatial relationships are very important to transportation costs, since these costs tend to increase with distance.

## Approaches to Analyzing Logistics Systems

The analysis of logistics systems frequently requires different views or perspectives of logistics activities. The best perspective to take depends on the type of analysis that is needed. For example, if an organization wants to analyze the long-run design of its logistics system, a view of logistics that focuses on the organization’s network of node and link relationships would probably be most beneficial. On the other hand, if an organization is evaluating a change in a carrier or mode of transportation, it should probably analyze the logistics system in terms of cost centers. In this section, four approaches to analyzing logistics systems are discussed: (1) materials management versus physical distribution, (2) cost centers, (3) nodes versus links, and (4) logistics channels.

### Materials Management versus Physical Distribution

The classification of logistics into materials management and physical distribution (inbound and outbound logistics) is very useful to logistics management or control in an organization. Frequently, the movement and storage of raw materials in an organization is different from the movement and storage of finished goods.

Balanced System: Some organizations have a reasonably balanced flow on the inbound and outbound sides of their logistics systems.

Heavy Inbound: Some organizations have a very heavy inbound flow and a very simple outbound flow.

Heavy Outbound: A chemical company like ExxonMobil offers a good example of a logistics system with a heavy outbound flow.

Reverse Systems: Some organizations have reverse flows on the outbound side of their logistics systems.

### Cost Centers

A previous discussion mentioned the management activities that many organizations include in the logistics area, namely, transportation, warehousing, inventory, materials handling, and industrial packaging. The breakdown of logistics into various cost centers represents a second approach to logistics system analysis.

### Nodes versus Links

A third approach to analyzing logistics systems in an organization is in terms of nodes and links. The nodes are fixed spatial points where goods stop for storage or processing. Links represent the transportation network and connect the nodes in the logistics system.

### Logistics Channels

A final approach to logistics system analysis is the study of the logistics channel, or the network of intermediaries engaged in transfer, storage, handling, communication and other functions that contribute to the efficient flow of goods. The logistics channel can be viewed as part of the total distribution channel, which includes both the logistics flow as well as the transaction flow which would be of specific interest to the marketing manager. The logistics channel can be simple or complex

### Logistics and Systems Analysis

An earlier section pointed out that improvements in analyses and methodologies have facilitated the development of logistics. One such improvement was systems analysis, or the systems concept. Essentially, a system is a set of interacting elements, variables, parts, or objects that are functionally related to one another and that form a coherent group. The systems concept is something to which most individuals have been exposed at an early educational stage.

## SUMMARY

- Logistics has developed as an important area or function of business since World War II. It has gone through several phases of development in achieving its present status.
- Logistics is a critical part of supply chain management. The coordination and, perhaps, integration of the logistics systems of all the organizations in a supply chain are necessary requirements for successful management of the supply chain.
- Logistics has a number of different definitions because of the broad-based interest in its activities and the recognition of its importance. The definition developed by the Council of Supply Chain Management Professionals is the primary definition used in this text.
- Logistics is an area of management that has four sub-disciplines: business, military, service, and event.
- On a macro basis, logistics-related costs have been decreasing on a relative basis, which has helped the U.S. economy regain its competitive position on a global basis.
- Logistics adds place, time, and quantity utilities to products and enhances the form and possession utilities added by manufacturing and marketing.
- Logistics has an important relationship to manufacturing, marketing, finance, and other areas of the organization.
- Logistics managers are responsible for a number of important activities, including transportation, inventory, warehousing, materials handling, industrial packaging, customer service, forecasting, and others.

- Logistics systems can be viewed or approached in several different ways for analysis purposes, including materials management versus physical distribution, cost centers, nodes versus links, and channels. All four approaches are viable for different purposes.
- Logistics systems are frequently analyzed from a systems approach, which emphasizes total cost and tradeoffs when changes are proposed. Either a short- or a long run perspective can be used.
- The cost of logistics systems can be affected by a number of major factors, including competition in the market, the spatial relationship of nodes, and product characteristics.

# ORDER MANAGEMENT AND CUSTOMER SERVICE

## LEARNING OBJECTIVES

- Understand the relationships between order management and customer service.

- Appreciate how organizations influence customers' ordering patterns as well as how they execute customers' orders.

- Realize that activity-based costing (ABC) plays a critical role in order management and customer service.

- Identify the various activities in the SCOR process D1 (deliver stocked product) and how it relates to the order-to-cash cycle.

- Know the various elements of customer service and how they impact both buyers and sellers.

- Calculate the cost of a stockout.

- Understand the major outputs of order management, how they are measured, and how their financial impacts on buyers and sellers are calculated.

- Be familiar with the concept of service recovery and how it is being implemented in organizations today.

## OVERVIEW

### Introduction

. First, the concept of influencing the order will be presented. This is the phase where an organization attempts to change the manner by which its customers place orders. Second, the concept of order execution will be discussed. This phase occurs after the organization receives the order.

Customer service includes all activities that impact information flow, product flow, and cash flow between the organization and its customers. Customer service can be described as a philosophy, as performance measures, or as an activity that can be an organization-wide commitment to providing customer satisfaction through superior customer service.

### Influencing the Order—Customer Relationship Management

Customer relationship management is the art and science of strategically positioning customers to improve the profitability of the organization and enhance its relationships with its customer base.  The concept of CRM, however, has not been widely used in the business-to business environment as traditionally, manufacturers and distributors are more adept at and actively involved in order execution which involves filling and shipping what their customers order.

There are four basic steps in the implementation of the CRM process in a business-to-business environment.

## Step 1: Segment the Customer Base by Profitability

Most firms allocate direct materials, labor, and overhead costs to customers using a single allocation criterion. However, firms today are beginning to use techniques such as activity-based costing.

## Step 2: Identify the Product/Service Package for Each Customer Segment

This step presents one of the most challenging activities in the CRM process. The goal of this step is to determine what each customer segment values in its relationship with the supplier. The challenge here is how to "package" the value-adding products and services for each customer segment. One solution is to offer the same product/service offering to each customer segment, while varying the product quality or service levels. Another solution to this part of the CRM process is to vary the service offerings for each customer segment.

## Step 3: Develop and Execute the Best Processes

In Step 2, customer expectations were determined and set. Step 3 delivers on those expectations. Organizations many times go through elaborate processes to determine customer needs and set target performance levels, only to fail when it comes to executing on those customer promises.

## Step 4: Measure Performance and Continuously Improve

The goal of CRM is to better serve the different customer segments of the supplier organization, while at the same time improving the profitability of the supplier. Once the CRM program has been implemented, it must be evaluated to determine if (1) the different customer segments are satisfied and (2) the supplier's overall profitability has improved.

The concept behind CRM is simple: align the supplier's resources with its customers in a manner that increases both customer satisfaction and supplier profits.

## Activity-Based Costing and Customer Profitability

Traditional cost accounting is well suited to situations where an output and an allocation process are highly correlated. Traditional cost accounting is not very effective in situations where the output is not correlated with the allocation base. This is the more likely scenario in logistics.

ABC can be defined as, “A methodology that measures the cost and performance of activities, resources, and cost objects.” Resources are assigned to activities, then activities are assigned to cost objects based on their use. ABC recognizes the causal relationships of cost drivers to activities.

Traditional customer profitability analyses would start with gross sales less returns and allowances (net sales) and subtract the cost of goods sold to arrive at a gross margin figure. Although this number might provide a general guideline for the profitability of a customer, it falls short on capturing the real costs of serving a customer.

Those customers who fall into the “Protect” segment are the most profitable as their interactions with the shipper provide the shipper with the most cost efficiencies. Those customers who are in the “Danger Zone” segment are the least profitable and are more than likely incurring a loss for the shipper. For these customers, the shipper has three alternatives: (1) change the manner in which the customer interacts with the shipper so the customer can move to another segment; (2) charge the customer the actual cost of doing business (this would more than likely make the customer stop doing business with the shipper—this is usually not an acceptable strategy employed by most shippers); or (3) switch the customer to an alternative distribution channel.

The customers who fall into the “Build” segment have a low cost to serve and a low net sales value. The strategy here is to maintain the cost to serve but build net sales value to help drive the customer into the “Protect” segment. Finally, the customers who are in the “Cost Engineer” segment have a high net sales value and a high cost to serve.

## Executing the Order—Order Management and Order Fulfillment

The order management system represents the principal means by which buyers and sellers communicate information relating to individual orders of product. Effective order management is a key to operational efficiency and customer satisfaction. To the extent that an organization conducts all activities relating to order management in a timely, accurate, and thorough manner, it follows that other areas of company activity can be similarly coordinated.

The logistics area needs timely and accurate information relating to individual customer orders; thus, more and more organizations are placing the corporate order management function within the logistics area.

### Order-to-Cash (OTC) and Replenishment Cycles

When referring to outbound-to-customer shipments, the term order to cash (or order cycle) is typically used. The term replenishment cycle is used more frequently when referring to the acquisition of additional inventory, as in materials management.

Traditionally, organizations viewed order management as all of those activities that occur from when an order is received by a seller until the product is received by the buyer which is called the order cycle.

Thirteen principal activities constitute the OTC cycle.

D1.1: Process Inquiry and Quote. This step in the process precedes the actual placement of the order by the customer.

D1.2: Receive, Enter, and Validate Order. This step involves the placement and receipt of the order.

D1.3: Reserve Inventory and Determine Delivery Date. This step in the process has traditionally been referred to as order processing. In the case where the seller has inventory to fill the order, the delivery date is based on the concept of available to deliver (ATD). If the seller does not have the inventory but knows when it will be produced internally or delivered from a supplier to the seller's distribution centers, the delivery date is based on the concept of available to promise (ATP).

D1.4: Consolidate Orders. This step examines customer orders to determine opportunities for both freight consolidation as well as for batch warehouse picking schedules. Both of these consolidation opportunities offer cost efficiencies for the seller.

D1.5: Plan and Build Loads. This step takes the freight consolidation opportunities identified in D1.4 and the delivery date given in D1.3 and develops a transportation plan.

D1.6: Route Shipments. This step can follow or be concurrent with D1.5. Here, the "load" (usually a transportation vehicle) is assigned to a specific route for delivery to the customer.

D1.7: Select Carriers and Rate Shipments. Following or concurrent with D1.5 and

D1.6, this step will assign a specific carrier to deliver an order or a consolidation of orders.

D1.8: Receive Product at Warehouse. This step gains importance when an ATP has been given to a customer's order. In this step, product is received at the distribution center and the order management system is checked to see if there are any orders outstanding that need this particular product.

D1.9: Pick Product. This step uses the outputs from D1.3, D1.4, and D1.5 to determine the order picking schedules in the distribution center.

D1.10: Load Vehicle, Generate Shipping Documents, Verify Credit, and Ship. Based on the output from D1.5 and D1.6, the transportation vehicle is loaded in. Finally, this step will generate shipment documents to provide to the carrier to execute the shipment. These documents might include bills of lading, freight bills, waybills, and manifests for domestic shipments as well as customs clearance documents for international shipments.

D1.11: Receive and Verify Product at Customer Site. Once the shipment is delivered to the customer location, the receiving location will determine whether or not the delivered product is what was ordered.

D1.12: Install Product. If an order involves a product that must be installed at the customer location, it is at this point in the OTC cycle where installation takes place.

D1.13: Invoice. This step is the culmination of the OTC cycle for the buyer and seller.

Length and Variability of the Order-to-Cash Cycle

While interest has traditionally focused more on the overall length of the OTC cycle, recent attention has been centered on the variability or consistency of this process. Industry practices have shown that while the absolute length of time is important, variability is more important. A driving force behind the attention to OTC cycle variability is safety stock.

The concept of the order cycle is used here because the focus is on the delivery of Order Management and Customer Service product to the buyer and not on the flow of cash to the supplier.

If the seller is concerned only with customer service prior to shipping, as per traditional metrics, the buyer might not be satisfied and the seller might not know it, because of problems occurring during the delivery process. Furthermore, the seller using traditional metrics would have no basis upon which to evaluate the extent and magnitude of the problem. The supply chain approach, focusing on measurement at the delivery level, not only provides the database to make an evaluation, but it also, and perhaps more importantly, provides an early warning of problems as they are developing.

E-Commerce and Order Fulfillment Strategies

Applying internet technology to the order management process has allowed organizations to take time out of the process and increase the velocity of cash back to the seller.

Customer Service

Having the right product at the right time in the right quantity without damage to the right customer is an underlying logistics principle.  Successful companies have adopted customer service strategies that recognize the importance of speed, flexibility, and customization.

The Logistics/Marketing Interface

Customer service is often the link between logistics and marketing within an organization. Today, logistics is taking on a more dynamic role in influencing customer service levels as well as impacting the organizations financial position.

## Defining Customer Service

Customer service needs to be put into the context of anything that touches the costumer. From a marketing perspective there are three levels of a product that the firm provides: the core benefit or service, the product or service itself, and the augmented product which encompasses benefits that are secondary to the primary benefit but still yet an integral enhancement.

## Elements of Customer Service

Time: Time refers to order to cash from the sellers perspective. Successful logistics operations maintain a high degree of control of most elements of lead time including processing, picking, and shipping.

Dependability: This may be more important for many buyers than the absolute length of time. There are three dimensions of dependability: cycle time, order safety, and order correctness.

Communications: Three types of communication occur between a buyer and seller: pretransaction, transaction, and posttransaction. Pretransaction information includes availability and delivery dates. Transaction information includes specifics about the order. Posttransaction information involves repair, assembly, or returns.

Convenience: The logistics service level must be flexible. System capabilities should be matched to customer segment needs.

## Performance Measures for Customer Service

Traditionally measures of performance have been created from the customer's perspective. These basic outputs of logistics include product availability, order cycle time, logistics operations responsiveness, logistics systems information, and postsale product support. Typically measurement is made after Step D1.10 of the SCOR model.

## Expected Cost of Stockouts

A principal benefit of inventory availability is to reduce the number of stockouts. Once a convenient method is determined to calculate the cost of a stockout, stockout probability information can be used to determine the total expected stockout cost. Alternative customer service levels can be analyzed by directly comparing the expected cost of stockouts with the revenue-producing benefits of improved customer service.

Calculating stockout costs for finished goods is generally more challenging than calculating these costs for raw material stockouts. The main reason for this is that finished goods stockouts might result in lost current and/or future customer revenue.

A stockout occurs when desired quantities of finished goods are not available when or where a customer needs them. When a seller is unable to satisfy demand with available inventory, one of four possible events might occur: (1) the buyer waits until the product is available; (2) the buyer back-orders the product; (3) the seller loses current revenue; or (4) the seller loses a buyer and future revenue.

## Back Orders

As previously mentioned, a back order occurs when a seller has only a portion of the products ordered by the buyer. The back order is created to secure the portion of the inventory that is currently not available. By placing the back order, the buyer is indicating that it is willing to wait for the additional inventory. However, after experiencing multiple back orders with a seller, a buyer might decide to switch to another seller.

## Lost Sales

Most organizations find that although some customers might prefer a back order, others will turn to alternative supply sources. Much of the decision here is based on the level of substitutability for the product. In such a case, the buyer has decided that if the entire order cannot be delivered at the same time, it will cancel the order and place it with another seller.

In the likely event that the seller will sustain lost sales with inventory stockouts, the seller will have to assign a cost to these stockouts as suggested earlier. Then the seller should analyze the number of stockouts it could expect with different inventory levels.

## Lost Customer

The third possible event that can occur because of a stockout is the loss of a customer; that is, the customer permanently switches to another supplier. A supplier who loses a customer loses a future stream of income. Estimating the profit (revenue) loss that stockouts can cause is difficult.

## Determining the Expected Cost of Stockouts

To make an informed decision as to how much inventory to carry, an organization must determine the expected cost it will incur due to a stockout. The first step is to identify a stockout’s potential consequences. These include a back order, a lost sale, and a lost customer. The second step is to calculate each result’s expense or lost profit (revenue) and then to estimate the cost of a single stockout.

## Product Availability

Although not the most important, product availability is usually the most basic output of an organization's order management and logistics systems. This is true because product availability can be measured by asking the simple question: Did I get what I wanted, when I wanted it, and in the quantity I wanted?

Sellers will normally hold more inventory to increase product availability. Buyers will hold more inventory to reduce stockouts, thus increasing product availability.

An important aspect of product availability is defining where in the supply chain it is being measured.

Another important aspect of product availability is determining whether or not all products should be made available at the same level. Some organizations strive to have 100 percent product availability across all products. The cost associated with achieving this goal would be prohibitive and unnecessary. Product availability levels for products can be determined by examining the level of substitutability and related stockout costs for a product as well as the demand profile for that product.

Many methods exist to measure the efficiency and effectiveness of product availability. However, four metrics are widely used across multiple industries: item fill rate, line fill rate, order fill rate, and perfect order. Item fill rate and line fill rate are considered internal metrics; that is, they are designed to measure the efficiency of how well the seller is setting its inventories to fill items or lines on an order. Order fill rates and perfect order rates are external metrics; that is, they are designed to capture the buyer experience with product availability. Order fill rate is the percent of orders filled complete. Finally, perfect order rate is the percent of orders filled completely, received on time, billed accurately, etc.

A strategic profit model calculation would be required to determine the change in ROI as a result of the improvement in order fill rate. The next step would require the seller to determine the break-even point between order fill rates and inventory costs.

## Order Cycle Time

Order cycle time is the time that elapses from when a buyer places an order with a seller until the buyer receives the order. The absolute length and reliability of order cycle time influences both seller and buyer inventories and will have resulting impacts on both revenues and profits for both organizations. Normally, the shorter the order cycle time the more inventory that must be held by the seller and the less inventory that must be held by the buyer, and vice versa.

Order cycle time, or lead time, includes all activities and related time from when an order is placed by a buyer until the order is received by the buyer. This definition can be viewed as the buyer's perception of lead time because this time ends when the buyer receives the ordered goods. A seller might look at lead time from the perspective of order-to-cash cycle time. This definition of lead time for the seller is important because the receipt of payment for the shipment ends this process for the seller. Another, often overlooked, definition of order cycle time is customer wait time (CWT). Used in both the private and public sectors, CWT includes not only order cycle time but also maintenance time.

Order cycle time can also have an impact on a buyer’s or seller’s financial position, depending on who owns the inventories in the supply chain. Inventory costs have an impact on both the balance sheet and income statement. Balance sheet impacts reflect ownership of inventory as an asset and liability; income statement impacts reflect the cost of holding inventory as an expense and therefore a reduction in cash flow. Order cycle time influences two types of inventory: demand, or cycle, stock and safety stock.

## Logistics Operations Responsiveness

The concept of logistics operations responsiveness (LOR) examines how well a seller can respond to a buyer’s needs. This “response” can take two forms. First, LOR can be how well a seller can customize its service offerings to the unique requirements of a buyer. Second, LOR can be how quickly a seller can respond to a sudden change in a buyer’s demand pattern.

Usually, LOR metrics will measure performance above and beyond basic on-time delivery or order fill rates. Examples of LOR metrics can be found in Process D1 of the SCOR model under flexibility. These three metrics are: (1) upside deliver flexibility, (2) downside deliver adaptability, and (3) upside deliver adaptability.

Another dimension of LOR metrics is one that addresses a seller’s ability to customize a product or its packaging. In the consumer-packaged goods (CPG) industry, manufacturers routinely offer special packaging of products through the use of co-packers. So, a metric that could be used to address customization might be one that measures the time it takes the seller to offer a new package for sale in the retailers’ stores.

LOR activities require an investment by the seller to create a savings for the buyer. However, both parties enjoy a favorable financial impact from this LOR activity.

## Logistics System Information

Logistics system information (LSI) is critical to the logistics and order management processes. It underlies an organization’s ability to provide quality product availability, order cycle time, logistics operations responsiveness, and postsale logistics support. Timely and accurate information can reduce inventories in the supply chain and improve cash flow to all supply chain partners.

Three types of information that must be captured and shared to execute the order management process: pretransaction, transaction, and posttransaction. Pretransaction information includes all information that is needed by the buyer and seller before the order is placed. Transaction information includes all information that is required to execute the order. Posttransaction information includes all information that is needed after the order is delivered.

Most metrics involved with LSI address how accurate and timely the data are to allow a decision to be made or an activity to be performed. For example, forecast accuracy is the result of accurate data on past consumption as well as on good predictions on future consumption. Another example would be inventory accuracy. The accuracy of the inventory counts in a distribution center is the result of capturing consumption data from that facility in an accurate and timely manner. Data integrity is another metric that can be used to measure the quality of outputs from an LSI.

As previously mentioned, LSI is usually not directly measured. What is measured are the results of how an organization uses the information generated by an LSI. Similarly, the financial impacts of an LSI are usually not measured but its results are.

### After Sale Logistics Support

Many organizations focus primarily on outbound logistics, i.e., getting the product to the customer. For some organizations, supporting a product after it is delivered is a competitive advantage. Postsale logistics support (PLS) can take two forms. First, PLS can be the management of product returns from the customer to the supplier. The second form of PLS is product support through the delivery and installation of spare parts.

For the most part, the PLS that manages product returns is measured by the ease in which a customer can return a product. A metric such as time to return a product to a seller is usually not important to a customer. Remember, a product return usually involves some level of dissatisfaction by a customer for a seller's product. So, making it easy for a customer to return a product is a critical metric.

Of the two types of PLS, spare parts logistics provides an easier methodology for calculating financial impacts.

### Service Recovery

No matter how well an organization plans to provide excellent service, mistakes will occur. Even in a Six Sigma statistical environment, 100 percent performance will not happen. High performance organizations today realize this and are using the concept of service recovery. Basically, service recovery requires an organization to realize that mistakes will occur and to have plans in place to fix them.

## SUMMARY

- Order management and customer service are not mutually exclusive; there is a direct and critical relationship between these two concepts.

- There are two distinct, yet related, aspects of order management: influencing the customer's order and executing the customer's order.

- Customer relationship management (CRM) is a concept being used today by organizations to help them better understand their customers' requirements and understand how these requirements integrate back into their internal operations processes.

- Activity-based costing (ABC) is being used today to help organizations develop customer profitability profiles which allow for customer segmentation strategies.

- Order management, or order execution, is the interface between buyers and sellers in the market and directly influences customer service.

- Order management can be measured in various ways. Traditionally, however, buyers will assess the effectiveness of order management using order cycle time and dependability as the metric, while sellers will use the order-to-cash cycle as their metric.

- Customer service is considered the interface between logistics and marketing in seller organizations.

- The three definitions of customer service are: (1) as an activity, (2) as a set of performance metrics, and (3) as a philosophy.

- The major elements of customer service are time, dependability, communications, and convenience.

- Stockout costs can be calculated as back order costs, the cost of lost sales, and/or the cost of a lost customer.

- The five outputs from order management that influence customer service, customer satisfaction, and profitability are: (1) product availability, (2) order cycle time, (3) logistics operations responsiveness, (4) logistics system information, and (5) postsale logistics support.

- The concept of service recovery is being used by organizations today to help identify service failure areas in their order management process and to develop plans to address them quickly and accurately.

# SUPPLY CHAIN RELATIONSHIPS

## LEARNING OBJECTIVES

- Understand the types of supply chain relationships and their importance.
- Describe a process model that will facilitate the development and implementation of successful supply chain relationships.
- Recognize the importance of "collaborative" supply chain relationships.
- Define what is meant by third-party logistics (3PL) and know what types of firms provide 3PL services.
- Know what types of 3PL services are used by client/customer firms and what types of 3PL providers are used.
- Discuss the role and relevance of information technology-based services to 3PLs and their clients/customers.
- Know the extent to which customers are satisfied with 3PL services and identify where improvement may be needed.
- Understand some of the likely future directions for outsourced logistics services.

## OVERVIEW

### Introduction

This section focuses on two, highly related topics. The first is that of supply chain relationships in general, with an emphasis on the types of relationships, the processes for developing and implementing successful relationships, and the need for firms to collaborate to achieve supply chain objectives. The second is that of the third-party logistics (3PL) industry in general, and how firms in this industry create value for their commercial clients.

### Logistics Relationships

#### Types of Relationships

There are two types of logistics relationships. The first is what may be termed vertical relationships; these refer to the traditional linkages between firms in the supply chain such as retailers, distributors, manufacturers, and parts and materials suppliers.

The second type of logistics relationship is horizontal in nature and includes those business agreements between firms that have "parallel" positions. A horizontal relationship may be thought of as a service agreement between two or more independent logistics provider firms.

## Intensity of Involvement

As suggested by Figure 4-1, the range of relationship types extends from that of a vendor to that of a strategic alliance. In the context of the more traditional “vertical” context, a vendor is represented simply by a seller or provider of a product or service, such that there is little or no integration or collaboration with the buyer or purchaser.

Alternatively, the relationship suggested by a strategic alliance is one in which two or more business organizations cooperate and willingly modify their business objectives and practices to help achieve long-term goals and objectives.

Regardless of form, relationships may differ in numerous ways. A partial list of these differences follows:

- Duration
- Obligations
- Expectations
- Interaction/Communication
- Cooperation
- Planning
- Goals
- Performance analysis
- Benefits and burdens

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Most companies feel that there is significant room for improvement in terms of the relationships they have developed with their supply chain partners.

## Model for Developing and Implementing Successful Supply Chain Relationships

Figure 4-2 outlines the steps in a process model for forming and sustaining supply chain relationships.

Step 1: Perform Strategic Assessment. This first stage involves the process by which the manufacturer becomes fully aware of its logistics and supply chain needs and the overall strategies that will guide its operations.

Step 2: Decision to Form Relationship. Depending on the type of relationship being considered by the manufacturing firm under consideration, this step may take on a slightly different decision context. This decision comprises several drivers, e.g. asset/cost efficiency, customer service, marketing advantage, profit stability/growth, and facilitators, e.g. corporate compatibility, management philosophy and techniques, mutuality of commitment to relationship formation, size and financial symmetry.

Step 3: Evaluate Alternatives. Using a methodology by which the apparent levels of drivers and facilitators may suggest the most appropriate type of relationship to consider. If neither the drivers nor the facilitators seem to be present, then the recommendation would be for the relationship to be more transactional, or “arm’s length” in nature.

Step 4: Select Partner(s). While this stage is of critical concern to the customer, the selection of a logistics or supply chain partner should be made only following very close consideration of the credentials of the most likely candidates.

Step 5: Structure Operating Model. The structure of the relationship refers to the activities, processes, and priorities that will be used to build and sustain the relationship.

Step 6: Implementation and Continuous Improvement. Once the decision to form a relationship has been made and the structural elements of the relationship identified, it is important to recognize that the most challenging step in the relationship process has just begun. Depending on the complexity of the new relationship, the overall implementation process may be relatively short, or it may be extended over a longer period of time.

Finally, the future success of the relationship will be a direct function of the ability of the involved organizations to achieve both continuous and breakthrough improvement.

Need for Collaborative Relationships

Collaboration may be thought for the benefit of all of as a “business practice that encourages individual organizations to share information and resources.” Collaboration allows companies to “leverage each other on an operational basis so that together they perform better than they did separately.”

While this approach creates a synergistic business environment in which the sum of the parts is greater than the whole, it is not one that comes naturally to most organizations, particularly those offering similar or competing products or services.

Collaboration requires the following:

- Parties involved to dynamically share and interchange information
- Benefits experienced by parties to exceed individual benefits
- All parties to modify their business practices
- All parties to conduct business in a new and visibly different way
- All parties to provide a mechanism and process for collaboration to occur

## Third-Party Logistics—Industry Overview

Firms have directed considerable attention toward working more closely with other supply chain participants, including customers, suppliers, and various providers of logistics services.

One way of extending the logistics organization beyond the boundaries of the company is through the use of a supplier of third-party or contract logistics services.

## Definition of Third-Party Logistics

A third-party-logistics firm may be defined as an external supplier that performs all or part of a company's logistics functions.

Depending on the firm and its positioning in the industry, the terms contract logistics and outsourcing are sometimes used in place of third-party logistics. While some industry executives take care to distinguish among terms such as these, each of these terms refers to the use of external suppliers of logistics services.

## Types of 3PL Providers

These providers include are transportation-based, warehouse/distribution-based, forwarder-based, shipper/management-based, financial-based, and information-based firms.

Transportation Based: Its approaches to operations, management, and planning significantly utilize and leverage information technologies.

Warehouse/Distribution Based: Traditionally, most warehouse/distribution-based logistics suppliers have been in the public or contract warehousing business and have expanded into a broader range of logistics services.

Forwarder Based: Essentially, these firms are non-asset owners, are very independent, and deal with a wide range of suppliers of logistics services.

Financial Based: These firms provide services such as freight payment and auditing; cost accounting and control; and logistics management tools for monitoring, booking, tracking, tracing, and managing inventory.

Information Based: These resources effectively represent alternative sources for those in need of purchasing transportation and logistics services, and they may be thought of as a newer, innovative type of third-party provider.

## 3PL Market Size and Scope

Estimates of the global 3PL industry revenues for the year 2010 for North America at US $143.3 billion represents about one-quarter of the total estimated global spending of US $539.1 billion where turnover growth has risen from US $30.8 billion in 1996 to an estimated US $121.6 billion in 2010.

## Third-Party Logistics Research Study – Industry Details

A significant ongoing research study is the Third party logistics: The state of logistics outsourcing study by Dr. John Langly Jr. of Penn State. This study incorporates surveys of global providers, focused interviews with experts, and workshops with customers to develop insights into the current state of logistics.

## Profile of Logistics Outsourcing Activities

A recent study showed that the logistics services most frequently outsourced are those that are more operational, transactional, and repetitive in nature. Looking at the results over all of the regions studied, the most frequently outsourced services include transportation (83%), international transportation (75%), warehousing (74%), customs clearance and brokerage (70%), customs brokerage (58%), and forwarding (53%).

## Strategic Role of Information Technology

The most currently used services include transportation management and warehouse/distribution center management (WMS), global trade management, yard management, transportation sourcing, and transportation planning

## Management and Relationship Issues

The need for competency as it relates to the formation and continuation of successful relationships has become critical in today's 3PL industry. Although both providers and users of 3PL services have been improving in their ability to create more productive, effective, and satisfying business relationships, the media is replete with examples of failed relationships.

The two most prevalent 3PL selection factors were price of 3PL services and quality of tactical, operational logistics services.

Successful 3PL relationships establish appropriate roles and responsibilities for both 3PLs and client firms.

An important issue relates to how customers think of their 3PLs and approximately two-thirds of the customers think of their 3PLs as providers of tactical or operational services, while approximately one-third think of them as strategic or integrative.

## Customer Value Framework

Participating executives provided continuing evidence of logistics and supply chain metrics that provide tangible documentation of the benefits they have experienced from the use of 3PL services.

Respondents in recent studies reported experiencing a number of problems. Categorically, their responses tended to focus on several key areas of concern as follows:

- Service-level commitments not realized
- Time and effort spent on logistics not reduced
- Cost reductions have not been realized
- Cost "creep" and price increases once relationship has commenced
- Unsatisfactory transition during implementation stage
- Inability to form meaningful and trusting relationships

- Lack of ongoing improvements and achievements in offerings
- Lack of strategic management and/or consultative/knowledge-based skills
- Lack of global capabilities

A Strategic View of Logistics and the Role of 3PLs

One major accomplishment of the past 10–15 years has been establishing the validity of the logistics outsourcing model and specifically of the 3PL provider. There is also an increasing acceptance of the 4PL model, likely growth in expenditures by current users of 3PL services, and a growing sophistication in the outsourced business approaches that respond to a dynamic set of customer logistics and supply chain needs.

Fourth-Party Relationships: Although it has been around for some time, the concept of “fourth-party-logistics” (4PL) provider is becoming more evident in the business world. Essentially a supply chain integrator, a 4PL may be thought of as a firm that “assembles and manages the resources, capabilities, and technology of its own organization with those of complementary service providers to deliver a comprehensive supply chain solution.

Expected Growth in Customers’ Use of 3PL Services: One way to look at the future plans for outsourcing is to ask users of 3PL services to estimate the expected three- to five-year growth rate of outsourcing expenditures as a percent of overall logistics expenditures.

Logistics Outsourcing Model for the Future: Figure 4-13 suggests a possible future direction for the further development of logistics outsourcing models. Proprietary provision of logistics services, or insourcing, at the bottom of the diagram, the model evolves through several successive stages. Included are basic services (e.g., transportation, warehousing, etc.), value-added or third-party logistics services, lead logistics or 4PL services, and advanced services.

## SUMMARY

- The two most basic types of supply chain relationships are “vertical” (e.g., buyer-seller) and “horizontal” (e.g., parallel or cooperating).

- In terms of intensity of involvement, interfirm relationships may span from transactional to relational and may take the form of vendor, partner, and strategic alliances.

- There are six steps in the development and implementation of successful relationships. These six steps are critical to the formation and success of supply chain relationships.

- Collaborative relationships, both vertical and horizontal, have been identified as highly useful to the achievement of long-term supply chain objectives. The “Seven Immutable Laws of Collaborative Logistics” provide a framework for the development of effective supply chain relationships.

- Third-party logistics providers may be thought of as an “external supplier that per-forms all or part of a company’s logistics functions.” It is desirable that these suppliers provide multiple services, and that these services are integrated in the way they are managed and delivered.

- The several types of 3PLs are transportation-based, warehouse/distribution-based, forwarder-based, financial-based, and information-based suppliers.

- Based on the results of a comprehensive study of users of 3PL services in the United States, over 70 percent of the firms studied are, to some extent, users of 3PL services.

- User experience suggests a broad range of 3PL services utilized; and the most prevalent are transportation, warehousing, customs clearance and brokerage, and forwarding.

- While nonusers of 3PL services have their reasons to justify their decision, these same reasons are sometimes cited by users as justification for using a 3PL.

- Customers have significant IT-based requirements of their 3PL providers, and they feel that the 3PLs are attaching a priority to respond to these requirements.

- Approximately two-thirds of the customers suggest 3PL involvement in their global supply chain activities.

- Although most customers indicate satisfaction with existing 3PL services, there is no shortage of suggestions for improvement.

- Customers generally have high aspirations for their strategic use of 3PLs and consider their 3PLs as keys to their supply chain success.

- There is a growing need for fourth-party logistics relationships that provide a wide range of integrative supply chain services.

# MANAGING INVENTORY

## LEARNING OBJECTIVES

- Appreciate the role and importance of inventory in the economy.

- List the major reasons for carrying inventory.

- Discuss the major types of inventory, their costs, and their relationships to inventory decisions.

- Understand the fundamental differences among approaches to managing inventory.

- Describe the rationale and logic behind the economic order quantity (EOQ) approach to inventory decision making, and be able to solve some problems of a simple nature.

- Understand alternative approaches to managing inventory—just-in-time (JIT), distribution requirements planning (DRP), and vendor-managed inventory (VMI).

- Explain how inventory items can be classified.

- Know how inventory will vary as the number of stocking points changes.

- Make needed adjustments to the basic EOQ approach to respond to several special types of applications.

## OVERVIEW

### Introduction

The effective management of inventories in the supply chain is one of the key factors for success in any organization. Inventory as an asset on the balance sheet and as a variable expense on the income statement has taken on greater importance as organizations attempt to more effectively manage assets and working capital. However, inventory takes on added importance because of its direct impacts on service levels. As such, inventory management has taken a strategic position in many firms today.

Organizations would ideally want to have enough inventory to satisfy the demands of its customers for its products with no lost revenue because of stockouts. However, the organization does not want to have too much inventory on hand because it consumes valuable working capital.

## Inventory in the Firm: Rationale for Inventory

Inventory plays a dual role in organizations and it impacts the cost of goods sold as well as supporting order fulfillment (customer service).

Consumer-packaged goods (CPG) firms and the wholesalers and retailers that are a part of their distribution channels face a special challenge in keeping inventories at acceptable levels because of the difficulty of forecasting demand and increasing expectations from customers concerning product availability.

The point is that managing inventory is a critical factor for success in many organizations. Many organizations have responded to this challenge—as indicated by the macro data presented in the previous section—and have reduced inventory levels while maintaining appropriate customer service levels. Their ability to achieve the twin goals of lower inventory (efficiency) and acceptable customer service levels (effectiveness) is based on a number of factors.

### Batching Economies/Cycle Stocks

Batching economies or cycle stocks usually arise from three sources—procurement, production, and/or transportation. Scale economies are often associated with all three, which can result in the accumulation of inventory that will not be used or sold immediately. This means that some cycle stock or inventory will be used up or sold over some period of time.

Larger purchased volumes result in lower prices per unit and vice versa. Transportation firms usually offer rate/price discounts for shipping larger quantities.  Note that purchase economies and transportation economies are complementary.

The third batching economy is associated with production. Many organizations feel that their production costs per unit are substantially lower when they have long production runs of the same product.

### Uncertainty/Safety Stocks

All organizations are faced with uncertainty. On the demand or customer side, there is usually uncertainty in how much customers will buy and when they will buy it. On the supply side, there might be uncertainty about obtaining what is needed from suppliers and how long it will take for the fulfillment of the order.

Tradeoff analysis is appropriate and can be accomplished using the appropriate tools to assess the risk and measure the inventory cost. Setting safety stock levels for an organization is both an art and a science.

### Time-In-Transit and Work-in-Process Stocks

The time associated with transportation (e.g., supplier to manufacturing plant) and with the manufacture or assembly of a complex product means that even while goods are in motion, an inventory cost is associated with the time period. The longer the transport time period, the higher the cost.

The time period for in-transit inventory and work-in-process (WIP) inventory should be evaluated in terms of the appropriate tradeoffs. The various transportation modes available for shipping freight have different transit time lengths, transit time variability, and damage rates.

WIP inventories are associated with manufacturing. The length of time WIP inventory sits in a manufacturing facility waiting to be included in a particular product should be carefully evaluated in relationship to scheduling techniques and the actual manufacturing/assembly technology.

## Seasonal Stocks

Seasonality can occur in the supply of raw materials, in the demand for finished product, or in both. Organizations that are faced with seasonality issues are constantly challenged when determining how much inventory to accumulate.

While the supply of the raw material is available during only one part of the year, demand is stable throughout the year. This scenario many times is faced with high storage costs and/or high obsolescence costs and sometimes seasonality can impact transportation as well.

## Anticipatory Stocks

A fifth reason to hold inventory arises when an organization anticipates that an unusual event might occur that will negatively impact its source of supply. Examples of these events would include strikes, significant raw materials or finished goods price increase, a major shortage of supply because of political unrest or weather.

## The Importance of Inventory in Other Functional Areas

Logistics interfaces with an organization’s other functional areas, such as marketing and manufacturing. The interface is usually more prominent in the inventory area.

The primary mission of marketing is to identify, create, and help satisfy demand for an organization’s products/services. Marketing tends to have a favorable view on holding sufficient and/or extra inventory to ensure product availability to meet customer needs.

Manufacturing operations are measured by how efficiently they can produce each unit of output, and long production runs will result in high inventory levels but low labor and machine costs per unit.

Inventories impact both the income statement and balance sheet of an organization. Inventories create both an asset and liability on the balance sheet as well as a cash flow impact on the income statement. Proper inventory management and control affects customers, suppliers, and an organization's functional areas.

## Inventory Costs

Inventory costs are important for three reasons. First, inventory costs represent a significant component of logistics costs in many organizations. Second, the inventory levels that an organization maintains at nodes in its logistics network will affect the level of service the organization can offer its customers. Third, cost tradeoff decisions in logistics frequently depend on and ultimately impact inventory carrying costs.

### Inventory Carrying Costs

Inventory carrying costs are those that are incurred by inventory at rest and waiting to be used. From a finished goods inventory perspective, inventory carrying costs represent those costs associated with manufacturing and moving inventory from a plant to a distribution center to await an order. There are four major components of inventory carrying cost: capital cost, storage space cost, inventory service cost, and inventory risk cost.

Sometimes called the interest or opportunity cost, capital cost focuses on the cost of capital tied up in inventory and the resulting lost opportunity from not investing that capital elsewhere. One calculation method is the hurdle rate, the minimum rate of return on new investments. Another way of calculating capital cost is for an organization to use its weighted average cost of capital (WACC). WACC is the weighted average percent of debt service of all external sources of funding, including both equity and debt. The inventory valuation method used is critical to accurately determining capital cost and is subsequently critical to determining overall inventory carrying cost.

The commonly accepted accounting practice of valuing inventory at fully allocated manufacturing cost is unacceptable in inventory decision making because raising or lowering inventory levels financially affects only the variable portion of inventory value and not the fixed portion of allocated cost.

Storage space cost includes handling costs associated with moving products into and out of inventory, as well as storage costs such as rent, heating, and lighting. Storage space costs are relevant to the extent that they either increase or decrease as inventory levels rise or fall.

Inventory service cost includes insurance and taxes.

Inventory risk cost, the final major component of inventory carrying cost, reflects the very real possibility that inventory dollar value might decline for reasons beyond an organization's control.

## Calculating the Cost of Carrying Inventory

Calculating the cost to carry (or hold) a particular item in inventory involves three steps. First, the value of the item stored in inventory must be determined. Second, determine the cost of each individual carrying cost component and add them together to determine the total direct costs consumed by the item while being held in inventory. Two types of costs should be considered here: variable-based costs and value-based costs. Third, divide the total costs calculated in Step 2 by the value of the item determined in Step 1.

## Nature of Carrying Cost

Items with basically similar carrying costs should use the same estimate of carrying cost per dollar value. However, items subject to rapid obsolescence or items that require servicing to prevent deterioration might require separate cost estimates.

## Ordering and Setup Cost

A second cost affecting total inventory cost is ordering cost or setup cost. Ordering cost refers to the expense of placing an order and does not include the cost of the product itself. Setup cost refers more specifically to the expense of changing or modifying a production or assembly process to facilitate line changeovers.

The costs associated with ordering inventory have both fixed and variable components. Separating the fixed and variable portions of order/setup cost is essential. When calculating annual ordering costs, organizations usually start with the cost or charge associated with each individual order or setup. Correspondingly, the annual number of orders or setups affects the total order cost per year.

Due to the magnitude of these as highly automated systems for order management and order processing, and the streamlining of inventory receiving practices, the variable cost of handling individual orders is certain to decrease significantly.

## Carrying Cost versus Order Cost

Order cost and carrying cost respond in opposite ways to changes in the number of orders or size of individual orders. Total cost also responds to changes in order size.

## Expected Stockout Cost

Stockout cost is the cost associated with not having a product available to meet demand and several consequences might occur. First, the customer might be willing to wait and accept a later shipment (back order). Second, the customer might decide to purchase a competitor’s product in this instance, resulting in a direct loss of profit and revenue for the supplier. Third, the customer might decide to permanently switch to a competitor’s product. Stockout costs can be difficult to determine because of the uncertainty of future consequences that might occur.

As previously sated, most organizations will hold safety stock, or buffer stock, to minimize the possibility of a stockout. Stockouts will occur because of the uncertainties in both demand and lead time.

Determining safety stock levels and the related inventory carrying costs might be relatively straightforward, but not so for determining the cost of a lost sale. Likewise, determining the cost of a production shutdown for lack of raw materials is also a challenge.

### In-Transit Inventory Carrying Cost

Another inventory carrying cost that many organizations ignore is that of carrying inventory in transit. This cost might be less apparent than those discussed earlier. However, under certain circumstances, it might represent a very significant expense. Terms of sale are a factor.

Earlier discussions covered four major components of inventory carrying cost: capital cost, storage space cost, inventory service cost, and inventory risk cost, they apply differently to the cost of carrying inventory in transit. Capital cost of carrying inventory in transit generally equals that of carrying inventory in a warehouse.

Storage space cost generally will not be relevant to inventory in transit and while taxes generally would not be relevant to inventory service costs, the need for insurance requires special analysis.

Obsolescence or deterioration costs are lesser risks for inventory in transit because the transportation service typically takes only a short time.

## Fundamental Approaches to Managing Inventory

Managing inventory involved two fundamental questions: how much to order and when to order. But now questions regarding where inventory should be held and what specific line items should be available at specific locations pose challenges to managers.

The current dynamic operating environment has caused organizations to examine their inventory policies as well as their customer service policies and find the optimal solution that balances both service and cost. Many approaches exist to identify and analyze this tradeoff. Organizations will choose the approach that serves them the best as defined by their markets and corporate goals.

Several factors make this objective achievable: (1) “real-time” order management systems, (2) improved technologies to manage logistics information, (3) more flexible and reliable transportation resources, and (4) improvements in the ability to position inventories so that they will be available when and where they are needed.

## Key Differences among Approaches to Managing Inventory

These differences in various approaches include dependent versus independent demand, pull versus push, and system-wide versus single-facility solutions to inventory management decisions.

Demand for a given inventory item is termed “independent” when such demand is unrelated to the demand for other items. Conversely, demand is defined as “dependent” when it is directly related, or derives from, the demand for another inventory item or product. An important point to remember is that developing inventory policies for items exhibiting independent demand requires that forecasts be developed for these items.

The approaches to inventory management to be discussed include just-in-time (JIT), materials requirement planning (MRP), and manufacturing resource planning (MRP II). These are usually associated with items having dependent demand. Alternatively, DRP generally involves the movement of items having independent demand. The economic order quantity (EOQ) and vendor-managed inventory approaches apply to both independent and dependent demand items.

The “pull” approach relies on customer orders to move product through a logistics system, while the “push” approach uses inventory replenishment techniques in anticipation of demand to move products. A principal attribute of pull systems is that they can respond quickly to sudden or abrupt changes in demand because they produce to an order and have very little, if no, finished goods inventory. Pull systems usually run on short-term forecasts, allowing them the flexibility to adapt to swings in demand.

JIT is a pull system since organizations place orders for more inventory only when the amount on hand reaches a certain minimum level, thus “pulling” inventory through the logistics system as needed. Having established a master production schedule, MRP develops a time-phased approach to inventory scheduling receipt.

MRP and MRP II approaches are push based because they generate a list of required materials in order to assemble or manufacture a specific amount of finished products DRP involves the allocation of available inventory to meet market demands. DRP, on the outbound or physical distribution side of logistics, is also a push-based strategy. VMI uses preset reorder points and economic order quantities along with on-hand inventory levels in customers’ warehouses to generate replenishment orders and can be considered a push approach. Finally, the EOQ approach is generally a pull approach,

## Fixed Order Quantity Approach (Condition of Certainty)

The fixed order quantity model involves ordering a fixed amount of product each time reordering takes place, and uses a minimum stock level to determine when to reorder the fixed quantity. This is called the reorder point. When the number of units of an item in inventory reaches the reorder point, the fixed order quantity (the EOQ) is ordered.

The fixed order quantity model is often referred to as the two-bin model. When the first bin is empty, the organization places an order.

Both notions (trigger and bin) imply that an organization will reorder inventory when the amount on hand reaches the reorder point.

### Inventory Cycles

Figure 9-5 shows the fixed order quantity model with three inventory cycles, or periods. Establishing a reorder point provides a trigger or signal for reordering the fixed quantity. Business inventory situations base the reorder point on lead time and the demand during lead time. The constant monitoring necessary to determine when inventory has reached the reorder point makes the fixed order quantity model a perpetual inventory system.

### Simple EOQ Model

The following are the basic assumptions of the simple EOQ model:

1. A continuous, constant, and known rate of demand

2. A constant and known replenishment or lead time

3. All demand is satisfied

4. A constant price or cost that is independent of the order quantity (i.e., no quantity discounts)

5. No inventory in transit

6. One item of inventory or no interaction between items

7. Infinite planning horizon

8. Unlimited capital

### Mathematical Formulation

The EOQ model can be developed in standard mathematical form, using the following variables:

$R$ = Annual rate of demand (units)
$Q$ = Quantity ordered (units)
$A$ = Cost of placing an order ($ per order)
$V$ = Value or cost of one unit of inventory ($ per order)
$W$ = Carrying cost per dollar value of inventory per year (% of product value)
$S = VW$ = Inventory carrying cost per unit per year ($ per unit per year)
$t$ = Time (days)
$TAC$ = Total annual cost ($ per year)

Below is the calculation of Q, the economic order quantity.

$$\mathrm{TAC} = \frac{1}{2}QVW + A\frac{R}{Q}$$

$$\frac{d(\mathrm{TAC})}{dQ} = \frac{VW}{2} - \frac{AR}{Q^2}$$

## Reorder Point

Knowing when to order was as necessary as knowing how much to order. The when, called the reorder point, depends on the inventory level on hand. Under the assumptions of certainty, an organization needs only enough inventory to last during the replenishment time or lead time. Therefore, given a known lead time, multiplying lead time length by daily demand determines the reorder point. Replenishment time consists of several components: order transmittal, order processing, order preparation, and order delivery.

## A Note Concerning the Min-Max Approach

One widely used adaptation of the fixed order quantity approach is the min-max inventory management approach, which applies when demand might be larger and when the amount on hand might fall below the reorder point before the organization initiates a replenishment order. In this case, the min-max approach increments the amount ordered by the difference between the reorder point and the amount on hand.

## Summary and Evaluation of the Fixed Order Quantity Approach

Many organizations have become more sophisticated in their use of EOQ-based approaches, adapting them to include a push as well as a pull orientation. As a result, many EOQ-based systems effectively blend both push and pull concepts. One principal shortcoming of the EOQ-based approach is that it suits inventory decision making at a single facility more than it suits decision making at multiple locations and can sometimes encounter problems when parallel points in the same logistics system experience peak demands simultaneously.

## Fixed Order Quantity Approach (Conditions of Uncertainty)

Until now, the reorder point was based on the amount of inventory on hand and demand was known and constant. When inventory on hand reached zero, a new order was received in an economic order quantity and stockout costs were not incurred. Most firms would not operate under conditions of certainty for a variety of reasons and several factors can affect lead time. Because of all the potential factors that can influence the reliability of demand and lead time, inventory models need to be adjusted to account for this uncertainty.

### Reorder Point—A Special Note

The reorder point under the basic model is the on-hand inventory level needed to satisfy demand during lead time. Calculating the reorder point is relatively easy since demand and lead time are constant. Under uncertainty, an organization must reformulate the reorder point to allow for safety stock. In effect, the reorder point becomes the average daily demand during lead time plus the safety stock.

### Uncertainty of Demand

The first factor that might cause uncertainty deals with demand or usage rate. While focusing on this variable, the following assumptions concerning EOQ still apply:

1. A constant and known replenishment or lead time

2. A constant price or cost that is independent of order quantity or time

3. No inventory in transit

4. One item of inventory or no interaction between items

5. Infinite planning horizon

6. No limit on capital availability

In order to find the number of units the organization expects to be short or in excess at each of the seven possible reorder points. The variables for this calculation are as follows:

$e$ = Expected excess in units
$g$ = Expected shorts in units
$k$ = Stockout cost in dollars per unit stocked out
$G = gk$ = Expected stockout cost per cycle
$G\left(\frac{R}{Q}\right)$ = Expected stockout cost per year
$eVW$ = Expected carrying cost per year for excess inventory

The total cost model can be expanded to include the safety stock and stockout cost as shown using the formula shown below.

$$\mathrm{TAC} = \frac{1}{2}QVW + A\frac{R}{Q} + (eVW) + \left(G\frac{R}{Q}\right)$$

Solving for the lowest total cost gives Formula 9-8.

$$\frac{d(\mathrm{TAC})}{dQ} = \left[\frac{1}{2}VW\right] - \left[\frac{R(A+G)}{Q^2}\right]$$

The optimum solution to the problem with conditions of uncertainty is a fixed order quantity of 245 units, and the organization will reorder this amount when inventory reaches a level of 140 units (the calculated reorder point). This situation requires a recalculation of total annual cost as shown using the formula shown below.

$$\mathrm{TAC} = \frac{1}{2}QVW + A\frac{R}{Q} + eVW + G\frac{R}{Q}$$

Uncertainty of Demand and Lead Time Length

Consider the possibility that both demand and lead time might vary and builds in attempting to make this inventory approach more realistic and determining how much safety stock to carry will be noticeably more complex now than when only demand varied.

$$\overline{X} = SR \qquad 9.12$$

$$\sigma = \sqrt{R(\sigma_S)^2 + S^2(\sigma_R)^2} \qquad 9.13$$

where:

$\overline{X}$ = Average demand during lead time (units)
$\sigma$ = Standard deviation of demand during lead time (units)
$R$ = Average replenishment cycle (days)
$\sigma_R$ = Standard deviation of replenishment cycle (days)
$S$ = Average daily demand (units)
$\sigma_S$ = Standard deviation of daily demand (units)

## Fixed Order Interval Approach

The second form of the fixed order interval approach to inventory management is also called the fixed period or fixed review period approach, which involves ordering inventory at fixed or regular intervals. In comparison with the basic EOQ approach, the fixed interval model does not require close surveillance of inventory levels; thus, the monitoring is less expensive, which is best used for inventory items that have a relatively stable demand.

Using this approach for volatile demand items might quickly result in a stockout since time triggers orders rather than inventory levels. Like the fixed order quantity approach to inventory management, the fixed order interval approach typically combines elements of both the pull and push philosophies.

## Summary and Evaluation of EOQ Approaches to Inventory Management

There are four basic forms of the EOQ inventory model: fixed quantity/fixed interval, fixed quantity/irregular interval, irregular quantity/fixed interval, and irregular quantity/irregular interval, each with its own advantages and disadvantages, based on factors such as lead time, demand, and variability. Firms that are expanding beyond the basic order quantity and order interval approaches have had considerable success with concepts such as JIT, MRP, MRP II, and DRP.

## Additional Approaches to Inventory Management

The interest in reducing inventory levels along the supply chain is indicative of the importance of inventory as a cost of doing business as for many, inventory is the first or second largest asset on the balance sheet. Firms can reduce their costs of doing business and improve their return on investment or assets (ROI/ROA) by decreasing inventory levels as long as service levels are met when decreasing inventories. There are several approaches to inventory management which will be examined: JIT, MRP, and DRP.

## The Just-in-Time Approach

The underlying theme of the phrase "just-in-time" suggests that inventories should be available when an organization needs them. Generally, just-in-time systems are designed to manage lead times and to eliminate waste. Four major elements underlie the JIT concept: zero inventories; short, consistent lead times; small, frequent replenishment quantities; and high quality, or zero defects.

JIT attempts to eliminate excess inventories for both the buyer and the seller, but some believe that the concept simply forces the seller to carry inventory previously held by the buyer. However, successful JIT applications will significantly reduce inventories for both parties.

Second, JIT systems typically involve short production runs and require production activities to change frequently from one product to another, which will result in higher changeover costs, assuming that the cost of each changeover is constant but will result in lower finished goods inventory levels. There should be tradeoffs between changeover costs and finished goods inventory levels.

Third, JIT minimizes wait times by delivering materials and products when and where an organization needs them. Fourth, the JIT concept uses short, consistent lead times to satisfy the need for inventory in a timely manner. Fifth, JIT-based systems rely on high-quality incoming parts and components and on exceptionally high-quality inbound logistics systems. Sixth, the JIT concept requires a strong, mutual commitment between the buyer and the seller.

The just-in-time concept can enable logistics managers to reduce unit costs and to enhance customer service, saving money on downstream inventories by placing greater reliance on improved responsiveness and flexibility.

## Materials Requirements Planning

MRP deals specifically with supplying materials and component parts whose demand depends on the demand for a specific end product and consists of a set of logically related procedures, decision rules, and records designed to translate a master production schedule into time-phased net inventory requirements and the planned coverage of such requirements for each component item needed to implement this.

MRP begins by determining how much end products (independent demand items) customers desire and when they are needed, then disaggregates the timing and need for components based on the end-product demand by using the following key elements:

- Master production schedule (MPS)
- Bill of materials file (BOM)
- Inventory status file (ISF)
- MRP program
- Outputs and reports

The MRP program develops a time-phased approach to inventory scheduling and inventory receipt. As it generates a list of required materials in order to assemble or manufacture specified number of independent demand items, the system MRP represents a push approach. Typically, MRP applies primarily when the demand for parts and materials depends on the demand for some specific end product. Since actual demand is key to the establishment of production schedules, MRP systems can react quickly to changing demand for finished products.

MRP can achieve objectives more commonly associated with the JIT-based approaches, while at times decisions made through the pull concept do not reflect the future events for which the JIT policies are intended.

The principal advantages of most MRP-based systems include the following:

- They attempt to maintain reasonable safety stock levels and to minimize or eliminate inventories whenever possible.
- They can identify process problems and potential supply chain disruptions long before they occur and take the necessary corrective actions.
- Production schedules are based on actual demand as well as on forecasts of independent demand items.
- They coordinate materials ordering across multiple points in an organization's logistics network.
- They are more suitable for batch, intermittent assembly, or project processes.

Shortcomings of MRP-based approaches include the following:

- Their application is computer intensive, and making changes is sometimes difficult once the system is in operation.
- Both ordering and transportation costs might rise as an organization reduces inventory levels and possibly moves toward a more coordinated system of ordering product in smaller amounts to arrive when the organization needs it.
- They are not usually as sensitive to short-term fluctuations in demand as are order point approaches (although they are not as inventory intensive, either).
- They frequently become quite complex and sometimes do not work exactly as intended.

## A Note Concerning MRPII Systems

Manufacturing resource planning has a far more comprehensive set of tools than MRP alone. Although MRP is a key step in MRPII, MRPII allows an organization to integrate financial planning and operations/logistics. MRPII serves as an excellent planning tool and helps describe the likely results of implementing strategies in areas such as logistics, manufacturing, marketing, and finance. Thus, it helps an organization to conduct "what if?" analyses and to determine appropriate product movement and storages strategies at and between points in the logistics system.

## Distribution Requirements Planning

Distribution requirements planning is a widely used and potentially powerful technique for outbound logistics systems to help determine the appropriate level of inventory to be held to meet both cost and service objectives. DRP determines replenishment schedules between an organization's manufacturing facilities and its distribution centers. DRP is usually coupled with MRP systems in an attempt to manage the flow and timing of both inbound materials and outbound finished goods. The underlying rationale for DRP is to more accurately forecast demand and to explode that information back for use in developing production schedules.

DRP develops a projection for each SKU and requires the following:

- Forecast of demand for each SKU
- Current inventory level of the SKU (balance on hand, BOH)
- Target safety stock
- Recommended replenishment quantity
- Lead time for replenishment

A DRP system can accomplish for outbound shipments what MRP accomplishes for inbound shipments and is an example of a push approach and can be used for both single-facility and system-wide applications. The key to a successful DRP approach is having accurate demand forecasts by SKU by distribution center.

## Vendor-Managed Inventory

A relatively new inventory management technique, vendor-managed inventory, manages inventories outside an organization's logistics network or is a technique to manage its inventories held in its customer's distribution centers. The basic principles underlying the concept of VMI are relatively simple. First, the supplier and its customer agree on which products are to be managed using VMI in the customer's distribution centers. Second, an agreement is made on reorder points and economic order quantities for each of these products. Third, as these products are shipped from the customer's distribution center, the customer notifies the supplier, by SKU, of the volumes shipped on a real-time basis. This notification is also called "pull" data.

VMI was traditionally used for independent demand items between suppliers and Retailers and can be used for both independent and dependent demand items. Many organizations are now using VMI in conjunction with CPFR to manage system-wide inventories. Remember that CPFR is a concept that allows suppliers and their customers to mutually agree upon system-wide demand for products. A major benefit of VMI is the knowledge gained by the supplier of real-time inventory levels of its products at its customer locations.

The use of VMI to manage inventories is not affected by which organization owns those inventories. Some customers have been investigating the use of what can be called almost consignment inventory as the supplier manages and owns the inventory in the customer's distribution until that inventory is pulled for shipment.

## Classifying Inventory

Multiple product lines and inventory control require organizations to focus on more important inventory items and to utilize more sophisticated and effective approaches to inventory management. Inventory classification is usually a first step toward efficient inventory management.

### ABC Analysis

This classification technique assigns inventory items to one of three groups according to the relative impact or value of the items that make up the group. A items are considered to be the most important, with B items being of lesser importance, and C items being the least important. Important to remember here is that the criteria used to evaluate an item will determine the group to which it is assigned.

Pareto's Law, or the "80–20 Rule," is based on the principle that a relatively small percentage of a population might account for a large percentage of the overall impact or value. This rule has been found to exist in many practical situations.

ABC classification is relatively simple. The first step is to select some criterion, such as revenue, for developing the ranking. The next step is to rank items in descending order of importance according to this criterion and to calculate actual and cumulative total revenue percentages for each item. This calculation will allow the items to be grouped into the ABC categories.

### Quadrant Model

This is typically used to classify raw materials, parts, or components for a manufacturing firm, the quadrant model can also be used to classify finished goods inventories using value and risk to the firm as the criteria. Value is measured as the value contribution to profit; risk is the negative impact of not having the product available when it is needed.

### Inventory at Multiple Locations—The Square-Root Rule

The square-root rule helps determine the extent to which inventories might be reduced through such a consolidation strategy. In general, the greater the number of stocking locations, the greater the amount of inventory needed to maintain customer service levels. Conversely, as inventories are consolidated into fewer stocking locations, aggregate inventories will decrease.

The square-root rule states that total safety stock inventories in a future number of facilities can be approximated by multiplying the total amount of inventory in existing facilities by the square root of the number of future facilities divided by the number of existing facilities. Mathematically, this relationship can be stated as shown in the below formula.

$$X_2 = (X_1)\sqrt{n_2/n_1}$$

where:

$n_1$ = Number of existing facilities
$n_2$ = Number of future facilities
$X_1$ = Total inventory in existing facilities
$X_2$ = Total inventory in future facilities

The model is based on several reasonable assumptions: (1) inventory transfers between stocking locations are not common practice; (2) lead times do not vary, and thus inventory centralization is not affected by inbound supply uncertainty; (3) customer service levels, as measured by inventory availability, are constant regardless of the number of stocking locations; and (4) demand at each location is normally distributed. Combining the square-root rule with ABC analysis explains why aggregate inventories are reduced when stocking locations are reduced.

## SUMMARY

- Inventory as a percent of overall business activity continues to decline. Explanatory factors include greater expertise in managing inventory, innovations in information technology, greater competitiveness in markets for transportation services, and emphasis on reducing cost through the elimination of non-value-adding activities.

- As product lines proliferate and the number of SKUs increases, the cost of carrying inventory becomes a significant expense of doing business.

- There are a number of principal reasons for carrying inventories. Types of inventory include cycle stock, work-in-process, inventory in transit, safety stock, seasonal stock, anticipatory stock, and anticipatory stock.

- Principal types of inventory cost are inventory carrying cost, ordering and setup cost, expected stockout cost, and in-transit inventory carrying cost.

- Inventory carrying cost is composed of capital cost, storage space cost, inventory service cost, and inventory risk cost. There are precise methods to calculate each of these costs.

- Choosing the appropriate inventory model or technique should include an analysis of key differences that affect the inventory decision. These differences are determined by the following questions: (1) Is the demand for the item independent or dependent? (2) Is the distribution system based upon a push or pull approach? (3) Do the inventory decisions apply to one facility or to multiple facilities?

- Traditionally, inventory managers focused on two important questions to improve efficiency, namely, how much to reorder from suppliers and when to reorder.

- The two aforementioned questions were frequently answered using the EOQ model, trading inventory carrying cost against ordering costs, and then calculating a reorder point based on demand or usage rates.

- The two basic forms of the EOQ model are the fixed quantity model and the fixed interval model. The former is the most widely used. Essentially, the relevant costs are analyzed (traded off), and an optimum quantity is decided. This reorder quantity will remain fixed unless costs change, but the intervals between orders will vary depending on demand.

- The basic EOQ model can be varied or adapted to focus more specifically on decisions that are impacted by inventory-related costs, such as shipment quantities where price discounts are involved.

- Just-in-time inventory management captured the attention of many U.S. organizations during the 1970s, especially the automobile industry. As the name implies, the basic goal is to minimize inventory levels with an emphasis on frequent deliveries of smaller quantities and alliances with suppliers or customers. To be most effective, JIT should also include quality management.

- Materials requirements planning and distribution requirements planning are typically used in conjunction with each other. In addition, a master production schedule is utilized to help balance demand and supply of inventory. DRP is used on the outbound side of a logistics system. Demand forecasts of individual SKUs are developed to drive the DRP model. Then, an MPS schedule is developed to meet the scheduled demand replenishment requirements.

- VMI is used to manage an organization’s inventories in its customers’ distribution centers. Using pull data, suppliers monitor inventory levels and create orders to ship product to bring inventory levels up to an economic order quantity in the customers’ distribution centers.

- ABC analysis is a useful tool to improve the effectiveness of inventory management. Another useful tool is the quadrant model.

- When organizations are adding warehouses to their logistics networks, a frequently asked question is, “How much additional inventory will be required?” The square root rule is a technique that can be used to help answer this question.

## TRANSPORTATION

## LEARNING OBJECTIVES

- Explain the role transportation plays in the supply chain.

- Discuss the service and cost characteristics of the primary transportation modes.

- Discuss the key activities involved in transportation planning and execution.

- Explain current transportation management strategies used to improve supply chain performance.

- Use service and cost metrics to analyze transportation performance.

- Describe how information technology supports transportation planning and execution.

## OVERVIEW

### Introduction

Transportation involves the physical movement of goods between origin and destination points, links geographically separated partners and facilities in a company's supply chain, and facilitates the creation of time and place utility in the supply chain.

In 2006, more than $800 billion was spent on freight transportation in the United States, which is nearly 63 percent of all expenditures for logistics activities, far exceeding the amount of money spent on warehousing, inventory management, order processing, and other fulfillment system expenses.

### The Role of Transportation in Supply Chain Management (SCM)

A supply chain is a network of organizations that are separated by distance and time with transportation allowing these organizations to extend the reach of their supply chains beyond local supplier capabilities and market demand. With efficient, effective transportation capabilities, organizations can build global supply chains that leverage low-cost sourcing opportunities, which allows them to compete in new markets.

Transportation efficiency promotes the competitiveness of a supply chain. In terms of supply management, cost-effective transportation helps companies gain access to higher-quality, lower-priced materials and realize economies of scale in production. Likewise, low-cost transportation improves demand fulfillment opportunities.

Transportation plays a key role in supply chain design, strategy development, and total cost management.

- Transportation service availability, capacity, and costs influence decisions regarding the number and location of supply chain facilities

- Transportation capabilities must align with the company’s strategy.

- Intentional tradeoffs should be made between transportation and related activities to optimize supply chain efficiency.

## Challenges to Carrying out This Role

There are numerous obstacles to synchronizing transportation with other supply chain activities. And part of the challenge is a variety of supply chain trends and external issues that must be addressed.

The growth of outsourcing, particularly offshore manufacturing creates major transportation challenges. While the vast distances produce higher transportation costs, the extended transit times and greater potential for supply chain disruptions necessitate higher inventory levels.

Customer demands for tailored services and defect-free delivery also impact the transportation function. Transportation capacity constraints pose another challenge to organizations moving freight through the supply chain.

Rising transportation rates present another major concern for organizations. The transportation industry is also impacted by governmental requirements that affect cost structures and service capabilities.

While the government has taken a market-focused approach toward carrier competition, legislation has been passed to improve the safety of the transportation industry, reduce its impact on the environment, and defend the country against terrorism including:

- Changes in commercial drivers’ licensing and in the hours of service that drivers can work.

- Environmental protection issues including aircraft noise pollution, transportation of hazardous materials and air pollution.

- The continued threat of terrorism has led to security-focused legislation such as requirements the “24 Hour Rule,” which requires ocean carriers to provide complete manifest information for all cargo bound for the United States to the CBP 24 hours prior to loading aboard a vessel in a foreign port and specific attention is given to the movement of food products.

Ultimately, this variety of external issues makes it difficult to develop transportation processes that mesh well with supply chain requirements

## Modes of Transportation

The primary modes of transportation available to the logistics manager are truck, rail, air, water, and pipeline along with intermodal transportation which combines the use of two or more of the basic modes. Each mode has different economic and technical structures, and each can provide different qualities of link service.

The U.S. transportation system moves approximately 12.5 billion tons of goods for businesses, valued at nearly $11.7 trillion. In terms of ton-miles (an output measurement combining weight and distance, or tonnage multiplied by miles transported), truck and rail are similar. However, the trucking industry dominates the U.S. transportation market in terms of the value of goods moved, followed by multimodal transportation. In terms of freight expense, organizations spent $760 billion for transportation services in 2010 as follows:

78% trucking ($592 billion)

7.9 % on rail

4.3 % air

4.3 % domestic water

1.3 % pipeline

Truck, multimodal, and air transportation move higher-value goods while rail, water, and pipeline provide more economically priced services for mostly but not all lower-value commodities with new automobiles being one of the exceptions.

## Motor Carriers

Motor carriage is the most widely used mode of transportation in the domestic supply chain. The sophisticated U.S. highway network permits trucks to reach all points of the country. The trucking industry is highly competitive and made up of 502,000 private, for hire, and other U.S. interstate motor carriers.

There are no significant cost economies of scale that makes it possible for small carriers to compete. Most expenses are incurred as the result of moving freight; thus, trucking is a high-variable-cost, low-fixed-cost business. The highway network is maintained by the government so variable operating costs have a greater impact on the economics of motor carriers.

Much of the freight moved by the trucking industry is regional in nature, moving within a 500-mile radius of the origin.

The trucking industry is comprised of for-hire and private fleet operations. Private fleets transport freight that is owned by the organization that is operating the trucks.

For-hire trucking companies are broken down into three general types:

- Truckload carriers (TL) handle single large shipments per trailer that exceed 15,000 pounds or use the full cubic capacity of a trailer. TL carriers provide direct service, picking up the load at the origin point and delivering it directly to the destination without stopping at freight-handling terminals.

- Less-than-truckload (LTL) carriers move multiple shipments ranging from 150 pounds up to 15,000 pounds in each trailer. National LTL carriers use a hub-and-spoke network of local and regional terminal facilities to sort and consolidate shipments moving to a particular market area. Regional LTL carriers focus their efforts on a particular area of the country.

- Small package carriers handle shipments up to 150 pounds and move multiple shipments on a single van or truck. They use networks similar to LTL carriers to move freight efficiently throughout the country.

The lines between these carrier types has blurred over the past few years with regional LTL carriers are offering some direct TL-like services, and TL carriers are providing multi-stop deliveries for their customers. The flexibility of the trucking industry allows it to handle varying commodities and shipment sizes.

Motor carriers face daunting challenges in the future—rising costs, labor issues, and competition and while trucking companies have been able to pass along rising fuel and insurance costs,  excess capacity may limit this ability. The shortage of truck drivers that has contributed to capacity shortages many only get worse.

Railroads

Railroads transport more than 1.9 billion tons of freight annually despite a lack of direct accessibility to all parts of the supply chain. Rail service is perceived as being a slow, inflexible, and inconsistent mode.

The industry is dominated by a very small number of large firms. With merger and acquisitions, there are seven Class I railroads (revenues in excess of $379 million) generating more than 92 percent of total rail industry revenues ($46.1 billion), handling 35.9 million loads, including 9.9 million intermodal trailers and containers.

Four of these companies—BNSF Railway, CSX Transportation, Norfolk Southern Railway, and Union Pacific Railroad—have evolved as the dominant carriers in the industry. However, as none of these rail carriers services the entire country, they work together to provide coast-to-coast rail service.

This mode requires a large investment in terminals, equipment, and trackage to begin operation, and the accompanying huge capacity allows railroads to be a decreasing cost industry. As output (ton-miles) increases, the average per-unit production cost decreases.

Rail transportation is primarily used for the long-distance movement of low value raw materials and manufactured products but they also handle some high-value goods, primarily automobiles and intermodal containers filled with imported finished goods.

The rail industry is comprised of the following two carrier types:

- Linehaul freight carriers provide service between major markets and customers within those markets.

- Short line and regional carriers provide the local and regional links between individual customers and the national rail network of the Class I railroads.

Railroads can move almost any type of freight in very large quantities. Hopper cars, boxcars, intermodal well cars, gondolas, and other specialized equipment are available from railroads, railcar leasing companies, or private owners.

Rail equipment can be organized into loads and transported in one of the three following primary ways:

- Manifest trains contain a mixture of equipment and freight for multiple customers.
- Unit trains move an entire block of railcars carrying a single commodity from the origin to a single destination.
- Intermodal trains are special types of unit trains of intermodal containers and trailers.

The rail industry faces a number of challenges moving forward. Capacity is a key issue as volume has surged. With the track infrastructure remaining largely unchanged, the additional freight, crews, and equipment have continued to clog the system. Interest in intermodal rail service is high but service quality is an issue among potential customers and the railroads must address their congestion issues and deliver goods on time.

## Air Carriers

The advent of e-commerce, the growth of global supply chains, and initiatives to reduce inventory and order cycle time has contributed to a sustained increase in demand for air transportation with spending of $33 billion in 2010. International air transportation is projected to grow at annual rate of 6.1 percent over the next 20 years.

The majority of air cargo revenue is generated by FedEx, UPS Air, Delta, United. International air freight movement is handled by a broader range of organizations with FedEx, Korean Air Lines, Cathay Pacific, and Lufthansa recording the largest ton-kilometers activity in the industry.

The air carrier cost structure consists of high variable costs in proportion to fixed costs, similar to the motor carrier cost structure. The government builds terminals and provides traffic control of the airways. Air carriers pay variable lease payments and landing fees for their use. Equipment costs, though quite high, are still a small part of the total cost.

Air transportation is used to ship small quantities of high-value, low-weight, semi-finished, and finished goods.

The following two primary carrier types dominate this mode:

- Combination carriers move freight and passengers, often on the same trip with cargo loaded in the belly of the aircraft.
- Air cargo carriers focus exclusively on the movement of letters and envelopes, and freight.

Air carriers can also be separated on the basis of service capabilities:

- Integrated carriers provide door-to-door service, a consistent schedule of pickup and delivery windows, and standard expedited service through their hub-and-spoke networks.
- Nonintegrated carriers provide on-demand, air-only service from airport to airport. They rely on freight forwarders or the customer to provide delivery service to and from the airport.

Air cargo carriers employ a wide variety of aircraft to move freight domestically and around the world.

The air cargo industry faces numerous obstacles to profitable growth, including cost issues, competition, and security challenges. The rising cost of fuel directly impacts the success of the industry as it is estimated that every additional penny paid for a gallon of jet fuel costs the industry $195 million annually. The growth of next-day trucking services is already putting pressure on the domestic air cargo industry and air carriers may find it difficult to pass along increased costs in the face of this growing competition. Finally, the industry is under pressure from costly security mandates are estimated to have an annual impact of more than $4 billion on the industry.

Water

Water transportation is a major facilitator of international trade. Globally, water carriers dominate all other modes, garnering approximately 50 percent of the international freight revenue and handling nearly all the tonnage. Water carriers offer tremendous capacity, efficient fuel consumption, and low cost. The 652 carriers in the U.S. domestic water industry generated $5 billion of revenues in 2010. More than a billion tons of freight is handled annually by the domestic fleet.

The market for international services is growing, with the U.S. market generating $22 billion in revenues for carriers. Volume also increased by 8 percent for imports and exports over the prior year.

Ocean transportation is similar to that of airlines as these carriers require no investment for the right-of-way and government entities known as port authorities provide unloading and loading services, storage areas, and freight transfer facilities. The water carriers pay user fees for these port services only when used. Large ocean-going ships require significant capital investments, but cost is spread over a large volume of freight transported during the lengthy life span of most ships.

The domestic carriers compete vigorously with railroads for long-distance movement of low-value, high-density, bulk cargoes that mechanical devices can easily load and unload. In contrast, water carriers handle a wider variety of goods. Every conceivable type of cargo is transported via international water carrier, from low-value commodities to imported automobiles and other imported consumer goods.

Two primary carrier types dominate the for-hire portion of the water industry:

- Liner services employ a wide variety of ships in their fixed route, published schedule service.
- Charter services lease ships to customers on a voyage or time basis and follow routes of the customer's choosing.

Ocean transportation of goods ranging from crude oil to electronics is facilitated by a wide range of specialized ships such as:

- Container ships are critical to the globalization of trade as they transport standardized containers, which are commonly rated in TEUs (20-foot equivalent units) or FEUs (40-foot equivalent units
- Bulk carriers carry cargoes with low value-to-weight ratios, such as ores, grain, coal, and scrap metal.
- Tankers carry the largest amount of cargo by tonnage, usually on a charter basis.
- General cargo ships are usually on a charter basis and have large cargo holds and freight-handling equipment to facilitate the loading and unloading of a large variety of freight.
- Roll-on, roll-off (RO–RO) vessels are another type of ship proving its value in international trade using built-in ramps to drive or tow vehicles on or off.

The major challenges faced by carriers in international water transportation relate to capacity, trade imbalances, and rising costs. Carriers have ordered new equipment to cope with capacity, but construction time for these ships is lengthy. The imbalance of international trade between export-dominant Asian countries and import-dominant North America creates equipment availability problems at the origin and destination port congestion issues. The industry is experiencing double digit cost increases due to security compliance and rising fuel expenses. These costs must be passed on to customers if ocean carriers are to maintain their slim profit margins.

## Pipeline

Pipelines handle a significant proportion of all intercity ton-mileage of freight. It is a unique mode of transportation as the equipment is fixed in place and the product moves through it in high volume. Pipelines effectively protect the product from contamination and also provide a warehousing function. Pipelines provide the most economical form of transportation with the lowest cost per ton of any mode.

Pipeline costs are predominantly fixed as they must build their own right-of-way. Variable costs in the industry are very low as little labor is required to operate the pipelines and limited fuel is needed to run pumps. The construction of a pipeline becomes cost effective when product flows continuously, allowing the fixed costs to be spread over a high volume of goods.

The vast majority of products moved by pipeline are liquids and gases, the economically feasible products to flow via this mode.

The pipeline industry is comprised of for-hire and private carriers that maintain their own infrastructures. For-hire carriers of liquid products can move different products through their system at the same time, separated by a batching plug that maintains the integrity of individual products. Private carriers include petroleum and natural gas companies that use pipelines to move product to and from their refineries, processing plants, and storage facilities

The oil system is made up of the following three primary types of pipelines:

- Gathering lines are very small pipelines usually from 2 to 8 inches in diameter.
- Trunk lines, measuring from 8 to 24 inches in diameter, bring crude oil from extraction points to refineries.
- Refined product pipelines carry petroleum products from refineries to large fuel terminals with storage tanks

Natural gas pipelines use similar networks of gathering lines, transmission lines, and main distribution lines to move product closer to the market.

The ongoing issues for the pipeline industry are safety and security. Compared to other modes, pipelines have enviable safety and environmental records with spills amounting to only one gallon per million barrel-miles.

## Intermodal Transportation

Intermodal transportation service refers to the use of two or more carriers of different modes in the origin-to-destination movement of freight.

These primary benefits of intermodalism include the following:

- Greater accessibility is created by linking the individual modes. Trucks provide the flow between airports and the customer. Railroads can also facilitate the use of domestic river transportation and international ocean transportation.
- Overall cost efficiency can be achieved without sacrificing service quality or accessibility. The speed and accessibility of trucks would be used for the initial pickup and final delivery, while the cross-country transportation would be handled by the cost-efficient railroads.
- Intermodal transportation facilitates global trade.

There is strong evidence that intermodal transportation is growing in importance and volume. The number of containers has increased from 15.5 million TEUs in 1990 to 37.2 million TEUs in 2009 with intermodal container volume reaching 80 million TEUs in 2015. Domestic flows of intermodal freight are also on the rise. The rail system moved 8.2 million containers and 1.6 million trailers in 2004. This continues the upward trend of the last two decades.

Much of this intermodal growth can be attributed to the development of standardized containers that are compatible with multiple modes. A container can be lifted, stacked, and moved from one piece of equipment to another; and is built to standard dimensional height and width specifications in a variety of lengths and specialized containers are also available for handling temperature-sensitive goods commodities and other unique cargoes. Better information systems to track freight as it moves through the supply chain and the development of intermodal terminals to facilitate efficient freight transfers between modes as well as new generations of ocean vessels, railcars, and truck trailers are helping growth.

Ocean carriers are continually developing larger containerships to handle international intermodal traffic which relatively fast, serving Pacific or Atlantic routes only and can only serve deep-water ports.

The rail industry also offers a variety of equipment for moving intermodal shipments which allow the movement of wider variety of containers, everything from 10-foot ocean containers to 53-foot domestic freight container in nearly any combination. Double-stack service is especially efficient.

The freight services provided by intermodal transportation can be viewed in terms of product-handling characteristics as follows:

- Containerized freight is loaded into/onto storage equipment (a container or pallet) at the origin and delivered to the destination in/on that same piece of equipment with no additional handling.

- Transload freight involves goods that are handled and transferred between transportation equipment multiple times.

## Transportation Planning and Strategy

Supply chain professionals must make a series of interrelated transportation decisions and design processes that properly align with the organization's supply chain strategies.

### Functional Control of Transportation

The initial decision for any organization is straightforward but important—determining which department(s) will be responsible for each part of the transportation process. In most organizations, responsibility for transportation decisions falls to one or more of the following departments: logistics, procurement, and marketing. Firms now assign transportation decision-making responsibility to a single department which strives to coordinate inbound and outbound transportation, develop common goals, leverage purchasing power, and procure quality service in support of supply chain excellence.

### Terms of Sale

Free-on-board (FOB) terms of sale specify when the ownership and title of the goods pass from a seller to a buyer. This is a critical issue as it determines control over mode and carrier selection, transportation rate negotiation, and other key decisions.

FOB terms determine where the buyer's responsibilities begin and where the seller's responsibilities end, as well as responsibility for carrier payment.

Strategically, the use of FOB origin for product purchases and FOB destination for product sales makes sense as this works well providing greater visibility of inbound freight and opportunities to consolidate outbound freight. Coordination of supply chain freight movement can also be achieved through these terms of sale. At times, both the seller and the buyer want to use the FOB terms to be in control of the freight. And factors such as power, expertise, and risk should impact which organization ultimately manages the transportation process.

### Decision to Outsource Transportation

The organization with FOB freight control and procurement responsibility must analyze the transportation "make or buy" decision. Firms must choose between transporting goods using a private fleet (the “make” option) which account for nearly half of all U.S. freight transportation spending.  Firms may also use external service providers to move freight (the “buy” option).

Some firms have decided that it is best to have external experts move the freight and/or manage the transportation process as they also offer a variable cost, simplified, headache-free alternative to private transportation. By using for-hire carriers, the customers do not have to incur the large capital cost, invest the time needed to build transportation expertise, or take on the potential risks inherent in operating a private fleet.

Third-party logistics provide and alternative and they offer wide array of transportation services and the 3PL serves as the firm’s private fleet and devotes a management team, drivers, and equipment to the relationship. Another service is traffic management where the 3PL provides transportation planning and tactical decision making, handles administrative functions like freight bill auditing, and coordinates supply chain activities. Some 3PLs provide international transportation assistance in the areas of documentation carrier and route selection, Customs clearance, and other tasks that impact the timely, cost-effective flow of goods across borders.

## Modal Selection

A critical transportation management issue is modal selection; it affects how fast and economically product will flow across portions of the supply chain. Choosing among the six modal options is a function of three factors: modal capabilities, product characteristics, and modal freight pricing.

All modes provide the same basic service of moving freight from point to point but each mode has unique attributes and capabilities that impact its ability to serve specific customer requirements.

Accessibility determines whether a particular mode can physically perform the transport service required and considers the mode’s ability to reach origin and destination facilities and provide service over the specified route in question.

Accessibility advantage: Motor carriage, because of its inherent ability to provide service to virtually any location.

Accessibility disadvantage: Air, rail, and water. All face accessibility limitations due to infrastructure issues.

Transit time is critical in supply chain management because of its impact on inventory availability, stockout costs, and customer satisfaction. Transit time is the total elapsed time that it takes to move goods from the point of origin to the destination (i.e., door to door).

Transit time advantage: Air transportation is very fast, motor carriage is also relatively fast because it can provide more direct movement from origin to destination

Transit time disadvantage: Rail, water, and pipeline are extremely slow with average transit speeds of 22 miles per hour, 5–9 miles per hour, and 3–4 miles per hour, respectively.

Reliability refers to the consistency of the transit time provided by a transportation mode and many companies feel that transit time reliability is more important than speed as it and is measured by the statistical variation in transit time.

Reliability advantage: Motor carriers and air carriers, as they are the most reliable.

Reliability disadvantage: Water carriers and rail carriers have been slow and consistent, but with the capacity and congestion challenges, they have become less consistent.

Product Safety is critical as goods must arrive at the destination in the same condition they were in when tendered for shipment. Precautions must be taken to protect freight from loss due to external theft, internal pilferage, and misplacement, as well as damage due to poor freight-handling techniques, poor ride quality, and accidents with packaging being important.

Safety advantage: Air transportation and motor carriage have the best reputations for product security.

Safety disadvantage: Rail and water face significant challenges to maintaining product integrity.

The cost of transportation is an important consideration in the modal selection decision, especially when a low-value commodity needs to be moved. A number of factors are taken into consideration when freight rates are developed, including weight of the shipment, distance from origin to destination, nature and value of the product, and the speed required.

Cost advantage: The cost of transportation service varies greatly between and within the modes and prices vary with the tradeoff is slow speed for low cost.

Cost disadvantage: Motor carriage and air transportation are high-cost modes compared to the others.

Each transportation situation is unique, and these higher cost modes are appropriate options. Given the varying capabilities and cost of each transportation mode, it is obvious that modal selection is not a quick and easy process.

Durability is another key consideration in the modal selection process. Product value is a critical factor in modal selection. Generally, an inverse relationship exists between product value and the impact of transportation on its value. Shipment characteristics—size, route, and required speed—cannot be ignored in modal selection. Infrastructure availability tend to limit modal selection to two or three realistic options and the shipment-related requirements of speed, reliability, and safety must be matched to the modal customer service capabilities

## Carrier Selection

Carrier selection is a specialized purchasing decision that typically will be made after the modal decision has been made with attention to selecting the individual transportation service providers within the mode. The carrier selection is based on a variety of shipment criteria and carrier capabilities: transit time average and reliability, equipment availability and capacity, geographic coverage, product protection, and freight rates. A major difference between modal and carrier selection is the number of options. Modal selection involves six primary options, but the carrier selection may involve fewer or many more alternatives.

Another difference is the frequency of the decision as carrier selection requires more active and frequent engagement of the transportation buyer and the type of service provided within a mode impacts carrier selection as well.

Within a mode, most carriers have the capabilities to provide similar service, but this can and does vary greatly from one provider to another. As the cost structures are essentially the same for carriers in a given mode, their rates tend to be aligned for a given movement so price it not always a factor.

Carrier selection strategy commonly focuses on concentrating the transportation buy with a limited number of carriers. Using a small group of carriers the organization leverage its purchasing dollars for lower overall rates while building relationships with service providers and is reflected by core carrier concept.

## Rate Negotiations

Firms have shifted to centralized freight rate negotiations with carriers focusing on developing contracts with carriers for a tailored set of transportation services at a specific price. Transportation companies have focused on volume commitments, shipment frequencies, origin-destination combinations, freight characteristics, and related cost issues that impact their ability to serve the buyer profitably. The strategy of centralized, contract-based rate negotiation aligns well with the core carrier concept described previously.

The contracts developed as part of this process also promote the creation of a mutually beneficial, long-term relationship in which the parties collaborate to create greater supply chain value beyond transportation savings.

## Transportation Execution and Control

When a shipment needs to be moved across the supply chain, transportation planning efforts culminate and execution processes take center stage.

## Shipment Preparation

To ensure maximum effectiveness in the shipment-carrier matching process, many organizations maintain a corporate transportation routing guide. The strategy behind routing guides is to promote supply chain excellence through transportation.

Transportation managers have the ability to make last-minute, cost-saving decisions such as efforts  to consolidate freight, coordinate shipment deliveries and take full advantage of container capacity or by combining multiple orders destined for a single location into a single shipment for distribution.

The transportation operation is the last line of defense in protecting product integrity and value.

## Freight Documentation

Shipments are accompanied by related documents that spell out the details of the shipment. The bill of lading is probably the single most important transportation document and is either negotiable or non-negotiable. A straight bill of lading is nonnegotiable and the carrier must deliver the goods only to the specific receiving organization and destination in return for freight charge payment. An order bill of lading is negotiable and serves as a title to the goods listed on the document.

Bills of lading also differ by type of move whether domestic or international as well as a being unique to the mode. The freight bill is the carrier’s invoice for the fees the carrier charges to move a given shipment. The freight bill lists the shipment, origin and destination, consignee, items, total weight, and total charges

A freight claims form is a document that the transportation buyer files with the carrier to recoup monetary losses resulting from the carrier’s failure to properly protect the freight.

Carriers are not liable for freight claims if the damage is attributable to some uncontrollable factor such as the following:

- Natural disaster of some other “act of God”
- Military attack or similar “act of public enemy”
- Government seizure of freight or “act of public authority”
- Failure to adequately package the freight or other negligent “act of the shipper”
- Extreme fragility, perishability, or similarly problematic “inherent nature of the goods”

A number of other documents may also be required to move freight efficiently which could include a commercial invoice or the certificate of origin and documentation-based freight delays and disruptions can be minimized with attention to detail.

## Maintain In-Transit Visibility

It is important to control the freight and manage key events as product moves across the supply chain and visibility of in-transit freight is a key facilitator of this control as it prevents freight from temporarily “falling off the radar screen.” Technology facilitates the ability to monitor product flowing across the supply chain, and such visibility tools must be linked to other capabilities and processes to have an impact on supply chain event management.

## Monitor Service Quality

Transportation managers must analyze the outcome of all their transportation strategy, planning, and decision-making efforts through a coordinated, ongoing effort to monitor carrier. Performance and a key requirement for service quality monitoring is information. A popular strategy for developing an objective, holistic view of carrier service quality is to develop standardized scorecards or evaluation reports.

## Transportation Metrics

The key service requirements are generally observable and quantifiable. This allows organizations to monitor activities through transportation metrics or key performance indicators (KPIs), which are objective measures of carrier or private fleet performance critical to the success of the organization.

Many aspects of transportation performance can be evaluated. Important issues include transportation spending efficiency, freight protection, delivery service quality, and customer satisfaction, among others. The two primary categories of transportation KPIs include service quality and efficiency.

The focus on lean supply chains and just-in-time operations makes consistent, on time delivery a critical requirement, which is the most important KPI used by transportation buyers to evaluate their carriers.

- On-time delivery KPIs measure the ratio of shipments delivered in a timely fashion to the total shipments delivered by the carrier.
- Delivery consistency metrics compare the average origin to destination transit time of shipments to the transit time promises made by carriers.

Freight protection is another key element of transportation service quality.

- Claims-free delivery is a primary freight protection KPI.

- Billing accuracy KPIs measure a carrier’s ability to properly translate customer bill of lading information and instructions to the freight bills.
- Freight bill accuracy KPIs measure the ratio of accurate freight bills to the total number of freight bills.
- The ultimate service quality KPI is the execution of perfect deliveries, the ratio of defect-free deliveries to the total number of deliveries made.

While service quality is critically important for customer satisfaction, transportation service efficiency cannot be ignored. Organizations need to balance their service requirements and the expenses related to moving freight.

Asset utilization is a critical aspect of transportation cost control. Moving empty or partially loaded equipment is inefficient and expensive. It is estimated that 18 percent of all truck movement involves empty equipment; a multibillion-dollar cost and customers ultimately pay for these empty miles in the form of higher rates. Equipment utilization KPIs also help buyers work toward effective freight deployment.

## Transportation Technology

Software and information technology tools have been developed to support transportation planning, execution, and performance evaluation.

### Transportation Management Systems

Software tools related to the movement of goods across the supply chain are lumped together in a general category called transportation management systems (TMS), which is defined as information technologies used to plan, optimize, and execute transportation operations

Critical TMS planning applications include the following:

- Routing and scheduling—proper planning of delivery routes has a major impact on customer satisfaction, supply chain performance, and organizational success.
- Load planning—effective preparation of safe, efficient deliveries can be accomplished via TMS load optimization programs to help managers build a database of package dimensions, loading requirements, and equipment capacity.

Three key TMS execution tools include the following:

- Load tendering determines which carriers are eligible to move the freight and then tenders the freight to the best carrier.
- Status tracking maintains visibility of shipments as they move across the supply chain through delivery confirmation.
- Appointment scheduling automates the scheduling function.

Two useful analytical applications are as follows:

- Performance reporting and scorecarding—managing carrier performance and TMS tools can automate the collection of data, measurement of KPIs, and dissemination of periodic reports.
- Freight bill auditing—payments made to carriers must reflect the agreed upon contractual rates and the services rendered.

## SUMMARY

- Transportation is a very dynamic activity and a critical supply chain process. Not only is it the largest logistics cost component in most supply chains, but it also directly impacts fulfillment speed and service quality. By providing the physical links between key participants across domestic and global supply chains, transportation facilitates the creation of time and place utilities.

- Managing the transportation process for maximum supply chain impact requires considerable knowledge of transportation options, planning, decision making, analytical skills, and information sharing capabilities.

- Transportation is a key supply chain process and must be included in supply chain strategy development, network design, and total cost management.

- Numerous obstacles—global expansion of supply chains, rising costs, limited capacity, and government regulation—must be overcome to synchronize transportation with other supply chain processes.

- Fulfillment of supply chain demand can be accomplished through five modal options or the intermodal use of truck, rail, air, water, and pipeline transportation.

- Multiple planning activities occur prior to carrier and mode selection: who will be responsible for managing the transportation function within the organization, what terms of sale and payment will be used, and how will goods be transported must all be determined with a strategic supply chain focus.

- Mode selection is based on the relative strengths of each modal/intermodal option in terms of accessibility, transit time, reliability, safety and security, transportation cost, and the nature of the product being transported.

- Carrier selection focuses on the type of service required (direct or indirect), geographic coverage, service levels, and carrier willingness to negotiate reasonable rates.

- Most commercial freight moves under contractual rates that are negotiated directly between freight buyers and transportation companies for specific volumes of tailored services at mutually agreed-upon prices.

- Shipment routing guides help organizations ensure internal compliance with service contracts and maintain centralized control over freight tendering decisions.

- Freight documentation provides the details of each shipment, sharing critical information that promotes uninterrupted flows of goods through the supply chain.

- Organizations must continue to manage freight after it has been tendered to carriers by maintaining in-transit visibility of shipments and monitoring carrier performance.

- Numerous metrics are available to evaluate transportation service quality in terms of carrier timeliness, freight protection, accuracy, and perfect deliveries. Service efficiency measures focus on spending proficiency, asset utilization, and labor productivity.

- Transportation management systems are widely used information technologies that support the effective planning, execution, and analysis of transportation processes.

## COSTING AND PRICING IN TRANSPORTATION

### Market Structure Models

**Pure competition** is defined as: a large number of sellers, no one firm can influence prices or supply, the product or service is homogeneous, and there is unrestricted entry. The demand curve facing the individual firm is one of perfect elasticity.

A **monopolistic market** has only one seller of a product or service for which there is no close competitor or substitute and that single seller is able to set the price for the service.

An **oligopoly** is defined as competition between a "few" large sellers of a relatively homogeneous product that has enough cross-elasticity of demand (substitutability) so that each seller must, in pricing decisions, take into account competitors' reactions.

**Monopolistic competition** has many small sellers, but there is some differentiation of products and no one seller controls a significant portion of the market.

### Theory of Contestable Markets

For deregulation to work for a mode, its market structure must closely resemble pure competition. Even when it appears that a mode is oligopolistic, *the theory of contestable markets,* which substitutes potential competition for the active participation of many sellers, can be used with some modes such as airlines to allow relaxation of government control.

For this theory to work, barriers to entry could not exist, economies of scale could not be present, and consumers had to be willing and able to switch quickly among sellers.

### Relevant Market Areas

A general statement classifying the market structure of the entire transportation industry cannot be made because it is necessary to view structures in particular market areas. In order to determine pricing in transportation, the situation between two points, for one commodity, in one shipment size, moving in one direction must be described.

The complexity of the situation for each mode, commodity, and market does not eliminate the validity of the economic models described above. It only means that in order to make use of these models we must have knowledge of the situation that exists in the particular market.

In setting prices, a carrier must have knowledge of the relevant market and they can possibly use one of the economic models described. Although there will be instances when carriers might find it expedient to generalize in adjusting prices, a much narrower focus is customary in the day-to-day negotiation and analysis of these prices.

The deregulation that has occurred in transportation between 1978 and 1996 has made these conclusions even more appropriate. The new competitive environment has made carriers and shippers more sensitive and more prices are being negotiated by shippers and carriers.

## COST-OF-SERVICE PRICING

There are two separate concepts in cost-of-service pricing: basing prices upon average cost or basing prices upon marginal cost.

If the firm desires to maximize its profits, it will produce quantity $Q_m$ and charge price $P_m$. The firm would be making excess profits in the economic sense because the price is above average cost and the firm is not producing at a point for optimal allocation of resources. This is a monopoly situation.

If this was subject to regulation, a single price would be set that would cover the firm’s cost of production and at the same time sell all the output, then the price should be $Pz$ and the output $Qz$. In this instance, we would be basing the price on average cost.

It appears that the average-cost approach is more socially desirable than the unregulated, profit-maximizing approach.

One of the arguments frequently raised against a strict marginal-cost approach to pricing is that, under decreasing cost conditions, if the firm equates marginal cost with demand, then it will necessitate the firm’s operating at a loss. There is one obvious solution and that is to allow the government to make up the deficit through a subsidy.

The assumption that only one group of customers is served exclusively is not a typical situation, except in very special cases among transportation companies. Likewise, costs are not usually separable according to the classes of customers, but rather, common costs are quite typical, particularly with respect to railroads.

The presence of common costs raises some problems for cost-of-service pricing, particularly the average-cost approach. Average cost pricing with fixed or common costs, or both, makes these costs price-determining when they should be price-determined. To some extent then, cost is a function of the prices; the prices are not a function of the cost.

The presence of **common costs** does not raise the same theoretical problem for marginal-cost pricing because no arbitrary allocation of these costs is technically necessary. There are some additional problems of a more practical nature, however, with respect to strict marginal-cost pricing. For example, in transportation, marginal costs could fluctuate widely, depending on the volume of traffic offered.

An obvious question is whether cost-of-service pricing has any relevance for establishing prices. Prices charged by transportation companies are actually one of the criteria that guide intelligent shippers in selecting the mode of transportation or carrier that is most appropriate for their shipment.

For the transportation decision to be properly made, the price charged should reflect the cost of providing the service to ensure carrier and economic system efficiency.

Cost-oriented prices should be related to what we have defined as marginal cost or variable cost. Such costs, measured as precisely as possible, should serve as the conceptual floor for individual prices. Differential pricing seems to make sense in most instances, but our rationale needs further explanation.

In the presentation of cost-of-service pricing, mention was made of **decreasing cost industries** and some transportation firms fall into this category. If prices are based on strict marginal cost, the firm experiences a loss but the firm has to recover its fixed costs. It can be accomplished by using marginal cost as a floor for prices and using the value of service, or demand, to establish how far above this minimum the rate or price should be set.

**Value-of-service pricing** can assume two meanings. First, prices are set so that on each unit the maximum revenue is obtained regardless of the particular costs involved. The second meaning is that no service should be charged a price that it will not bear when, at a lower price, the service could be purchased.

The differences in the elasticities of demand for the different services will determine the actual level of the prices. The presence of indivisibilities in the cost structure necessitates the dissimilar pricing.

Dissimilar pricing allows common and fixed costs to be spread out over large volumes of traffic. In other words, dissimilar pricing might render economical benefits because prices might be lower than they otherwise would be.

The variable, or marginal, cost of providing the service should serve as the floor for carriers when setting prices. This is going to rely entirely on how marginal, or variable, cost is defined and assumes that (1) the carrier knows its costs and (2) it is able to charge a price that will result in a profit.

It can be said that dissimilar pricing is the logical approach for pricing in regulated industries. Cost indivisibilities necessitate the practice of discriminatory pricing, but this was approached within what might be called a cost framework. Marginal cost sets the minimum basis for prices, whereas fixed or common costs are, in effect, allocated on the basis of demand elasticity.

## VALUE-OF-SERVICE PRICING

Value-of-service pricing is a frequently mentioned and often criticized approach to pricing that has generally been associated with the railroad industry.

One rather common definition of value-of-service pricing in transportation is pricing according to the value of the product; for example, high-valued products are assessed high prices for their movement, and low-valued commodities are assessed low prices.

If a cost-based approach is taken to setting prices, high-valued commodities would usually be charged higher prices because they are typically more expensive to transport. The value of the commodity is a legitimate indicator of elasticity of demand; for example, high-valued commodities can usually bear higher prices because transportation cost is such a small percentage of the final selling price.

Where alternatives are present at a lower price, shippers are not willing to pay higher prices based upon the value of the product alone. The value of the commodity gives some indication of demand or the ability to bear a charge, but competition also will affect the demand for the service, that is, the height and slope of the demand curve.

**Third-degree price discrimination** is a situation in which a seller sets two or more different market prices for two or more separate groups of buyers of essentially the same commodity or service. Three necessary conditions must exist to allow this: (1) the seller must be able to separate buyers into groups or submarkets according to their different elasticities of demand; (2) the seller must be able to prevent the transfer of sales between the submarkets; and (3) the seller must possess some degree of monopoly power.

**Differential** pricing can be done based on several methods of segregating the buyers into distinct groups. It can be done by commodity, by place, or by individual person. It should be noted, however, that discrimination based on an individual person is illegal per se on traffic that remains economically regulated by the STB.

Value-of-service or differential pricing makes sense from the perspective of the railroads, considering their high level of fixed costs and need to attract traffic.

The key to success lies in being able to determine the appropriate costs and to estimate demand elasticity in the various markets.

In value-of-service or differential pricing, each particular commodity is paying more than its variable cost and making a contribution to average cost, which also might be a concept of fully allocated cost.

One might argue that the coal shippers are not paying their full share and the computer shippers are paying too much. However, for example, Supersaver fares charged by the airlines and full-fare passengers complain hat they are subsidizing discount-fare passengers. Actually, full fares might be higher if the special fares were not offered.

The essential ingredient in the value-of-service analysis is the notion that each commodity movement has its own unique demand characteristics.

Several points about this example need to be emphasized. The determination of cost is a difficult task. Second, most railroads and many other carriers would be considering more than three commodities between two points. Third, the example applies to the railroad because it is more attractive in situations with high fixed costs, yet other carriers, even motor carriers, might find differential pricing attractive. Fourth, some difference would exist in rates among commodities because of cost differences. Finally, the elasticity of demand for a particular commodity might change with competition, or because of some other factors.

Conceptually, if cost-of-service pricing serves as the floor for carrier pricing, then value-of-service pricing can serve as the ceiling. However, if we accept the notion that value-of-service pricing is pricing based on "what the traffic will bear," then an argument can be made that value-of-service pricing is also the floor for carrier prices, rather than the marginal cost of providing the service.

For example, a truckload carrier moves a shipment from point A to point B with a variable cost of $90, an average cost of $100, and a price of $110. This is called the carrier's **headhaul** because it is this move that initiated the original movement of the carrier's equipment and the shipper's goods. As such, the carrier might be able to use value-of-service pricing, charging $110

With the carrier's equipment at point B, it is necessary to bring the equipment and driver back to point A. This is called a **backhaul** because it is the result of the original move (headhaul). The carrier now faces a totally different market in this backhaul lane. Assume that marginal cost in this backhaul lane is defined as the variable cost of fuel and driver wages, or $90. If the carrier decides to price based on its marginal cost of $90 (cost-of-service pricing), it is very possible that the market from point B to point A will not "bear" this price and the carrier will be forced to return empty. This will result in a loss to the carrier of $90. Now suppose that the carrier prices this backhaul in accordance with market demands at a level of $80. Although this results in a price below marginal cost, the carrier has minimized its losses by losing only $10 on the move instead of $90. Pricing in this manner can be called *loss minimization.* So it can be argued that value-of-service pricing can be used as the price ceiling (profit maximization) and as the price floor (loss minimization).

If the marginal cost in this backhaul lane is defined as those costs that would be avoided if the carrier, in fact, returned empty; that is, because the vehicle and driver are going to return anyway, the $90 for fuel and wages now becomes the fixed cost, which will now be included in the average cost figure. Marginal cost now becomes the added cost of loading the shipment and the reduced fuel efficiency, which will be assumed to be $20. On the headhaul, the price of $110 covers both the average cost of $100 and the marginal cost of $90. On the backhaul, the $90 is allocated as a fixed cost over the units of output to result in an average cost of $50. Now the $80 price charged covers both the average cost and marginal cost and results in a profit, just as the price produced a profit in the headhaul example. In this example, value of service provided the price ceiling and cost of service provided the price.

## RATEMAKING IN PRACTICE

A complete understanding of carrier cost economics and behavior is a necessary prerequisite to effective management of carrier pricing.

The overall carrier pricing function revolves around costing, rates, and tariffs. The work of the carrier's cost analysts should serve as a pricing input to rate personnel who are responsible for establishing specific rates and general rate levels for the carrier. A carrier may publish their own rates or they may use a rate bureau that is common to many carriers to establish and publish rates.

## General Rates

These are the class, exception, and commodity rate structures in the United States. The **class rate** system provides a rate for any commodity between any two points. It is constructed from uniform distance and product systems. **Exception rates** are designed so that carriers in particular regions can depart from the product scale system for any one of many possible reasons, which will be discussed later. **Commodity rates,** on the other hand, are employed for specific origin–destination shipping patterns of specific commodities. Each one of these three systems has a particular purpose.

There are thousands of important shipping and receiving points in the United States which gives some insight into the enormous magnitude of the transportation pricing problem. In order to have a rate between any combination, there would be trillions of trillions of possible rates. In addition, it is necessary to consider the thousands and thousands of different commodities and products that might be shipped over any of these routes.

## CLASS RATES

The thousands of shipping points are simplified by dividing the nation into geographic squares. And the most important shipping point for all other shipping points (based on tonnage) in each square serves as the **rate base point** for all other shipping points in the square. This reduces the potential number of distance variations for rate-making purposes. The distance from each base point to each other base point was determined by the railroads and is published in the National Rate Basis Tariff. The distance between any two base points is referred to as the **rate basis number.**

The second step deals with the thousands and thousands of different items that might be shipped between any two base points. The railroads and the motor carriers have established a national scale of rate in dollars per hundredweight for each rate basis number.

The third step simply groups together products with similar transportation characteristics so that one rating can be applied to the whole group. This number is called a *class rating* and it is the group into which the commodity is placed for rate-making purposes.

## CLASSIFICATION FACTORS

The factors that are used to determine the rating of a specific commodity are the product characteristics that impact the carrier's costs. There are four factors are to be considered: product density, storability, handling, and liability. An individual carrier can establish a commodity classification that differs from the national classification.

**Product density** directly impacts the use of the carrier's vehicle and the cost per hundredweight. The higher the product density, the greater the amount of weight that can be loaded within the vehicle and the lower the cost per hundredweight.

**Stowability and handling** reflect the costs the carrier will incur in securing and handling the product in the vehicle. Such product characteristics as excessive weight, length, and height result in higher stowage costs for the carrier and a corresponding higher classification rating. Likewise, products that require manual handling or special handling equipment increase the carrier's costs and are given a higher rating.

**Liability** considers the value of the product and because higher-valued products pose a greater liability risk (potential cost). Higher-valued products are classified higher than lower-valued products.

## DETERMINING A CLASS RATE

The procedure for determining a class rate for moving a specific commodity between two points is as follows. The first step is to determine the rate base points for the specific origin and destination from the groupings tariff. Next, from the rate basis number tariff, determine the rate basis number for the relevant rate basis points. The class rating for the particular commodity being shipped is found in the classification. Finally, the rate is found in the class rate tariff for the appropriate rate basis number and class rating. The shipping charge for moving a product between a specific origin and destination is determined by multiplying the class rate, which is in cents per hundredweight, by the total shipment weight in hundredweight.

## EXCEPTION RATES

An exception rate is a modification (change in rating, minimum weight, density groups, etc.) to the national classification instituted by an individual carrier. Exception ratings are published when the transportation characteristics of an item in a particular area differ from those of the same article in other areas

## COMMODITY RATES

A commodity rate generally is a specific rate published on a specific commodity or group of related commodities between specific points and generally via specific routes in specific directions.

When the commodity rate is published, it takes precedence over the class rate or exception rate on the same article between the specific points

## Rate Systems under Deregulation

The diminished role of the rate bureau in carrier rate making has resulted in plethora of individual carrier tariffs. In addition, the greater reliance upon the marketplace to control carrier rates has enabled shippers to greatly increase negotiations, resulting in rate reductions, discounts and contract rates.

The product classification will probably continue for some time and the class rate structure will survive for some time to come. The class rate structure is a benchmark from which, in many cases, negotiated rates are based.

Another pricing system is based on mileage. The rate is based on the total miles the shipment travels and weight might not even be a factor in the charges. In some cases, the rate is based on actual miles traveled while in other cases the rate is based on the shortest practical distance between the origin and destination.

## SPECIAL RATES

**LTL** rates reflect the fact the LTL shipments require several handlings while in transit. Each one of these handlings requires dock personnel, material handling equipment, terminal investment and additional management effort.

**Truckload** rates reflects the fact that there is little or no handling by the carrier. TL shipments have lower rates than LTL shipments.

**Multiple car rates** are one method by which a railroad can offer discounts from the single car rate. The cost of moving several cars in a single shipment is proportionally less than the cost of moving each car individually.

**Incentive rate** is a term applied to a rate which is designed to induce the shipper to load existing movements and equipment more fully. By inducing the shipper to load each vehicle more fully, fewer vehicles are needed and there are fewer moves over time, reducing the carrier’s cost.

**Unit-train rates** are another type of incentive rate where the railroad transports an entire trainload of one commodity such as coal or grain. In some cases, the shipper might even provide the railcars, further reducing the carrier’s cost.

**Per-car or per-truckload rates** reflect the use by the shipper of the entire vehicle and generally apply from the origin to the destination without regard to commodity or weight.

**Any-quantity rates** do not provide a discount for larger shipments. These rates are normally used with light weight and bulky commodities.

**Density rates** are based on the weight per cubic foot of the shipment and are used for light and bulky products that use space disproportionally to the weight. This is done to avoid loss of income to the carrier when a light or bulky commodity does not generate sufficient revenue based on weight to offset the carrier’s cost.

## AREA, LOCATION, OR ROUTE RATES

**Local rates** apply between two points served by the same carrier.

**Joint rates** apply to a shipment which requires two or more carriers to serve both the origin and the destination.

**Proportional rates** are a method by which a carrier with an indirect route can compete for business against a carrier with a more direct route. These rates normally only apply to points beyond the carrier's own line

**Differential rates** normally apply to a carrier's route that faces a disadvantage because of longer transit time. These were primarily used by railroads which did not have the shortest route or by water carriers in an effort to offset the slower transit time with lower cost.

**Per mile rates** are based on the actual miles traveled or, in some cases, the practical mileage between the origin and destination.

**Terminal to terminal** rates normally do not include pick up at the shipper and delivery to the consignee. These rates are most often found in connection with air freight. They may also be used in intermodal shipments where the shipper and consignee have their own tractors and can pick and deliver the trailers themselves.

**Blanket or group rates** apply to a range of points or a geographic region. This allows producers in that area to be on an equal competitive footing as it relates to freight rates.

## TIME/SERVICE RATE STRUCTURES

These rate structures are generally dependent on the transit time performance of the railroad in a particular service. One such contract provides for a standard rate for a transit time service norm. The shipper pays a higher rate for faster service and a lower rate for slower service. Another contract calls for additional shipper payments to the carrier for the fast return of empty backhaul shipper-leased cars.

**Contract rates** have become the most widespread type of rates being used, particularly after the 1980 partial deregulation of motor and rail carriers. Rates governed by contracts are not affected by the carrier's tariffs unless the contract so indicates. Contracts might require that an agreed volume must be shipped during the life of the contract in order to qualify for the lower rates.

## Contract Rates

Contract services are commonplace in motor carriage and rail moves, as well as in water and some air moves. These services are governed by contracts negotiated between the shipper and carrier, not by generally published tariffs. Some specific contract service features that are typically found are described here.

One basic contract service feature calls for a reduced rate in exchange for a guarantee of a certain minimum tonnage to be shipped over a specified period. Another contract service feature calls for a reduced rate in exchange for the shipper tendering a certain percentage of all tonnage over to the contracting carrier.

Another type of rail contract service feature calls for the rate to be higher or lower depending on the specific type of car supplied for loading and shipment, called a **car-supply charge.**

A few contract service features require the shipper to pay a monthly charge to the railroad that supplies certain special equipment for the shipper's exclusive use. This charge tends to increase the shipper's use of the cars.

Many different rate and service configurations are found in motor carriage and can call for such services as scheduled service, special equipment movements, storage service in addition to movement, services beyond the small package pickup and movement, bulk commodity movement, or hauling a shipper-owned trailer.

Carriers and shippers are relatively free to specifically tailor contract services to particular movements, equipment, and time-related services. The key in any contract service is to identify the service and cost factors important to each party and to construct inducements and penalties for each.

### Deferred Delivery

The deferred delivery rate is common in air transportation. In general, the carrier charges a lower rate in return for the privilege of deferring the arrival time of the shipment. For example, air express companies offer a discount of 25 percent or more for second- or third-day delivery, as opposed to the standard next-day delivery. The deferred delivery rate gives the carrier operating flexibility to achieve greater vehicle utilization and lower costs.

## OTHER RATE STRUCTURES

Several other rate forms serve particular cost or service purposes.

**Corporate volume rates** may contain a discount or other incentive which is based on all the business done by the corporation and is subsidiaries with a given carrier. This recognizes the fact that many large corporations conduct business through a variety of firms but control rests with the parent firm.

Many carriers provide shippers with **discounts** which are deducted from the transportation charges or from the rate itself. These discounts are normally reflected as a percent to be deducted from the base rate and might be subject certain restrictions.

**Loading and unloading** allowances are granted to shippers by LTL carriers when these companies perform the work which would normally be done by the carrier's personnel.

**Aggregate tender rates** are given as an incentive for the shipper to tender two or more shipments to the same carrier at the same time. The reduction in the rate offered by the carrier reflects the reduced cost the carrier enjoys when picking-up multiple shipments at the same location.

**Freight All Kinds** (FAK) rates are also called all commodity rates. The rate applies to all commodities that the customer ships and is very useful for firms that ship a wide variety of goods.

**Released-value rates** reflect the fact the shipper has agreed to accept a lower than actual value for their product in the event of loss or damage. Since the carrier is not liable for the full value of the products they can offer a lower rate to the shipper, reducing the shipper's cost.

**Empty-haul** rates are usually for transporting the shipper's empty equipment to the point of next loading.

**Two-way or Three-way** rates are those rates which apply for either round trip or a triangular move where the carrier is assured of few if any empty miles between loaded moves.

**Spot-market** rates are something new since deregulation. Carriers are now permitted to make "on the spot" rates to adjust for excess capacity or fill idle equipment. Since service cannot be "stored", it is in the carrier's best interest to sell the unused capacity at a discount.

**Menu pricing** also reflects the changes under deregulation. Carriers have "unbundled" their pricing and this allows customers to pick and choose which services they wish.

## PRICING IN TRANSPORTATION MANAGEMENT

Under traditional economic regulation, little incentive was present for carriers to differentiate themselves through either service enhancements or pricing strategies. Today, however, both of these differentiating tactics are critical to carriers in all modes, regardless of market structure.

### Factors Affecting Pricing Decisions

Many carrier pricing decisions are based on some reaction to a stimulus from the business environment, which can include customers (market), government, other channel members, and competition. The carrier's price will be set at the level that maximizes its return. The concept of price elasticity also plays an important role in the market’s impact on carrier prices and users have a formidable impact on carrier prices.

Other channel members can include other carriers in the same mode and in different modes. For example, interline movements between different carriers that involve revenue splits will certainly impact how each carrier prices its services. If one carrier decides to raise its price, the other carrier either has to reduce its price or risk losing business if that the market has high price elasticity.

Competitors will impact carrier pricing strategies. Price leaders that offer discounts to customers will find that competitors will match those discounts, even at the risk of reducing industry profits.

Carriers then must respond to changes and directions from their operating environment such as when government regulations force carriers to make a change that reduces efficiency.

### Major Pricing Decisions

Pricing decisions can be grouped into three categories. First, a carrier faces a decision when setting prices on a new service. Second, a carrier must make decisions to modify prices over time. Market changes, operating changes, and service changes will require prices to be changed. Finally, carriers will make decisions initiating and responding to price changes.

In transportation, where many of the markets are oligopolistic, price changes downward can be dangerous because of their potential to decrease industry revenues.

### Establishing the Pricing Objective

Carrier pricing objectives reflect overall company objectives and reflect how the carrier will compete in its markets. Pricing objectives might also change for a particular service offering as it progresses through its product life cycle or to establish various pricing objectives for these markets.

Survival pricing tries to take advantage of the marginal cost concept. Closely related is a unit volume pricing objective. This attempts to utilize a carrier’s existing capacity to the fullest, so the price is set to encourage the market to fill that capacity.

Another price objective is called profit maximization, which can occur in the short run or in the long run. Carriers using this type of pricing usually are concerned with measures such as return on investment.

A skimming price is a high price intended to attract a market that is more concerned with quality, uniqueness, or status and is insensitive to price.

Many times a skimming price strategy is followed by a penetration price strategy. This can be an effective strategy because (1) a high price can be charged until competition starts to enter; (2) a higher price can help offset initial outlays for advertising and development; (3) a high price portrays a high-quality service; (4) if price changes need to be made, it is more favorable to reduce a price than to raise it; and (5) after market saturation is achieved, a lower price can appeal to a mass market with the objective of increasing sales.

A market share pricing objective can be used in an industry whose revenues are stagnant or declining. This strategy might assume that competitors' offerings are substitutes and that competitors are not in a position to match the lower prices; if the services were not substitutes, a lower price would not provide a competitive advantage.

Finally, a social responsibility pricing objective forgoes sales and profits and puts the welfare of society and customers first. This is often seen where carriers will transport relief supplies at no cost.

### Estimating Demand

Probably one of the most difficult tasks associated with pricing is estimating demand as transportation carriers do not function in perfectly competitive markets. Demand estimation can become very tedious and difficult.

Certain concepts and procedures, such as price elasticity (which refers to the change in demand because of a change in price), can be used in this process. In an established market for a carrier, this relationship should be well developed to the point where demand implications from a price change should be easy to estimate.

A market test is a possible way to determine potential demand when market testing is feasible.

Although not a science, demand estimation is a critical part of pricing strategy as it results in potential revenue estimation. With revenue estimated, costs should next be established.

### Estimating Costs

A decision must be made as to which costs should be included in the total cost analysis.

Another cost relationship that must be examined is how costs behave at different levels of output or capacity. The existence or nonexistence of scale economies in transportation, for example, will affect how costs behave at different capacity levels.

### Price Levels and Price Adjustments

With demand and cost estimates generated, it is possible to set the actual price. Many methods for doing this exist, including demand-based methods, cost-based methods, profit-based methods, and competition-based methods.

Discounts are a reduction from a published price that rewards a buyer for doing something that is beneficial for the supplier.

LTL versus TL prices reflect carrier savings from larger shipments, a portion of which is passed on to the customer in the form of a lower price. This could be called a quantity discount.

Geographic adjustments are common in the transportation industry. Although not directly used by carriers, geographic adjustments are used by shippers and receivers to compensate for transportation costs in the final price to the customer.

When using discounts and allowances in the transportation industry, an important rule to remember is that a discount or allowance passed on to a customer must be the result of a reduction in carrier costs so as to avoid conflict with the STB (rebates) and the Justice Department (antitrust and rebates).

### Most Common Mistakes in Pricing

Carriers have not had many years of experience in setting and managing prices on a strategic level.

The first common mistake is to make pricing too reliant on costs. Competitive factors, customer preferences and values, and government regulations will affect the level at which the price will be most beneficial to the carrier.

The second common mistake is that prices are not revised frequently enough to capitalize on market changes.

Setting the price independently of the marketing mix is a third common mistake. The marketing mix, also known as the “4Ps,” consists of product, price, promotion, and place. Managing one of these areas independently of the others will result in a suboptimization of the carrier’s resources and its profits.

Finally, price is sometimes not varied enough for different service offerings and market segments. Charging one price for all services is not going to maximize the profits for the carrier.

## MOTOR CARRIERS

### Objectives:

1. Understand the development of motor carriers and their contributions to the U.S. economy

2. Be familiar with the different types of firms in the motor carrier industry

3. Appreciate the market forces shaping the motor carrier industry

4. Gain knowledge of the service characteristics of motor carriers

5. Identify the different types of vehicles and terminals used in the motor carrier industry

6. Understand the impacts of fuel and labor on the motor carrier cost structure

7. Be aware of current issues facing the motor carrier industry

### Brief History

The motor carrier industry played an important role in the development of the U.S. economy during the 20th century, and it continues this role in the 21st century.

The United States has spent more than $128.9 billion to construct its **interstate highway system** and as the interstate system was developed, motor carriers steadily replaced railroads in transporting finished and unfinished manufactured products.

In 1980 railroads moved 1.6 billion tons, compared to more than 200 billion tons by motor carriers. By 2006, motor carriers were handling 10.7 billion tons.

### Industry Overview

In 2006 the United States paid over $645.6 billion for highway transportation, approximately 83.8 percent of the total 2006 Nation's Freight Bill. Motor carriers transported 1,264 billion revenue freight ton-miles in 2003, or 31 percent of the ton-miles transported by all modes. During 2005, approximately 8.7 million people were employed in the motor carrier industry, with an average annual compensation of $51,683.

The first major division of motor carriers is between for-hire and private carriers. For-hire carriers can be either local or intercity operators, or both. Private carriers typically haul only for the owner company.

The for-hire carriers may be common and/or contract operators. The common carriers are required to serve the general public while the contract carriers serve specific shippers with whom the carriers have a continuing contract.

Another important distinction is the truckload (**TL**) and less-than-truckload (**LTL**) carriers. The truckload carriers provide service to shippers who tender sufficient volume to meet the minimum weights required for a truckload shipment and truckload rate or will pay the difference. Less-than-truckload carriers provide service to shippers who tender shipments lower than the minimum truckload quantities, such as 50 to 10,000 pounds.

A hybrid type of carrier that has developed can best be characterized as a "heavy LTL" motor carrier, utilizing consolidation terminals (like LTL carriers) to fully load and deliver from the trailer, much like a "pool" carrier, charging linehaul rates plus a charge for each stop-off (like TL carriers).

Interstate common carriers might be classified by the type of commodity they are authorized to haul but, since 1995, they can then transport any commodity they wish, with only household goods and related items being subject to any economic oversight.

## Number of Carriers

The motor carrier industry consists of a large number of small carriers, particularly in the TL (truckload) segment of the industry. As of 2008, a total of 616,187 interstate motor carriers were on file with the Office of Motor Carriers.

There is a significant difference between TL and LTL carriers, both in terms of number and start-up costs. The growth that happened in the industry was primarily in small TL carriers because of the low start-up costs required to enter the industry.

The LTL segment of the motor carrier industry requires a network of terminals to consolidate and distribute freight, called a "hub-and-spoke" system.

Perhaps a brief description of an LTL operation would be helpful. The LTL carrier collects the shipments at the shipper's dock which are taken to a consolidation or break-bulk facility. The packages are sorted by their final destination and loaded for movement. After the line-haul portion of the trip, the trailers are unloaded at another break-bulk facility and are then sorted and reloaded into a PUD vehicle to be delivered to the receiver.

The TL segment of the industry has been experiencing some limited concentration.

With the repeal of the Interstate Commerce Act, combined with changes in distribution patterns, a climate was created in which new TL carriers could easily enter the business Low startup costs in this sector still enabled new entrants to attempt success in this area.

## Market Structure

Motor carrier vehicles, both for-hire and private, primarily transport manufactured, high-value products Motor carriers transport less of commodities such as grain, primary nonferrous metal products, motor vehicles and equipment, and paper and allied products

### Competition

Motor carriers compete vigorously with one another for freight.

The motor carrier industry has few capital constraints to entry. With a relatively small investment combined with freedom of entry, price discounting, and lack of regulatory constraints that appear to dominate the industry and suggest that competition between firms can control the industry.

Certain segments of motor carriers such as LTL carriers have higher capital requirements than others, as indicated, and therefore have some degree of capital constraint for entry. Special equipment carriers – carriers of liquefied gases or frozen products – usually have larger investments. The large TL carriers like J. B. Hunt and Schneider National also have significant capital investment.

On the whole, the motor carrier industry, especially for contract carriers, has been market oriented. Meeting customer requirements has been a common trait of motor carriers.

## OPERATING AND SERVICE CHARACTERISTICS

### General Service Characteristics

The motor carrier possesses a distinct advantage over other modes in the area of accessibility as they can provide service to virtually any location. The U.S. system of highways is so pervasive that virtually every shipping and receiving location is accessible via highways

Motor carriers provide the bridge between the pickup and delivery point and the facilities of other modes such as rail intermodal; that is, the motor carrier is referred to as the universal coordinator.

Another service advantage of the motor carrier is speed. For shipments going under 500 miles, the motor carrier vehicle can usually deliver the goods in less time than other modes.

When compared to other modes, the smaller cargo-**carrying capacity** of the motor carrier vehicle enables the shipper to use the TL rate, or volume discount, with a lower volume. The smaller shipping size of the motor carrier provides the buyer and seller with the benefits of lower inventory levels, lower inventory-carrying costs, and more frequent services.

Another positive service characteristic is the smoothness of transport. This relatively damage-free service reduces the packaging requirements and thus packaging costs.

The for-hire segment of the motor carrier industry is customer or market oriented. The small size of most carriers has enabled (forced) the carriers to respond to customer equipment and service needs.

## Equipment

The high degree of flexibility, the relatively smooth ride, and the small carrying capacity of the vehicle are the unique characteristics that result in greater accessibility, capability, frequency of delivery and pickup, cargo safety, and lower transit time.

The motor carrier vehicle can also be loaded quickly. The capability to operate one cargo unit separately eliminates the time needed to collect several cargo units.

The other dimension of motor carrier equipment flexibility is the lack of highway constraint. The motor carrier is not constrained to providing service over a fixed railway or waterway.

In most cases, equipment represents the largest operating asset that a carrier maintains.

TL carriers need to make two types of equipment decisions: what type of tractor (power) and what type of trailer. Decisions for power include the terrain operated through and trailers include length and trailer type which must be made in light of market demands and the type of carrier operation.

LTL carriers must make the same types of equipment decisions as TL carriers, along with deciding where to deploy this equipment. Having the right mix of power and trailers at a particular terminal location determines its ability to efficiently serve its customers.

## Types of Vehicles

Motor carrier vehicles are either linehaul or city vehicles. Linehaul vehicles are used to haul freight long distances while city straight trucks are used to provide pickup and delivery service.

### LINE-HAUL VEHICLES

The linehaul vehicle is usually a tractor–trailer combination of three or more axles. The cargo–carrying capacity of these vehicles depends on the size (length) and the state maximum weight limits.

### CITY STRAIGHT TRUCKS

City vehicles, or “straight trucks”, are normally smaller than linehaul vehicles and may be single units. There is growing use of small trailers to pick up and deliver freight in the city as these trailers can also be used for linehaul.

### SPECIAL VEHICLES

In addition to the linehaul and city vehicle classifications, there are numerous special vehicles which are designed to meet special shipper needs.

The Department of Transportation's Federal Motor Carrier Safety Administration has established many rules and regulations governing the specifications of motor carrier vehicles.

## Terminals

Truckload carriers might not require terminals for the movement of freight but LTL freight operations do require terminals. The terminals used by motor carriers can be classified as pickup or delivery, break-bulk, and relay.

### PICKUP AND DELIVERY TERMINALS (PUD)

The terminal is a key facility in the operation of an LTL hub-and-spoke system. This section will present an expanded discussion of the types and roles of the terminals in this system.

The most common type of terminal found in the LTL system is the PUD terminal. The PUD terminal serves a local area and provides direct contact with both shippers and receivers.

A **peddle run** is a route that is driven daily out of the PUD terminal for the purposes of collecting freight for outbound moves or delivering freight from inbound moves.

Note that there are two elements of a peddle run, one called **stem time** and the other called **peddle time**. Stem time is the time from when the driver leaves the terminal until the driver makes the first pickup or delivery and when the driver makes the last pickup or delivery until returning to the terminal. A carrier would want to locate PUD terminals in such a way that this non-revenue-producing travel time is minimized.

The other type of time is peddle time and this is revenue-producing time as it occurs when shipments are handled. Carriers would want to maximize the amount of time a driver spends performing these activities.

The dispatch operation provided at the PUD terminal is critical to the operating efficiency of the peddle runs. The dispatcher needs to be familiar with the geography of the peddle runs and the capacity of the PUD drivers and trailers to efficiently route freight with the appropriate vehicle.

Other services that are provided at the PUD terminal might include tracing, rating and billing, sales, and claims but some carriers are beginning to centralize these functions at break-bulks or other locations.

### BREAK-BULK TERMINALS

Another type of terminal found in an LTL hub-and-spoke system is called a **break-bulk**. The main purpose of this terminal is to provide an intermediate point where freight with common destinations from the PUD terminals is combined in a single trailer for movement to the delivering PUD terminal.

Break-bulk facilities also serve as driver domiciles. City drivers located at a PUD terminal will always remain in their local area during their shift and will be able to return home when it is over. Linehaul drivers might or might not be able to return home after a trip, depending on the length of haul they are assigned.

## RELAY TERMINALS

**Relay terminals** are necessitated by the maximum hours-of-service regulation that is imposed on drivers. At the relay terminal, one driver substitutes for another who has accumulated the maximum hours of service.

An alternative to the relay terminal is the use of a sleeper team—two drivers. While one driver accumulates the off-duty time in the sleeper berth of the tractor, the other driver is driving. The sleeper team has been most successful for long trips with many destinations.

## TERMINAL MANAGEMENT DECISIONS

Many types of operating and location decisions need to be made when utilizing terminals in a carrier's network.

### Number of Terminals

LTL carriers have the most difficult decision primarily because of the vast number of terminals in these systems and the relatively small investment needed to develop a terminal site.

The first question is "How many terminals should we have?" The answer is affected by many different variables.

Second, the dilemma of small terminal versus long peddle must be addressed. The small-terminal-versus- long-peddle decision would be made based on the service implications of establishing terminals closer to customers versus the cost of adding another terminal.

### Locations of Terminals

Closely related to the decision of how many terminals to establish is the decision of *where* to establish them and LTL carriers, however, must consider some other variables. Driver time, minimizing the distance freight would need to be backhauled to the break-bulk, and market penetration and potential will help determine terminal location.

Recent trends in the LTL sector have seen significant reductions in the number of terminals as these carriers strive to provide overnight and second-day delivery to more and more customers.

## COST STRUCTURE

### Fixed Versus Variable Cost Components

The cost structure of the motor carrier industry consists of high levels of variable costs and relatively low fixed costs. Approximately 70 to 90 percent of the cost is variable, and 10 to 30 percent is fixed. The publicly funded highway, the carrier's ability to increase or decrease the number of vehicles used, and that most carriers as a group (with the exception of the LTL carrier) do not require expensive terminals create this high variable/low fixed cost situation.

The bulk of the motor carrier's cost, then, is associated with daily operating costs—the variable costs of fuel, wages, maintenance, and highway user fees.

The two categories with the largest share of the variable costs are labor and fuel.

**LABOR**

The cost of drivers accounts for 20 percent of the total costs per vehicle mile and labor costs usually absorb about 55 percent of a carrier's revenue dollar. The over-the-road (intercity) driver is typically paid on a mileage basis, such as 42.0 cents per mile; local drivers are paid by the hour.

The FMCSA's **driving time regulations** will permit drivers to drive a maximum of 11 hours after being off duty for 10 consecutive hours. A driver is permitted to be on duty a maximum of 14 hours after 10 consecutive hours off duty. In addition, no driver can drive after accumulating 60 hours on duty in 7 consecutive days, or 70 hours in 8 consecutive days.

The most pressing labor issue facing motor carriers is the shortage of qualified drivers. Along with the new licensing requirements, the DOT also imposed stringent rules dealing with drug and alcohol abuse.

The hardships imposed by the very nature of long-haul motor carrier operations have also impacted the availability of drivers. The motor carrier industry has undertaken several initiatives to counteract the problem of driver retention and recruitment.

**FUEL**

Carriers have experienced a 426-percent increase in diesel fuel prices from 1976 to 2007—approximately 53 cents per gallon in 1976 to about $2.79 per gallon in 2007.

The price of the diesel fuel includes a highway user tax imposed by both the federal and state governments. The federal fuel tax is 24.4 cents per gallon of diesel fuel plus a state average of 24.5 cents per gallon.

## Economies of Scale

There does not appear to be major economies of scale for large-scale motor carrier operations. The concentration of the LTL business is indicative of economies of operation in this segment. In the short run, certain economies exist in the greater use of indivisible inputs such as terminals, management specialists, and information systems.

For TL operations, very limited investment is required for terminals, but information systems are becoming increasingly important to efficient operations.

Operational cost trade-offs exist between large and small carriers. A large-scale operation affords savings in purchase economies of equipment and in such inputs as fuel, parts, and interest on loans.

Overall, long-term economies of scale appear not to be significant in TL motor carrier transportation and are present to some degree in the LTL segment.

### OPERATING RATIO

A measure of operating efficiency used by motor carriers is the **operating ratio.** The operating ratio measures the percent of operating expenses to operating revenue.

Operating expenses are those expenses directly associated with the transportation of freight, excluding non-transportation expenses and interest costs. Operating revenues are the total revenues generated from freight transportation services; non-transportation services are excluded.

An operating ratio of 94 indicates that 94 cents of every operating revenue dollar is consumed by operating expenses, leaving 6 cents of every operating dollar to cover interest costs and a return to the owners.

The federal government has the responsibility to provide highways to meet the national defense and commerce needs of the country. The state and local governments assume the responsibility for maintaining the highways, while the federal government provides up to 90 percent of the construction cost of new highways. The National Highway System consists of the 46,876-mile interstate highway system, 113,124 miles of existing state and federal non-interstate highways.

### FUNDING

Highway users pay for the construction, maintenance, and policing of highways through highway user taxes.

Federal and state governments assess highway user taxes which are paid into the Federal Highway Trust Fund that yields 90 percent of the construction costs for the interstate system and 50 percent of the construction costs for all other federal-aid roads.

The states also assesses highway user taxes such as fuel tax, vehicle registration fees, ton-mile taxes, and special-use permits to defray the cost of construction, maintenance, and policing of highways.

Motor carriers with operations in many states must buy vehicle registrations in each state and maintain records of miles driven in a particular state so that the state will receive a fuel tax or ton-mile tax.

## Current Issues

### Safety

The FMCSA has developed rules under which its inspectors determine whether a carrier is fit from a safety rule compliance perspective. The system includes three categories: Satisfactory, Conditional, and Unsatisfactory and a carrier might be forced to stop operating if it has received an Unsatisfactory rating and improvements are not made.

Many shippers seek safety fitness information as part of their selection process, so there is considerable pressure on carriers to operate safely. Many transportation contracts contain clauses that permit the shipper to cancel the contract if the carrier's safety rating is Unsatisfactory.

A major related concern is that of alcohol and drug abuse. Drug and alcohol testing are required in certain circumstances. All fleets, regardless of size, are required to have a complete program, including random and post accident testing in place.

Divers' hours-of-service and fatigue are two areas of concern. The hours of service rules have been revised to address today's changing environment.

Another safety issue receiving attention deals with vehicle size and weight. Recent studies have analyzed increasing total gross vehicle weight to 94,000 pounds with the addition of a third axle to the trailer but this will require federal legislation.

## Technology

The use of satellite technology has a major impact on the motor carrier industry. Using global positioning technology (GPS), satellites are being used to track vehicles throughout their movement from origin to destination.

One area where satellite communication has had a very positive effect is in the movement of hazardous materials. This tracking allows for quick reaction to any accidents or spills, and the computers can give the name of the authority in the area to call in case any emergency action needs to be taken. Satellite communication will continue to play a role in improved safety and customer service for motor carriers into the future.

## LTL Rates

Since the early 1980s, the LTL segment of the motor carrier industry has used discounts from published tariffs as a means of pricing segments to attract traffic of large shippers. The Interstate Commerce Commission (ICC) was eliminated and for all practical purposes LTL rates are subject to the free-market environment. The shipper has more choices for LTL today than existed during the height of regulation.

A limited amount of anti-trust immunity was also preserved but only for classifications, mileage guides rules, and general rate adjustments. Individual carrier rates are subject to anti-trust action but cannot be challenged that the rate is unreasonably high.

There is no longer any requirement to file tariffs, and contracts can be used instead.

This law also reduced the time for recovery of disputed freight charges from 3 years to 18 months.

### Financial Stability

Another major concern in the motor carrier industry is financial stability. In 2007, a total of 1,985 motor carrier firms failed, mostly those having at least five vehicles.

Overcapacity has periodically been a severe problem for the motor carrier industry, most recently during the recession of 2008 and 2009. Given that there is a finite amount of freight to be transported at any one time and there is little, if anything, that carriers can do to influence this, market share changes generally occur at the expense of one carrier over another.

Shippers have become increasingly cognizant of the failure rate among motor carriers, and many have introduced a financial evaluation of carriers into their overall decision framework for selecting carriers.

## RAILROADS

### Objectives:

1. Appreciate the contributions of the railroad industry to the development of the U.S. economy

2. Gain an understanding of the size and types of firms in the railroad industry

3. Discuss the relevance of intermodal and intramodal competition in the railroad industry

4. Know the major types of commodities hauled by the railroads

5. Recognize the different types of equipment used in the railroad industry

6. Discuss the nature of costs in the railroad industry and how they impact pricing decisions

7. Understand the importance of intermodal carloadings on the growth of the railroad industry

8. Be aware of the current issues facing the railroad industry today

## Brief History of the Rail Industry

During the first 30 years of its existence, the railroad industry evolved from a population of unconnected carriers focused on short-haul traffic to the completion of longer-distance lines located largely between the Atlantic seaboard on the east, the Mississippi River on the west, the St. Lawrence River and Great Lakes on the north, and the Potomac and Ohio Rivers on the south. The Civil War slowed but did not stop rail construction during the 1960s. Most notable was the completion in 1869 of the first rail link between the Midwest and the Pacific Coast. Total road mileage reached 52,922 in 1870. That year marked the beginning of the greatest boom in growth of railroad mileage. By 1900, total mileage stood at 196,345, accessing all parts of the country and providing shippers and travelers with a national network of carriers that connected with one another.

Rail transportation remained the dominant, largely unchallenged, mode of intercity freight and passenger movement through the first two decades of the 20th century. However, erosion of its dominance began during the 1920s with the beginning of large-scale government-funded construction of hard-surface roads and superior service and/or cost characteristics of motor carriers and automobiles. Additional competition came from a revival of inland water transportation, which was aided by government-financed navigation improvements on rivers and by privately financed construction of oil pipelines. Air transportation emerged as a serious contender for rail passenger and mail traffic during the 1930s. Overall, the railroad industry suffered significant decline in relative importance after 1920. However, its role in freight transportation remains important in the 21st century.

The railroad industry has stabilized in relative importance during the first part of the 21st century. This trend has been well documented and can be attributed in part to the following factors: alternate transport modes with superior services and/or cost characteristics (primarily motor carriers and pipelines); a resurgence in water transportation; and the changing needs of the U.S. economy. In 2006, railroads transported only 43 percent of the total intercity ton-miles transported by all modes. It is important to note that, on an actual basis, rail ton-miles have continued to increase and railroads are still the largest carrier in terms of intercity ton-miles, but not in terms of tonnage or revenues.

The railroads are still vital to our transportation system and play an important role in our economy. For example, in 2003 rail revenues accounted for approximately 12.7 percent of the nation’s freight expenditures. Railroads in 2007 employed 186,112 people. Investment is another indication of importance. In 2007, rail investment in new plant and equipment was over $117 billion. In 2007, for example, rail locomotive and freight car acquisition increased sharply over 2006 (increasing more than 50 percent).

As mentioned earlier, in 2006 the railroads shipped about 43 percent of all ton-miles moved by all transport modes in the United States. This percentage of ton-miles has been declining since its peak of 75 percent in 1929. However, actual ton-miles have, for the most part, been steadily increasing. In 1980 a total of 932 billion ton-miles of domestic intercity freight was moved. The figure dropped to 810 billion ton-miles in 1982 due mostly to the recession of 1982 to 1983. In 2006 the ton-miles were 1,853 billion, representing 43 percent of transportation’s total 4,309 billion.

These figures highlight the fact that, even though railroads continue to move record amounts of goods, they are capturing less of the total transportation market because other modes have been growing even faster. However, there are indications that railroads may experience a resurgence on a relative basis because of more aggressive marketing and growth in intermodal traffic. Between 2000 and 2007, intermodal traffic increased from a little over 9 million loadings to just over 12 million, an increase of 31 percent. Intermodal shipments have become more attractive as fuel prices escalate and highway congestion increases.

## INDUSTRY OVERVIEW

### INTRAMODAL

As only a few railroads serve a particular geographic region there is now an oligopolistic market structure because there are a small number of interdependent large sellers. Barriers to entry exist because of the large capital outlays and fixed costs required and, consequently, pricing can be controlled by the existing firms.

With the merger trend, the intramodal competition has been reduced and many cities now have only one railroad serving them. Shippers are concerned that there will not be enough effective intramodal competition to preserve railroad-to-railroad competition. Some shippers are called “captive” as they have only one rail carrier serving them.

### INTERMODAL

As noted earlier, the relative market share of railroad intercity ton-miles has been steadily declining because of increased intermodal competition. Inroads into the lucrative commodity markets have been facilitated by governmental expenditures on infrastructure that have benefited competing modes. For example, the government has provided an extensive local and national highway system, especially the interstate network, for motor carrier use.

Customers look for consistent on-time performance. Railroads need to provide this level of service to stay competitive. Railroad companies usually cannot deliver freight early because the customer then has to find a place to store it.

Overall, the railroads have been rate-competitive. Government influence, either in the form of economic regulation or expenditure programs aimed at promoting other modes, together with intermodal competition, forced the railways into making a determined effort to forestall industry decline by becoming more competitive.

### MERGERS

Many mergers have taken place in the railroad industry and the size of the remaining carriers has correspondingly increased. The most recent trend has seen both **side-by-side** combinations as well as **end-to-end mergers.**

Customer service and reliability can be improved by these mergers, because the many types of operating costs, such as car switching, and clerical costs, such as record keeping, can be reduced; but, such improvements have been slow to develop.

### ABANDONMENTS

Many factors led to the abandonment of track around the country starting with the elimination of parallel and overlapping routes.

The opening of the Interstate Highway System allowed motor carrier service to decrease transit time shifting freight from rail to motor. To effectively compete with motor carriers for time-sensitive traffic, railroads had to focus on efficient routes. Deregulation, which occurred in 1980, gave companies freedom to buy, sell, or abandon unprofitable track without federal interference. The land used for rights-of-way could also be used unless the original deed required the return when the property was no longer being utilized for railroad purposes.

## OPERATING AND SERVICE CHARACTERISTICS

### General Service Characteristics

### COMMODITIES HAULED

The railroad system has evolved into a system that primarily transports large quantities of heavyweight, low-value commodities (or bulk products). Although railroads still handle a wide variety of commodities, more than 83 percent of total rail car loadings in 2007 involved the movement of bulk materials.

***Coal.*** Railroads are the primary haulers of coal, accounting for 43.8 percent of the total tonnage transported in 2007.

***Farm products.*** Farm and food products constitute the third largest commodity group hauled by railroads.

***Chemicals.*** Chemicals and allied products, a great number of which are classified as “hazardous” by the U.S. Department of Transportation (DOT), are transported in specially designed tank cars.

***Transportation equipment.*** Transportation equipment carloadings have increased to more than 5 percent of total carloadings, but decreased by over 75,000 carloads from 2006 to 2007.

Although the commodities shipped by the railroad industry have changed over the years, with the emphasis placed on the movement of low-value, high-volume bulk materials, the railroads are still a possible mode of transport for many different types of goods, including both high-value merchandise and raw materials alike.

### TRAFFIC SHIFTS

The demand for freight transportation is a derived demand and economic conditions have an impact upon the demand for transportation service. This is especially true for railroads because they primarily move basic raw materials and supplies.

Intermodal movements by rail increased by 6.9 percent during the economic downturn of 2003. This trend toward intermodal moves could prove to be very beneficial to the railroad industry and allow them to be more competitive with the motor carriers.

## Constraints

Railroads are constrained by fixed rights-of-way and therefore provide differing degrees of service completeness. If both the shipper and receiver possess rail sidings, door-to-door service can be provided but if either or both do not have sidings, the movement of goods must be completed by some other mode.

Although on-time delivery performance and the frequency of service had deteriorated in the past, improvements have been made in recent years. The current position of the industry has been restored to competitive levels on selected. However, reliability and transit time will have to improve as well as equipment availability.

## Strengths

A large carrying capacity enables the railroads to handle large-volume movements of low-value commodities over long distances. Motor carriers, on the other hand, are constrained by volume and weight to the smaller truckload (TL) and less-than-truckload (LTL) markets.

Railroads are able to use a variety of car types to provide a flexible service because the rolling stock consists of boxcars, tankers, gondolas, hoppers, covered hoppers, flatcars, and other special types of cars.

Another important service is that the **liability** for loss and damage is usually assumed by the railroads. Such damage occurs because rail freight often goes through a rough trip due to vibrations and shocks (steel wheel on steel rail).

In an attempt to regain traffic lost to other modes and gain new traffic share, the railroads have been placing an increasing amount of attention on equipment and technology.

Multilevel suspension systems and end-of-car cushioning devices protect the goods in transit.

One area that has received much attention has been the intermodal era, namely, trailer-on-flatcar (**TOFC**) and container-on-flatcar (**COFC**) service. The railroads realized the necessity of improving the TOFC and COFC service to compete effectively with motor carriers. The railroads have invested a significant amount of money recently in improving right-of-way and structures to help improve service by preventing delays.

Microprocessors have found their niche in the railroad industry, particularly in communications and signaling. The rail industry has to realize that technology alone cannot mitigate their problems. Process change also has to occur.

## Equipment

The **carload** is the basic unit of measurement of freight handling and a carload can vary in size and capacity depending on the type of car being used.

The increases in average carrying capacity of railroad freight cars over the past 50 years have been dramatic. In 2007, the average carrying capacity per car stood at almost 99.5 tons, compared to 46.3 tons in 1929.

The railroads own and maintain their own rolling stock. Today's car fleet is highly specialized and is designed to meet the needs of the individual shipper.

The boxcar has been surpassed in use by the covered hopper car, which is followed closely in number by the tank car. In 2007, more than 85 percent of the total fleet was designed for the transport of bulk and raw materials.

Class I railroads own almost 42 percent of the freight cars while private companies own the remainder

To remain competitive with the other modes of transportation, the railroads have increased their capacity.

**Service Innovations**

The railroad cost structure makes it necessary to attract large and regular volumes of traffic to take advantage of scale economies and to operate efficiently.

TOFC service transports highway trailers on railroad flatcars while COFC transports containers without the chassis on specially designed cars. In 2007, more than 12 million trailers and containers in TOFC and COFC service were loaded.

TOFC/COFC combines the line-haul efficiencies of the railroads with the flexibility of local motor pickup and delivery service. This growth was stimulated by the advent of double-stack containers used in international trade.

In recent years, the railroads have largely segregated their intermodal traffic from regular freight, with most of the intermodal trains operating on a priority schedule.

United Parcel Service (UPS) has been a supporter of rail intermodal service for some time and is still the railroads largest single customer. The LTL motor carriers began using intermodal service during the 1980s to handle their surges of traffic, and as rail service has become more reliable, they are using the rail service on a continuing basis.

The biggest change came recently when two of the largest truckload carriers, Schneider National and J. B. Hunt, purchased equipment to use rail intermodal service on an extensive basis.

Economies are realized because putting finished goods in containers means not only lower packaging and warehousing costs but also faster transit times because time and effort are saved in the loading, unloading, and delivery of goods. The double stacking of the containers on traffic to and from ocean ports has improved the productivity of the rail COFC service dramatically.

The unit train specializes in the transport of only one commodity, usually coal or grain, from origin to destination. The movement could be directly from a coal mine to an electric power-generating station with no stops in transit, and loading and unloading would be accomplished while the train was moving.

Rail management is increasing the use of computers and communications to help improve discipline and maintain control over rail operations.

## COST STRUCTURE

### Fixed Costs

The railroad industry's cost structure in the short run (a period when both plant and capacity remain constant) consists of a large proportion of indirect fixed costs, rather than variable costs as they own and maintain their own network and terminals. In addition, they operate their own rolling stock and locomotives.

The major cost element borne by the railroad industry is the operation, maintenance, and ownership of rights-of-way.

Another major component of the railroad industry's high fixed costs is the extensive investment in private terminal facilities. Because of the large amount of fixed assets, the railroads as a group are not as responsive as other modes to the volume of traffic carried.

The investment for equipment in rail transport, principally for locomotives and various types of rolling stock, has been enormous. In 2007, more than $8.6 billion was spent on plant and equipment. It is apparent that the railroads have a high proportion of expenses that are fixed and constant in the short run. However, they also have costs that vary substantially with volume.

### Semivariable Costs

Semivariable costs, which include maintenance of rights-of-way, structures, and equipment, have accounted for more than 40 percent of railroad outlays in recent years. These figures, however, are deceptive because some railroads that were in poor financial health and their management found it necessary to forego maintenance to pay other expenses.

### Variable Costs

Variable costs are a large proportion of every revenue dollar with labor being the largest single element of variable costs for railroads. Fuel and power costs are the next largest group of variable costs.

## LABOR

In 2007, the cost of labor was $14.4 billion or $0.264 cents of every revenue dollar. Train, maintenance, and engine employees accounted for 78 percent of all the wages paid by the railroads. Railroad labor is represented by many different with three major classifications of labor unions: operating, non-operating craft, and non-operating industrial.

The railroad industry has been reducing the size of the standard train crew wherever possible and the dual basis for pay for a full day's work is inefficient in today's operating environment.

The railroad industry has been addressing work rules and staffing requirements in a very aggressive manner in the past several years. Two-person crews are now the standard, with both riding on the locomotive.

Railroad managers feel that continuing changes in modifying or eliminating work rules for rail employees must be implemented in the near future if the industry is to survive in its present form.

## FUEL

Fuel costs make up the second largest percentage of the revenue dollar and productivity and fuel efficiency have increased. The railroad's efficiency in the use of fuel is an important factor making intermodal movements with the motor carrier more attractive.

### Economies of Scale

As previously indicated, railroads have a high level of fixed costs as contrasted with variable costs. Fixed costs, such as property taxes, are incurred regardless of traffic volume. Variable costs, on the other hand, vary or change with the volume of traffic moved; that is, they rise with increases and fall with decreases in traffic levels.

It is obvious from the above example that, if average revenue stays the same, the economies of scale not only lower costs per unit but also increase profit.

## FINANCIAL PLIGHT

The railroad industry once enjoyed a virtual monopoly on the efficient and dependable transportation of passengers and freight. Over the decades, competition from other modes of transportation increased dramatically and the rail industry's share of the intercity freight market also declined to less than 50 percent.

Government funds were used to provide rail competitors with their rights-of-way without fully charging them the cost of constructing or maintaining them as with the rail industry.

The financial position of the railroads grew increasingly worse after World War II and it became obvious that the railroad industry could not continue to survive under these conditions.

## CURRENT ISSUES

### Alcohol and Drug Abuse

The problem of substance abuse can be brought on by the very nature of railroad work. Long hours, low supervision, and nights away from home can lead to loneliness and boredom, which can then lead to substance abuse.

The industry has established employee assistance programs (EAPs) that enable those troubled employees to be rehabilitated.

Employees can voluntarily refer themselves to EAPs before a supervisor detects the problem and disciplinary actions become necessary. However, substance abuse while on the job usually necessitates removal of the employee from the workplace to ensure his or her safety and the safety of co-workers.

### Energy

The energy shortages of the 1970s made the United States increasingly aware of the need to conserve natural resources. The railroads today are in a favorable position, especially when compared to motor carriers, because they are efficient energy consumers.

Another study by the U.S. DOT concluded that railroads are more energy-efficient than motor carriers, even when measured in terms of consumption per ton-mile.

The railroads economically shipped 905.6 million tons of energy-yielding products in 2007; 94 percent of these loadings were coal movements. Hence, the railroads can be an important factor in the development of the nation’s energy policy.

### Technology

To become more efficient and consequently more competitive, the railroad industry is becoming a high-tech industry. A line of “smart” locomotives is being equipped with onboard computers that can identify mechanical problems, and the legendary “red caboose” was phased out by a device attaches to the last car of the train and device transmits important information to engineers and dispatchers. Other applications of computer technology are as follows:

- Advanced Train Control Systems (ATCS): A joint venture between the United States and Canada that will use computers to efficiently track the flow of trains through the entire rail system

- Rail yard control: Computer control of freight yards that is used to sort and classify as many as 2,500 railcars a day

- Communications and signaling: Provides quick and efficient communications between dispatchers, yard workers, field workers, and train crews

- Customer service: By calling a toll-free number, customers can receive information on the status of their shipments, correct billing errors, and plan new service schedules

- Radio Frequency Identification (RFID) tags to track equipment and shipments and improve visibility. The role of high technology and computers will continue to expand and increase the ability of the railroads to provide progressively higher levels of customer service.

Radio Controlled Switch Engines uses remote control technology to allow a person to operate and control a locomotive from outside the locomotive cab. In most railroad applications, control is from a remote control unit (belt-pack) attached to a harness that places the belt-pack waist high within easy reach of the operator. The operator can perform duties such as coupling, uncoupling of cars and moving about to be in good visual distance of the operation, and remain in control of locomotive movement at all times.

### Future Role of Smaller Railroads

The consolidation among Class I railroads has led to an increase in the number of regional and small rail carriers. These small and regional rail carriers typically took over part of the infrastructure abandoned by the large railroads that spun off parts of their system that had low traffic levels and/or were deemed not to be needed for market success.

The small and regional carriers often have to operate at a cost disadvantage but have some advantages given that they are more flexible and adaptable in meeting the needs of their customers (shippers).

It should also be noted that local and state governments have assisted in financing the establishment of the new lines that have come into being since 1984.

### Drayage for Intermodal Service

One of the constraints on rail service is the fixed nature of the rail routes and the high cost to add rail segments to provide direct service. The pickup and delivery of trailers and containers in conjunction with a line-haul rail movement is usually referred to as local drayage.

## AIRLINES
### Objectives:

1. Appreciate the importance of air transportation

2. Gain knowledge of the types and number of carriers in. airline industry

3. Understand the level of competition in airline industry

4. Become aware of the operating and service characteristics of airline transportation

5. Be familiar with the different types of equipment used by airlines

6. Appreciate the impacts of fuel and labor costs on airlines cost structures

7. Understand the concepts of economies of scale and density in the airline industry

8. Be aware of current issues facing airlines today

### Overview
Airline travel is a common form of transportation for long-distance passenger and freight travel and the only reasonable alternative when time is of the essence. The tremendous speed of the airplane, coupled with more competitive pricing, has led to the growth of air transportation, particularly in the movement of passengers.

### Types of Carriers

The for-hire carriers cannot be easily categorized into specific types because carriers provide many types of services. For-hire carriers will be discussed according to type of service offered (all-cargo, air taxi, commuter, charter, and international) and annual revenue (majors, nationals, and regionals).

The categories used to classify air carriers in terms of revenue are as follows:
Majors — annual revenues of more than $1 billion
Nationals — annual revenues of $100 million to $1 billion
Regionals — annual revenues of less than $100 million

The charter carriers, also known as air taxis, use small to medium size aircraft to transport people or freight. The supplemental carrier has no time schedule or designated route. The carrier charters the entire plane to transport a group of people or cargo between specified origins and destinations.

### Numbers of Carriers

A look at carrier revenues shows a concentration of earnings by a small group of majors, nationals, and regionals. A majority of air movements are made by 151 carriers. The largest increase in number of carriers has occurred among the regionals. In fact, 82 percent of total industry revenue was generated by the top 10 carriers

Private air transportation has been estimated to include approximately 60,000 company-owned planes, with over 500 U.S. corporations operating a private air fleet. In addition, thousands of planes are used for personal, recreational, and instructional purposes.

## Competition

### Intermodal

Due to their unique service, air carriers face limited competition from other modes for either passengers or freight as they have an advantage in providing time-sensitive, long-distance movement of people or freight. Airlines compete to some extent with motor carriers, automobiles and, to a limited extent, from trains and buses.

### Intramodal

Competition in rates and service among the air carriers is very intense**,** even though the number of carriers is small. The top 10 air carriers accounted for about 82 percent of the total operating revenue. Due to excess capacity, airline prices have fallen 3.0 percent in 2007 (not adjusted for inflation). During this same period, inflation (measured by the Consumer Price Index) rose 2.8 percent.

New entrants to the airline market initially cause overcapacity to exist on many routes. To counter this and add passengers to their aircraft, carriers reduce prices and fare wars begin.

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### Service Competition

Competition in airline service takes many forms, but the primary service competition is the frequency and timing of flights on a route. Carriers promote such things as on-time arrival and friendly employees to convince travelers that it has the desired quality of service. Frequent flyer programs and special services for high-mileage customers are popular examples of other services to attract loyal customers.

A post-deregulation development in service competition was no-frills service**.** One hallmark of such carriers is that they only provide one class of service.

### Cargo Competition

Competition for cargo has become intense. Major airline freight companies (such as FedEx and UPS Airlines) have their own fleets of surface delivery vehicles to perform the ground portion of this door-to-door service.

Another interesting dimension has been the growth in volume of express carrier traffic, which is an important reason for the attraction of surface carriers into this segment of the business.

## Operating and Service Characteristics

### General

The major revenue source for air carriers is passenger transportation. In 2007, approximately 61.8 percent of total operating revenues were derived from passenger transportation.

In 2007, approximately 14.2 percent of the total operating revenues were generated from freight transportation. For emergency shipments**,** the cost of air transportation is often inconsequential compared to the cost of delaying the goods.
The high value of products transported by air freight provides a cost-savings trade-off, usually but not always from inventory carrying cost which might offset the higher cost of air service. The old adage “Time is money” is quite appropriate here.

### Speed of Service

Undoubtedly, the major service advantage of air transportation is speed with a trip from New York to California trip, approximately 3,000 miles, a mere six-hour journey.

This advantage of high terminal-to-terminal **speed** has been dampened somewhat by reduced frequency of flights and congestion at airports.

Air carriers have been concentrating their service on the high-density routes like New York to Chicago and while implementing the hub-and-spoke terminal approach which have aggravated the air traffic congestion and ground congestion at major airports.

The shippers who use air carriers to transport freight are primarily interested in the speed and reliability of the service and the resultant benefits, such as reduced inventory levels and inventory carrying costs.

### Length of Haul and Capacity

For passenger travel, air carriers dominate the long-distance moves. In 2007, the average length of haul for passenger travel was 1,078 miles for air carriers.

Adding freight to the baggage compartment on passenger flights necessitates rather small-size shipments and thus supports rate-making practices for these shipments.

### Accessibility and Dependability

Except in adverse weather conditions, air carriers are capable of providing **reliable** service. Sophisticated navigational instrumentation permits operation during most weather conditions.

Poor **accessibility** is one disadvantage of air carriers. Passengers and freight must be transported to an airport for air service to be rendered. Limited accessibility adds time and cost to the air service provided but even with the accessibility problem, air transportation remains a fast method of movement and the only logical mode when distance is great and time is restricted.
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## Equipment

### Types of Vehicles

There are several different sizes of airplanes in use, from small commuter planes to huge wide-body, four-engine planes used by the nationals.

### Terminals

The air carriers' **terminals** (airports) are financed by a government entity. The carriers pay for the use of the airport through various fees and users pay a tax on airline tickets and air freight charges.

The growth and development of air transportation is dependent upon adequate airport facilities. The federal government is financially responsible for the construction of airport facilities, the various state and local governments assume the responsibility for operating and maintaining the airports.

The carriers perform passenger, cargo, and aircraft servicing at the airport terminal.

Certain airports have become hubs with flights from outlying areas being fed into the hub airport to connect with other flights.

Airport terminals also provide services to passengers, such as restaurants, banking centers, souvenir and gift shops, and snack bars.

## Cost Structure

### Fixed Versus Variable Cost Components

Air carriers' cost structure consists of high variable and low fixed costs with approximately 80 percent variable and 20 percent fixed. The relatively low fixed cost structure is attributable to government (state and local) investment and operations of airports and airways.

Flying operations accounted for 37.9 percent of airline operating costs in 2007 while maintenance costs equaled 10.2 percent of total operating costs. Both of these expenses are variable costs.

The increased price competition in the airline industry has caused airlines to try to operate more efficiently by cutting costs where possible. There has been much effort put forth to decrease labor costs because the airline industry tends to be labor-intensive compared to other modes, such as railroads and pipelines.

## Fuel

Escalating **fuel costs** have caused problems in the past for the airlines. By December 2007, the price per gallon of aviations fuel was $2.10 per gallon. Rapidly escalating fuel costs in recent years has caused airlines to suffer financially in an already depressed pricing market.

More fuel-efficient planes have been developed and added to carrier fleets and carriers are substituting smaller planes on low-density routes and eliminating service completely on others. The average cost per gallon of fuel increased from $1.97 to $2.10 from 2006 to 2007 and fuel consumption increased by 187 million gallons (1.03-percent increase) from 2006 to 2007, resulting in additional fuel expenses of $2.94 billion.

## Labor

In 2007, average salaries and wages increased by 2.7 percent but were offset by a reduction in average benefits and pensions of 11.9 percent.  In 2007 carriers employed 560,997 people at an average annual compensation of $74,786.

Airlines employ people with a variety of different skills. To operate the planes, the carrier must employ pilots, copilots, and flight engineers. Overall employment has decreased as airlines have moved aggressively to reduce costs to improve their competitiveness and lower prices in selected markets.

Strict safety regulations are administered by the FAA with acceptable flight operations, as well as hours of service, being specified for pilots.

The **wages** paid to a pilot usually vary according to the pilot’s equipment rating.

Wages can also vary according to whether a person works for a union airline or not.

## Equipment

The cost of operating airplanes varies with larger planes being more costly to operate per hour than smaller planes, but the cost per seat-mile is lower for larger planes.

## Economies of Scale/Economies of Density

Large-scale air carrier operations do have some **economies of scale**, which result from more extensive use of large-size planes or indivisible units.

Market conditions (sufficient demand) must exist to permit the efficient utilization of larger planes (i.e., if the planes are flown near capacity, the seat-mile costs will obviously decrease). Another factor indicating large-scale operations for air carriers is the integrated communication network required for activities such as operating controls and passenger reservations.

The air carrier industry overall has a cost structure that closely resembles that of motor carriers and both industries are characterized by high variable cost ratios (airlines and motor carriers) can relatively easily add equipment to a given market. As such, the ability to decrease fully allocated cost per mile by adding aircraft does not exist.

Economies of density exist when a carrier has significant volume between an origin-destination pair to fully utilize capacity on forward-haul movements as well as utilize significant capacity on back-haul movements.

Over the years the federal government has provided direct operating subsidies (that is, public service revenues) to air carriers to provide service to less-populated areas.

## RATES

### Pricing

Airline pricing for passenger service is characterized by the discounts from full fare. Seats on the same plane can have substantially different prices, depending on restrictions attached to the purchase, such as having to stay over a weekend or having to purchase the ticket in advance. Business people generally pay more for their airline travel due to the more rigid schedules they are on and the fact that they usually depart and return during the high-demand times.

The price of seats on different flights and the price of the same seat on a particular flight can vary due to competition with other airlines, the time and day of departure and return, the level of service (first class versus coach or no-frills service), and advance ticket purchase. Discount pricing has continued throughout the 2000s as airlines have attempted to increase their "payload."

Cargo pricing is dependent mainly on weight and/or cubic dimensions. Some shipments that have a very low density can be assessed an over-dimensional charge, usually based on 8 pounds per cubic foot. This over-dimensional charge is used to gain more appropriate revenue from shipments that take up a lot of space but do not weigh much. Other factors affecting the price paid to ship freight via air transportation include completeness of service.

### Operating Efficiency

An important measure of operating efficiency used by air carriers is the operating ratio**.** The operating ratio measures the portion of operating income that goes to operating expenses:

$$\text{Operating Ratio} = (\text{Operating Expense}/\text{Operating Income}) \times 100$$

Only income and expenses generated from passenger and freight transportation are considered.

Another widely used measure of operating efficiency is the load factor (previously discussed). The load factor measures the percentage of a plane's capacity that is utilized.
Load Factor = (Number of Passengers/Total Number of Seats) × 100

Airlines have raised plane load factors to the 70–80-percent range. The particular route and type of plane (capacity) directly affect the load factor, as does price, service level, and competition.

Equipment substitution**,** however, might not be possible, and substitution might result in excess capacity. The jumbo planes have large carrying capacities that might not be utilized in low-demand routes. Thus, large-capacity planes are used on high-demand routes such as New York–Chicago and New York–Los Angeles, and smaller capacity planes are used on low-demand routes such as Toledo–Chicago and Pittsburgh–Memphis.

## CURRENT ISSUES

### Safety

The issue of airline safety is of great importance to the airline industry.

Several factors affect airline safety. First, airport security has come under close scrutiny over the past several years. On September 11, 2001, four aircraft were hijacked and two were flown into the Twin Towers in New York City, killing and injuring thousands of people. As a result, airport security has reached an all-time high, causing more delays at airport terminals.

Air travel is still the safest way to travel even thought there is a significant loss of life in an airline tragedy; air travel is still the safest mode for passenger travel.

Finally, as with other transportation modes, the issue of substance abuse concerning pilots and ground crews, has become important.

### Security

The aftermath of the tragic fatalities of 9/11 gave rise to the establishment of the Department of Homeland Security as well as the Transportation Security Administration (TSA). Both of these agencies are responsible for the safety of passengers while in airports and in-flight. New screening procedures have been established at airports for passengers and new guidelines developed for carry-on luggage. Aircraft security is, and will continue to be, an important issue in defending the United States from terrorist acts.

### Technology

Because the airline industry must offer quick and efficient service to attract business, it constantly needs more sophisticated equipment. The FAA and the federal government are proposing an entire overhaul to the current air traffic control system that would rely on the use of GPS navigation aids. This would increase the capacity for aircraft in operating space as well as reduce travel times between origin/destination pairs. However, this change would also require new technology on current and new aircraft.

## WATER CARRIERS AND PIPELINES

### Objectives:

1. Understand the importance of domestic waterways in the development of the economy.
2. Discuss the various types of water carriers and their role in the overall water carrier system.
3. Understand the competitive environment for water carriers on an intra-modal as well as an inter-modal basis.
4. Discuss the service and operating characteristics of water carriers as well as their cost structure and equipment challenges.
5. Understand the current issues faced by the water carrier industry in the 21st century.
6. Appreciate the development and current position of the pipeline industry in the economy.
7. Discuss the types of pipeline companies and their role in the transportation system.

### Overview

Water carriers and pipelines are frequently overlooked by the general public. Most people are aware of trucks, planes and trains, but they have limited appreciation of the role and contribution of water and pipeline carriers to businesses and our economy. These two modes of transportation are a very important part of our transportation system and overall infrastructure, particularly for certain types of products. In this chapter, we will explore the role and importance of water carriers and pipelines to a modern transportation system to gain an understanding and appreciation of their significance.

## WATER TRANSPORT INDUSTRY OVERVIEW

### Significance of Water Transport

Water transportation remains a viable mode of transportation for the movement of products and especially basic raw materials. Domestic water carriers compete with railroads for the movement of bulk commodities (such as grains, coal, ores, and chemicals) and with pipelines for the movement of bulk petroleum, petroleum products, and chemicals.

Water transportation is the second most efficient form of transportation, in terms of energy costs per dollar of gross output, or, the market value of goods and services produced. The most efficient form is rail, with 6% of its energy inputs as a percentage of output, while water transportation has 9%; air travel has 21%. However, water transportation energy costs have raised more rapidly than for other modes.

Strong competitive pressures have pushed average freight rate levels down for some modes during the 1990s. However, prices for producers or manufacturers have increased 16 percent during the last decade, but average freight rates for barge shipments have decreased by 8 percent. Rail rates also declined during this period, reflecting the competitiveness of the marketplace, especially intermodal competition.

It is obvious that the water carriers' importance in the U.S. transportation system declined over the past decade. However, many manufacturers and suppliers would experience serious problems in maintaining their competitive position without the availability of low-cost water transportation. The decline in water transportation is attributable in part to the transformation of the U.S. economy from basic manufacturing to service industries and technology. The focus on logistics and supply chain management has also impacted water transportation because companies have switched to carriers offering better service (e.g., motor carriers to offset other costs such as carrying cost for inventory, warehousing cost, packaging cost, etc.).

## Types of Carriers

Like motor carriers, the first major classification of the domestic water carrier industry is between for-hire and private carriers. A **private carrier** cannot be hired and only transports freight for the company that owns or leases the vessel. Private water carriers are permitted to transport, for a fee, exempt commodities; when they are hauling such exempt goods, they are technically exempt for-hire carriers.

The **for-hire** water **carriers** consist of regulated and exempt carriers that charge a fee for their services. Exempt carriers, as indicated above, are excluded from the federal economic regulations administered by the **Surface Transportation Board** (STB). When authority was transferred to the STB under the **ICC Termination Act of 1995**, the STB's authority was expanded over domestic water traffic.

Water carriers are exempt from economic regulation when transporting bulk commodities, both dry and liquid. Because the majority of freight transported by domestic water carriers consists of bulk commodities, exempt carriers dominate the for-hire segment of the industry.

**Regulated** water **carriers** are classified as either common or contract carriers. Economic regulation, similar to that controlling motor carriers (e.g., operating certificates, rates, etc.).

The domestic water carrier industry is most commonly classified by the waterway used. Carriers that operate over the inland navigable waterways are classified as **internal** water **carriers**.

The Great Lakes carriers operate along the northeastern portion of the United States and provide service between ports on the five Great Lakes that border the states of New York, Pennsylvania, Ohio, Michigan, Indiana, Illinois, Wisconsin, and Minnesota. This Great Lakes-to-Atlantic traffic is classified as a coastal operation.

**Coastal carriers** operate along the coasts serving ports on the Atlantic or Pacific oceans or the Gulf of Mexico. Intercoastal carriers transport freight between East Coast and West Coast ports via the Panama Canal.

### Number and Categories of Carriers

The domestic for-hire water carrier industry consists of a limited number of relatively small firms. The latest numbers available from the Bureau of Transportation Statistics is for 2006, when it was reported that there were 682 vessel operators in service, and that number has decreased from 1,114 in 2000.

Operating revenues on the inland waterway has remained relatively constant over the last decade, whereas revenue on the Great Lakes has increased about 23 percent because of an increase in higher-valued freight movements. Water carriers have experienced increased competitive pressure, but the intensity has varied from segment to segment, with carriers operating along the coastal waterways experiencing the greatest impact of the competition especially from railroads and pipeline carriers.

### Competition

Water carriers vigorously compete for traffic with other modes and, to a limited degree, with other water carriers. The relatively small number of water carriers results in a limited degree of competition. Because the number of carriers on a given waterway is limited, there is little incentive for the water carriers to compete with one another by lowering rates because they realize that the rate decrease will most likely be matched.

The major water carrier competition is with two other modes, namely rail and pipelines. Water carriers compete with railroads for the movement of dry bulk commodities such as grain, coal, and ores.

Rail and water carriers compete heavily to move coal out of the coal-producing states of Pennsylvania, West Virginia, and Kentucky. On the Great Lakes, water carriers compete with railroads for the movement of coal, ores, and grain.

Water carriers and pipelines are vigorous competitors for the movement of bulk liquids (petroleum and petroleum products) which account for about one-third of the total tonnage transported by domestic water carriers.

To a very limited degree, water carriers compete with trucks. However, trucks are usually used to overcome the accessibility constraints of water carriers because trucks tie inland areas to the waterways for pickup and/or delivery. Shipment quantities argue against an all-motor carrier movement for long hauls because one barge can transport the equivalent of 58 tractor–trailers.

## OPERATING AND SERVICE CHARACTERISTICS

### Commodities Hauled and Related Characteristics

In 2007, water carrier's hauled 164.8 million short-tons of petroleum, which represents 26.5 percent of the total short tons hauled that year. Chemicals accounted for about 8.2 percent of the water carrier total. Coal and coke and represent about 29 percent of the total freight moved by water carriers. Crude materials transported by water carriers are typically raw materials such as forest products, pulp, sand, metal ores, accounting for 17.6 percent. Agricultural products account for about 15 percent of the total.

Water carriers are considered to be medium-to-long-haul carriers. Their carrying capacity is relatively large, which makes short hauls with frequent stops uneconomical. However, the length of haul varies by segment from about 400 miles (inland water carriers) to over 1,500 miles for coastal carriers.

Barges are capable of carrying 1,500 to 3,000 tons, and lake carrier vessels can carry about 20,000 tons. A 1,500-ton load represents the typical carrying capacity of 15 railcars or about 50 trucks. The long hauls and the large carrying capacity combined with fuel efficiency allow water carriers to offer low-cost service—about 72 cents per ton-mile on average.

Water carriers are relatively slow, with average speeds on inland rivers, for example, of 5.5 to 9 miles per hour. The limited accessibility of the water carrier usually necessitates pickup or delivery by another mode of transportation to bridge the accessibility gap.

Service can also be disrupted by weather.

Overall, water carriers are an attractive alternative for low-value traffic, where transportation rates are a significant part of the total delivered cost and price of the good.

However, the poor service characteristics may add cost for the user, which has to be traded off against the low rate to calculate the true total cost.

## EQUIPMENT

### Types of Vehicles

Because most domestic water carriers transport bulk materials, they use ships with very large **hold** openings to facilitate easy loading and unloading which allows a ship to carry more than one commodity at a time.

The largest ship in the domestic water carriage industry is the tanker. A **tanker** can carry anywhere from 18,000 to 500,000 tons of liquid, generally petroleum or petroleum products.

Another type of vessel is the **barge**, a powerless vessel towed by a tugboat. Barges are most commonly used by internal waterway carriers. Additional barges can be added to a tow at very little additional cost.

### Fuel

The majority of fuel used by water transportation is residual fuel oil, also known as heavy fuel oil. This is the remainder, or “residue,” of fuel after crude oil is distilled. Diesel, also typically extracted from crude oil, makes up about a quarter of fuel consumption in water transportation.

### Terminals

Water carrier terminals are often provided by the public.

It has been recognized for a long time that water transportation is a catalyst to economic activity in the community, and it is this belief that has spurred public investment in the operation of ports.

Over the past few decades, major port improvements have centered on the mechanization of materials-handling systems, especially for internal waterway ports especially handling of larger volumes of bulk commodities.

The port facilitates ship loading and unloading, which means that the port must be equipped with cranes, forklifts, and other handling equipment.

Because barges and ships carry larger loads than rail or motor carrier vehicles, storage facilities are necessary at the port.

## COST STRUCTURE

### Fixed vs. Variable Cost Components

The basic cost structure of water carriers consists of relatively high variable costs and low fixed costs. Like motor carriers and air carriers, water carriers do not provide their own highways (rights-of-way). The waterways are provided by nature (except canals) and are maintained, improved, and controlled by the government. The carriers pay **user charges**—lock fees, dock fees, fuel taxes—for the use of government-provided facilities. These user charges are directly related to the volume of business, and therefore, are considered variable costs.

The **operating costs** for water carriers are approximately 85 percent variable and 15 percent fixed.

## INFRASTRUCTURE

As indicated above, the domestic water carrier's low fixed costs can be attributed in part to **public aid** in the area of infrastructure. The construction of locks and dams on rivers makes the waterways navigable for domestic water carriers.

## CURRENT ISSUES

### Port Development

Ports now have to balance competitive economic concerns with the concerns of the public, which, rightly or wrongly, often view ports as a main source of air, water, and noise pollution.

### Global Perspective "Ports: An Essential Link"

The U.S. port infrastructure makes the important connection between the maritime trading system represented by the world fleet to the U.S. economy and U.S. consumers and producers. There are more than 300 ports in the United States, and they vary greatly in ownership, size and the type of cargo and vessels handled.

## PIPELINE TRANPORTATION

### Pipelines Industry Overview

The pipeline industry is unique in a number of important aspects, including the type of commodity hauled, ownership, and visibility. Pipelines are the only mode with no **backhaul**; that is, they are unidirectional with products that only move in one direction through the line.

### Significance of Pipelines

The pipeline network grew steadily until the early 1980s. With the increase in the diameter there has been increased capacity significantly because of the increased volume that can move through the pipeline.

The low rates of the pipeline are reflected in the very low percentage of the total intercity revenue paid to all pipeline carriers which account for approximately 4 percent of the total transportation revenues, compared to motor carriers, for example, which account for more than 75 percent of the total revenue.

### Types of Carriers

Many pipelines operate as **common** carriers. Although some private carriers exist today, the for-hire carriers dominate the industry. Common carriers account for approximately 90 percent of all pipeline carriers.

### Ownership

Oil companies have been the owners of the oil pipelines.

Some pipelines are joint ventures among two or more pipeline companies because of the high capital investment necessary for large-diameter pipelines.

### Number of Carriers

In 2006 there were approximately 2,297 total pipeline operators.

The oligopolistic nature of the industry is demonstrated by the fact that 20 major integrated oil companies control about two-thirds of the crude oil pipeline mileage. There are a number of reasons for the limited number of pipeline companies such as startup costs and the economies of scale are such that duplication or parallel competing lines would be uneconomic. Large-size operations are more economical because capacity rises more than proportionately with increases in the diameter of the pipeline and investment per mile decreases, as do operating cost per barrel.

## NATURAL GAS CARRIERS

Another part of the pipeline industry is involved with the transportation of natural gas, which, like oil, is an important source of energy.

## OPERATING AND SERVICE CHARACTERISTICS

### Commodities Hauled

Pipelines are a very specialized carrier in that they transport a very limited variety of products. The four main commodities hauled by pipeline are oil and oil products, natural gas, coal, and chemicals.

### Oil and Oil Products

The bulk of pipeline movements are crude oil and oil products which account for about 60 percent of total pipeline use. Pipelines move about 66 percent of the total ton-miles of crude oil and petroleum products.

The length of haul in the oil pipeline industry is medium in length compared to other modes. Crude oil movements average about 800 miles per shipment, and product lines average about 400 miles per movement. The average shipment size for these movements is very large.

### Natural Gas

Natural gas pipelines are an important part of our total pipeline network. They account for the second largest number of miles of intercity pipelines.

### Coal

Coal pipelines are frequently called **slurry lines** because the coal is moved in a pulverized form in water (one-to-one ratio by weight). The large slurry pipeline that operates between Arizona and Nevada covers 273 miles and moves 5 million tons of coal per year.

### Chemicals

Chemical lines are another type of product line, although only a limited number of different types of chemicals are carried by pipelines. The three major chemicals are anhydrous ammonia, propylene, and ethylene.

### Relative Advantages

A major advantage offered by the pipeline industry is low rates with average revenues are below one-half of a cent per ton-mile.

Two other advantages are that pipelines have a very good **loss and damage record** and they can provide a warehousing function because their service is slow. Another positive service advantage of pipelines is their dependability. They are virtually unaffected by weather conditions, and they very rarely have mechanical failures.

### Relative Disadvantages

The pipeline’s slow speed can be also be a disadvantage as a pipeline will not be able to deliver an extra amount of the product in a short period of time.

The use of pipelines is limited to a rather select number of products: crude oil, oil products, natural gas, coal, and a limited number of chemicals. While large shipments and slow speed of pipelines reduces the frequency, the service is offered 24 hours a day, 7 days a week.

Pipelines are generally regarded as somewhat inflexible because they serve limited geographic areas and limited points within that area. Also, they carry limited types of commodities and only offer one-way service. Finally, the operations technology precludes small shipment sizes.

In summary, pipelines offer a good set of services for particular types of products, but they have some serious limitations for many other products.

## COMPETITION

### Intermodal

**Intermodal competition** in the pipeline industry is limited of the small number of companies, the economies of scale and high fixed costs preclude of facilities to a large extent.

### Intermodal

Pipelines compete with railroads, water carriers, and motor carriers but the level of competition is limited. The most serious competition is water, or tanker operations, because their rates are competitive with pipelines. It is difficult for other modes to compete as costs are extremely low, dependability is quite high, and there is limited risk of damage to the product being transported.

In the oil segment of the pipeline industry, sophisticated operating and monitoring techniques are used because of the different petroleum products moving through the product lines and the different grades of crude oil moving through the crude oil lines. When two or more grades of crude oil or two or more products move through a system at one time, the “batches” may need to be separated by a rubber ball called a **batching** pig.

## COST STRUCTURE

### Fixed- vs. Variable-Cost Components

The pipeline industry has a high proportion of fixed costs with low capital turnover. Property taxes, amortizations of depreciation, the return to investors, and preventative maintenance all contribute to the high ratio of fixed to variable expenses.

In addition to the right-of-way costs, the terminal facilities of pipelines contribute to the high level of fixed costs. The same types of expenses associated with the right-of-way, such as depreciation and property taxes, are incurred by the pipeline terminals.

The high fixed costs and the economies of scale help to explain the joint ownership and investment in large-diameter pipelines.

Labor costs are very low in the pipeline industry because of the high level of automation.

## Rates

Pricing in the pipeline industry is unique compared to its major modal competitors.

The nature of operation (one-way movement, limited geographic coverage of points, limited products, etc.) provides little opportunity to provide differential pricing practices. Pipelines quote rates on a per-barrel basis (one barrel equals 42 gallons).

Pipeline rates are very low, as they carry more than 15 percent of the total intercity ton-miles and receive only about 2 percent of the total revenues.

## TRANSPORTATION PLANNING

### Objectives:

1. Discuss the relationship between international trade and global transportation
2. Identify the three critical flows in global supply chains
3. Recognize the importance of proper global transportation planning
4. Understand the role of Incoterms in determining transportation responsibilities, risks, and costs
5. Describe the payment term options available to exporters and importers
6. Appreciate the value of timely, accurate global freight documentation
7. Analyze the key issues in effective international transportation mode and carrier selection
8. Evaluate the critical factors in route design for international shipments

### Overview

The unprecedented growth of the global economy over the past decade makes global transportation a key area of study. Companies around the world require efficient and effective transportation service to support their manufacturing, distribution, and retail operations. It is a huge cost for companies - more than $750 billion spent on global transportation services in 2007 to facilitate merchandise flows - that must be well managed. The distance factor also creates potential disruptions that must be assessed and protected against.

### Global Trade Agreements Stimulate Transportation Activity

The growth of international trade and transportation activity is bolstered by the creation of global trade agreements. A discussion of bi-lateral and regional trade agreements is provided with a particular focus on the North American Free Trade Agreement (NAFTA). Details regarding NAFTA are provided to demonstrate its impact on transportation processes, regulation, and network structure. While NAFTA transportation provisions were scheduled to be operational by 1995, some issues remain unresolved today that impact carrier operations, particularly between the United States and Mexico.

### Logistics Channel Issues in Global Transportation

To help students understand the supply chain impacts of global trade and the scope of transportation planning, three aspects of freight flows are covered. The Wood et. al. (2002) conceptualization and integration of the transaction channel, the communication channel, and the distribution channel are used to emphasize the critical need to manage the flow of money and information, as well as the physical flow of goods.[i]

- Transaction Channel - addresses the importance of negotiating transaction details, including the transfer of ownership, to protect financial interests and control risk.
- Communication Channel - focuses on timely information sharing and proper documentation to improve visibility and facilitate the uninterrupted flow of goods
- Distribution Channel - highlights the value of mode, carrier, and route planning to overcome the inherent challenges of distance, complexity, and multiple intermediaries involved in global transport.

### Global Transportation Challenges

The section wraps up with a discussion of the widespread challenges that impact the flow and cost of global freight movement. Current issues related to trade fluctuation, carrier consolidation, security risks, and regional sourcing pattern shifts are highlighted. Other issues mentioned in this section - government regulation, volatile fuel prices, global warming, etc. - present potentially negative implications for global transportation and warrant additional classroom attention.

## EXPORT PREPARATION ACTIVITIES

Prior to loading freight and transporting it to global destination, key decisions must be made and requirements completed. Four primary export preparation activities are choosing the terms of trade, securing freight insurance, agreeing upon the terms of payment, and completing the required freight documentation. These pre-shipment steps help to clarify responsibilities of the exporter and importer, protect each party's financial interests, improve freight control and visibility, and facilitate problem-free transport.

### Cargo Insurance

Importers and exporters are exposed to countless hazards when their freight moves through the global supply chain. They must determine their insurable interests and how to most effectively manage risk. Insurance is a critical, but complex, aspect of global trade preparation. This section identifies the financial risks associated with global freight flows as well as a long list of potential perils that must be considered. Also discussed are the options for managing risk, the use of insurance to transfer that risk, and the relevance of insurable interest when making risk management decisions.

### Terms of Payment

Terms of payment is another relevant topic that is discussed in the planning section of the chapter. Exporters are concerned about the creditworthiness of new customers and non-payment for goods that are sold internationally. Importers may be apprehensive about payment timing and methods. Balancing the relative risks of the two parties is the goal. This section identifies various payment terms, ranging from cash in advance to open terms, and discusses their realtive abilities to facilitate trade while balancing risks.

### Freight Documentation

The preparation section wraps up with an extensive discussion of freight documentation. The importance of timely and accurate paperwork is often underappreciated by students. Freight documents control the cargo on its journey from origin point in the country of export to its final destination in the country of import. Missing or incorrect paperwork can cause delays and additional costs, particularly with the expanded security-related regulation and attention being paid to freight documentation today.

The growing use of information technology for completing and transfering freight related documents concludes the section. The role of electronic data interchange is discussed. These systems are intended to enhance border security while expediting legitimate global trade.

## TRANSPORTATION PLANNING

The final phase of global transportation preparation focuses on the selection of the modes, carriers, and routes. While trade terms and documentation issues are fairly technical and their execution is methodical, global transportation managers have the opportunity to be strategic and innovative when choosing transportation providers and routes. These decisions must align with corporate strategies, control risk, and provide the required level of customer service. Also, the transportation costs generated by these planning decisions must not push the total landed cost for products beyond a competitive level in the marketplace.

### Mode Selection

The mode selection decision involves the exporter and/or the importer, depending upon the Incoterm used for the transaction. Each party will choose the mode for the portion of the delivery for which they are responsible. The important concept to convey to students is that the general strategy regarding mode selection for global freight focuses is similar to domestic freight. Transportation managers must determine which mode or combination of modes best suits the requirements of the customer.

This long range decision requires an analysis of the best fit and balance between modal capabilities, product characteristics, supply chain requirements for speed and service, and transportation cost. However, the geographic distances and barriers involved in global trade may limit modal options to just a few types of service providers. The flexible option of intermodal transportation should be stressed to students.

### Carrier Selection

Carrier selection is another key planning activity. Selecting individual service providers from within a mode is based on a variety of shipment criteria and carrier capabilities: geographic coverage, transit time average and reliability, equipment availability and capacity, product protection, and freight rates. Carrier selection requires active and frequent engagement of the transportation buyer, consideration of multiple service providers and service types, and management of each carrier’s service level and freight rates on an ongoing basis.

The strategy of concentrating the transportation buy with a limited number of carriers is also discussed. Using a small group of carriers helps the organization leverage their purchasing dollars for lower overall rates, build relationships with service providers who gain a better understanding of freight flows and requirements over time, and allows the organization to effectively monitor performance of the carrier base.

### Route Planning

The transportation planning section wraps up with coverage of route planning. Students (particularly those who lack of geography skills) often do not realize the challenges and importance of this topic. Route selection affects transportation costs, impact transit time, and can cause major headaches if not properly managed. Route planning can be particularly challenging, given the long distances, multiple paths available, and regional issues present.

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# NETWORK ANALYSIS AND DESIGN

## LEARNING OBJECTIVES

- Understand the need to evaluate the structure and functioning of logistics/supply chain networks, and for making changes and improvements as appropriate.

- Identify factors that may suggest a need to redesign a logistics/supply chain network.

- Structure an effective process for logistics/supply chain network design.

- Be aware of key locational determinants, both national/regional and site specific, and the impacts they may have on prospective locational alternatives.

- Describe the different types of modeling approaches that may be used to gain insight into logistics/supply chain network design and facility location decision making.

- Apply the simple “grid” or center-of-gravity approach to facility location.

- Discuss certain ways in which transportation alternatives and transportation costs may affect the location decision.

## OVERVIEW

### Introduction

As firms continue their searches for new ways to lower costs and improve service to their customers, the issue of where to locate logistics and manufacturing facilities has never been more complex or critical. In addition to enhancing the efficiency and effectiveness of a logistics/supply chain operation, the redesign of a firm’s overall network can help to differentiate a firm in the marketplace. Considering the increasingly dynamic aspects of today’s business world, companies are continually seeking new and improved approaches to network design and operation.

The process of logistics/supply chain network redesign is examined in detail. This content provides a useful framework for understanding the key steps that must be included in a comprehensive approach to network design and facility location. Following these discussions, attention shifts to several major locational determinants. These factors may be either regionally focused or site-specific. Also included is a summary of current trends governing site selection.

Several examples of transportation-specific factors are also considered.

## The Need for Long-Range Planning

In the short run, a firm's logistics/supply chain network and the locations of its key facilities are givens, and the logistics manager must operate within the constraints imposed by the facility locations. Site availability, leases, contracts, and investments make changing facility locations impractical in the short run. In the long run, however, the design of the overall network must be thought of as variable.

## The Strategic Importance of Logistics/Supply Chain Network Design

This section discusses several types of change that may suggest a need to reevaluate and/or redesign a firm's logistics network. Such changes are as follows: Changing Customer Service Requirements, Shifting Locations of Customer and/or Supply Markets, Change in Corporate Ownership, Cost Pressures, Competitive Capabilities, and Corporate Organizational Change.

Customer service requirements are varied and ever-changing, becoming more and more demanding.

Considering the manufacturing and logistics facilities are positioned between customer and supply markets, any changes in either of these necessitates a need to reevaluate the network design and potentially facilities locations.

A relatively common occurrence today is the firm experiencing a change in corporate ownership.

A major propriety today is for firms today is to figure out new and innovative ways to take cost out of their processes, including logistics.

Another factor relates to competitive pressures that may force a firm to examine its logistics service levels and the costs generated by the network of logistics facilities.

Lastly, corporate organizational change leads to discussions of reorganizing key firm capabilities, to include logistics capabilities.

### Changing Customer Service Requirements

While some customers have intensified their demands for more efficient and more effective logistics services, others are seeking relationships with suppliers who can take logistical capabilities and performance to new, unprecedented levels. While customer service requirements may experience change, the types of customers served may also evolve over time.

### Shifting Locations of Customer and/or Supply Markets

Considering that manufacturing and logistics facilities are positioned in the supply chain between customer and supply markets, any changes in these markets should cause a firm to reevaluate its logistics network

On the supply side, the service and cost requirements of the automobile industry's movement to JIT-based manufacturing have forced companies to examine the locations of logistics facilities.

Also on the global scene, changes such as the unification initiatives of the European Union, the continued searches for lower-cost manufacturing, and the growing economic importance of China and the Asia-Pacific area in general have forced many companies to examine facility locations in terms of their suitability for competition in these rapidly developing markets.

### Change in Corporate Ownership

A relatively common occurrence today is for a firm to experience an ownership-related change associated with a merger, an acquisition, or a divestiture. In such instances, many companies choose to be proactive and to conduct a formal evaluation of new versus previous logistics/supply chain networks in advance of such a change.

### Cost Pressures

A major priority for many firms today is to figure out new and innovative ways to take cost out of their key business processes, including those relating to logistics.

On a global basis, labor wage rates have a significant impact on the location of manufacturing and logistics operations Companies considering plant modernization needs also sometimes benefit from a comprehensive cost analysis, which might accompany a reevaluation of the logistics network.

### Competitive Capabilities

Another factor relates to competitive pressures that may force a company to examine its logistics service levels and the costs generated by its network of logistics facilities.

### Corporate Organizational Change

It is not unusual for logistics/supply chain network design to become a topic of discussion at the same time that a firm considers any major corporate organizational change, such as downsizing. In such instances, the strategic functioning of the firm's logistics network is viewed as something that must be protected and even enhanced through the process of organizational change. Considering the current popularity of corporate reengineering efforts, the logistics process is frequently a prime candidate for attention.

## Logistics/Supply Chain Network Design

Figure 12-1 and 12-2 (located on page 516 and 517 in the text) identifies the six major steps that are recommended for a comprehensive logistics network process. They are:

Step 1: Define the Logistics/Supply Chain Network Design Process

First, a logistics network reengineering team is formed who is responsible for all elements of the logistics network design process. Parameters and objectives of the logistics network design or redesign process itself are established. The use of third-party suppliers of logistics services is a topic also addressed early.

Step 2: Perform a Logistics/Supply Chain Audit

A logistics audit provides members of the reengineering team with a comprehensive perspective on the firm's logistics process and the ability to gather essential types of information that will be useful in the redesign process.

Step 3: Examine the Logistics/Supply Chain Network Alternatives

Examining logistics network alternatives involves applying suitable quantitative models to the current logistics system as well as to the alternative systems and approaches under consideration. The use of these models provides insight into the functioning and cost/service effectiveness of various possible networks.

Step 4: Conduct a Facility Location Analysis

Once a desired logistics network has been recommended, the next task is to carefully analyze, both qualitatively and quantitatively, the attributes of specific regions and cities that are candidates for sites of logistics facilities. Next, a location selection team is formed, in order to collect information on specific attributes, as well as to examine potential sites in terms of topography, geology, and facility design.

Step 5: Make Decisions Regarding Network and Facility Location

The network and specific sites recommended in steps 3 and 4 should be then compared with the design criteria that were identified in step 1. This step should confirm the types of change that are needed to the firm's logistics network also keeping within the context of overall supply chain positioning.

Step 6: Develop an Implementation Plan

Once an overall direction has been established, an implementation plan is developed, serving as a useful road map for changing the logistics network.

## Major Locational Determinants

The importance of major locational determinants varies among industries and individual companies. Labor-intensive industries such as textiles, furniture, and household appliances place more emphasis on favorable labor climate and labor rates than do high-tech industries such as engineering and scientific instrument manufacturers. Logistics variables are important in industries such as drugs, beverages, and printing and publishing. The major general locational determinants identified are: labor climate, availability of transportation, proximity to markets and customers, quality of life, taxes and industrial development incentives, supplier networks, land costs and utilities, and company preference.

### Key Factors for Consideration

- Labor climate. Factors to consider in determining an area's labor climate are: the work force's degree of unionization, skill level, work ethic, and productivity, and public officials' attitudes.

- Transportation services and infrastructure. With many firms requiring high-quality, capable transportation services, considerations such as a suitable location, cost, and modal choice are made.

- Proximity to markets and customers. Considered are both logistics and competitive variables. Logistics variables include: transportation availability, freight cost, and market size within one day's travel time. The more firms in the market area, the greater the competitive advantage the proposed location offers.

- Quality of life. This involves the employees' wellbeing. This factor is more important to companies that must attract and maintain a professional and technical mobile workforce. The qualify of life variables in metropolitan areas include: climate, housing costs, health care and environment, crime, passenger transportation, education, recreation, the arts, and economic opportunities.

- Taxes and industrial development incentives. Other determinants that influence facility location include environmental considerations, and both business and personal taxes. Environmental permits are important to companies producing certain chemicals or drugs. Business taxes affect operating costs in an area, and personal taxes affect the area's cost of living and the wages that have to be paid. Another location influence factor is industrial development incentives extended by communities to attract companies to locate in their area. These may include tax incentives, financing arrangements, reduced water and sewage rates, and rent-free buildings. The importance of various determinants depends on the specific needs of the company.

- Supplier networks. This considers the availability and cost of raw materials and their transportation cost, as well as the cost of transporting of raw materials and component parts, as well as the cost of transporting materials to the proposed site.

- Land costs and utilities. Issues relating to the costs of land and the availability of needed utilities are considered. Also, the availability and expense of utilities such as electrical power, sewage, and industrial waste disposal will need to be factored into the decision making process.

- Company preference. In some cases, location selection may be based upon company or CEO preference to an area. Locating near the competition and/or common access with other firms to benefits such as a skilled labor supply, excellent marketing resources, or proximity to key supplier industries is also a determinant.

### Current Trends Governing Site Selection

A number of trends in today's logistics environment may have a significant effect on decisions involving logistics facility location. Included among these are the following:

- Strategic positioning of inventories, such that fast-moving, profitable items may be located at "market-facing" logistics facilities.
- Aside from a general trend toward "disintermediation" of many wholesaler/distributor operations, companies are moving to greater use of "customer direct" delivery from manufacturing and other upstream supply chain locations.

- There is a growing use of and need for strategically located "cross-docking" facilities that serve as transfer points for consolidated shipments that need to be disaggregated or mixed into typically smaller shipments for delivery to individual customers.
- Due diligence for location and site selection decisions is placing great emphasis on access to major airports and/or ocean ports for import and export shipments.
- Greater use of providers of third-party-logistics services, who may assume part or all of the responsibility for moving a firm's products to its customers, and/or moving its inbound parts and materials to its manufacturing process. In the global setting, many of these companies are developing specialized abilities to facilitate the movements of import and export shipments.

## Modeling Approaches

The modeling approaches are classified as: optimizing, heuristic, or simulation.

### Optimization Models

Optimizing models seek the "best" answer given the way in which the problem is formulated. Linear programming and mathematical programming provides the optimum distribution of products among plants, warehouses, and markets. They are optimizing approaches. Advantages of optimizing models are as follows:

- The user is guaranteed to have the best solution possible for a given set of assumptions and data.
- Many complex model structures can be handled correctly.
- The analysis and evaluation of all alternatives that are generated result in a more efficient analysis.
- Reliable run-to-run comparisons can be made, since the “best” solution is guaranteed for each run.
- Cost or profit savings between the optimum and heuristic solution can be significant.

However, an optimization technique, linear programming, is limited due to the need for the problem formulation to be deterministic and capable of linear approximation. Also, linear programming does not allow for consideration of fixed as well as variable costs of operating logistics facilities.

On a more advanced scale, the use of mixed-integer linear programming allows consideration of issues such as fixed and variable costs, capacity constraints, economies of scale, cross-product limitations, and unique sourcing requirements. One of the leading models of this type is Strategic Analysis of Integrated Logistics Systems (SAILS™).

Simulation Models

Simulation models develops a computer representation of a logistics system, manipulates key variables and provides logistics managers with a helpful test medium for evaluating alternative logistics strategies. Although simulation models are not designed to produce optimum solutions, they are very capable in terms of their ability to incorporate relatively comprehensive and detailed problem descriptions. However, extensive data collection and mathematical relationships are required.

Heuristic Models

Heuristic models do not generate a “best” solution, but produce a good first approximation. These models are used for warehouse location, truck routing, and warehouse product layout. They help to reduce a problem to a manageable size and search automatically through various alternatives in an attempt to find a better solution.

Potential Supply Chain Modeling Pitfalls to Avoid

Short term horizon

- Too little or too much detail
- Thinking in two dimensions
- Using published costs

- Inaccurate or incomplete costs
- Use of erroneous analytical techniques
- Lack of appropriate robustness analysis
- Too little or too much detail

Example of a Heuristic Modeling Approach: The Grid Technique.

The grid technique is used to determine a least-cost facility location for company situations having multiple markets and raw materials sources. It attempts to determine a fixed facility location that is the least-cost center for moving materials and goods within a geographic grid; a low cost “center of gravity”. After assuming the materials sources and goods’ markets are fixed, and the number consumed or sold is known, a grid is superimposed over the geographic area containing the sources and markets. With the use of the grid, each source and market can be determined by its grid coordinates.

The ton-mile center, or center of mass can be calculated mathematically (the equation is on page 533 of the text). The equation can be solved for the least-cost location, provided the transportation rates for materials and goods are the same. But this is seldom the case, so the ton-mile center equation does not show the cost differences for moving commodities. Higher finished goods rates draws the least-cost location to their markets; reducing the distance to transport the goods. This increases the distance to transport raw materials. Another equation takes into account different transportation rates (the equation is on page 534 of the text).

The advantage of the grid technique is its simplicity and ability to provide a starting point for location analysis. There are a number of limitations to the technique. First, it is static, and the solution is only optimum for one point in time. Second, linear transportation rates are assumed. Actual rates are tapered. Third, topographic conditions at the optimum location are not considered. Fourth, the proper direction of movement is not considered.

Sensitivity analysis can be used to ask “what if” questions and measure the impact on the least-cost situation. A variety of scenarios could be examined: a five-year sales projection, adding or eliminating new markets and/or sources, and switching transportation modes or carriers.

This is a static approach, and the solution is optimum for only one point in time. The technique assumes linear transportation rates, whereas actual transportation rates increase with distance but less than proportionally. The technique does not consider the topographic conditions existing at the optimum location. It does not consider the proper direction of movement; most moves occur along a straight line between two points, not “vertically” and then “horizontally.”

Sensitivity Analysis: As mentioned in the preceding paragraph, the grid technique is a static approach; the computed location is valid only for the situation analyzed. If the transportation rates, market and source locations, and volumes change, then the least cost location changes.

Sensitivity analysis enables the decision maker to ask what-if questions and measure the resulting impact on the least-cost location.

Application to Warehouse Location in a City: A special case exists for applying the grid technique to the location of a warehouse in a city. The situation's uniqueness comes from the blanket rate structure, which applies the same rate from an origin to any point within the city or commercial zone.

Transportation Pragmatics

The grid technique shows the importance of transportation rates in facility location. Tapering rates, blanket rates, commercial zones, and in-transit privileges are special rate structures that affect facility location. A tapering rate is one that increases with distance but not in direct proportion to distance. Most transportation rates are tapered. The tapering results from the carrier's ability to spread its fixed costs–loading, billing, and handling—over a greater number of miles. The blanket rate does not increase with distance, but remains the same for all points in the blanket area. It is an exception to tapering rates. These rates are established to ensure a competitive price for a product in a given area. The rate eliminates any transportation cost advantage or disadvantage associated with a given location. A commercial zone is a specific blanket area. It is the transportation definition of a particular city or town plus various surrounding areas. If a site is to be located beyond the municipality's commercial zone, rates that apply to the city, will not apply to the site.

Foreign Trade Zones (FTZ) is a geographic area into which importers can enter a product and hold it without paying duties—and only paying duties or customs when is it shipped into U.S. customs territory. Advantages of FTZs include the following: Deferred customs duties and federal excise taxes on imports, No duties or quota payments on re-exported materials, choice of duty rates paid—based either on the rate for component parts or for the finished product Exemption from state and local inventory taxes or foreign and domestic goods that are to be exported

The transit privilege permits the shipper to stop a shipment in transit to perform some function that physically changes the product's characteristics. The lower through rate for origin to final destination applies, rather than the higher combination rate. The transit privilege makes intermediate locations, not just origins or destinations optimum, and eliminates any geographic disadvantage associate with a producer's location.

## SUMMARY

• The logistics/supply chain network design decision is of great strategic importance to logistics, the firm as a whole, and the supply chain. This decision is becoming increasingly important due to trends related to globalization of manufacturing, marketing, sourcing, and procurement.

- A number of factors may suggest the need to redesign the logistics/supply chain network.

- A formal, structured process for network design is preferable; the potential impacts on cost and service justify a significant effort toward following a sound process.

- Numerous factors may affect the design of a logistics network and the location of specific facilities within the context of the network.

- Principal modeling approaches to gain insight into the topic of logistics/supply chain network design include optimization, simulation, and heuristic models.

- The "grid" method represents a useful way to obtain a good, but not necessarily optimal solution to a logistics facility location problem.

- The availability and cost of transportation affect the location decision in a number of significant and unique ways.

# DISTRIBUTION, WAREHOUSING AND MATERIAL HANDLING

## LEARNING OBJECTIVES

- Discuss the strategic value-adding role distribution plays in the supply chain.

- Recognize the tradeoffs between distribution and other supply chain functions.

- Understand the analytical framework for distribution planning decisions.

- Evaluate fulfillment strategies and distribution methods.

- Describe the primary fulfillment processes and support functions in distribution center (DC) operations.

- Use productivity and quality metrics to analyze fulfillment performance.

- Describe how information technology supports distribution operations.

- Discuss materials-handling objectives, principles, and equipment uses.

## OVERVIEW

### Introduction

Distribution in the twenty-first century focuses on the continuous flows of product to fulfill customer requirements at the lowest possible cost and is no longer focused on long term storage of inventory in static warehouses. Distribution operations provide a variety of capabilities for the supply chain. While speed is of the essence, running efficient distribution facilities and networks is also critical. With U.S. warehousing and distribution-related costs of $101 billion in 2006, there is a great need to focus on fulfillment costs in the supply chain.

### The Role of Distribution Operations

As production and consumption are not perfectly synchronized, transportation of individual units is too costly.

To overcome such issues, distribution operations—distribution centers, warehouses, cross-docks, and retail stores—are established within the supply chain. These inventory handling, storage, and processing facilities help supply chains create time and place utility.

The role of these facilities includes the following:

- Balancing supply and demand.

- Protecting against uncertainty.
- Allowing quantity purchase discounts.
- Supporting production requirements.
- Promoting transportation economies

Distribution Facility Functionality

Distribution facilities can provide four primary functions:

- Accumulation involves the receipt of goods from a variety of sources
- Sortation focuses on assembling like products together for storage in the distribution facility or for transfer to customers
- Allocation function focuses on matching available inventory to customer orders for a SKU.
- Assortment involves the assembly of customer orders for multiple SKUs held in the distribution facility.

Distribution Tradeoffs

Supply chain professionals must determine how to best balance customer service and costs with an understanding of the tradeoffs between distribution and other supply chain functions, as well as within distribution facilities.

Organizations may benefit substantially from the establishment of one or several warehouses to reduce transportation costs. However, there comes a point where you build too many warehouses and total costs increase. Another key tradeoff must be made between distribution and inventory. Generally, the more DCs and warehouses, the higher the total inventory carrying costs will be.

A common fulfillment strategy of many firms is to use the normal distribution network for most items and maintain one centralized facility for their low velocity items.

The tradeoff between distribution operations and customer service is another important issue. The primary tradeoffs and relationships include the following:

- Space vs. equipment—the larger the facility and the more space used for distribution operations, the more equipment will be needed in the facility.

- Equipment vs. people—the greater the use of equipment to automate materials handling and distribution activity, the lower the labor requirements of a facility.

- People vs. space—the larger the facility workforce, the larger the facility size and operation possible.

## Distribution Challenges

Chief among these challenges are labor availability issues, demand variation, and increasing customer requirements. In most organizations, distribution is a people-intensive activity. It is growing increasingly difficult to find and train high-quality personnel for DC operations. Demand variation is another supply chain challenge that affects distribution operations. These trends place a great deal of pressure on DCs to maximize speed and service while keeping costs under control.

## Distribution Planning and Strategy

A series of interrelated distribution planning decisions must be made to ensure that the strategy can be executed at a reasonable cost while supporting supply chain demands.

### Capability Requirements

Product characteristics must drive the design of the distribution process. Issues such as product value, durability, temperature sensitivity, obsolescence, volume, and other factors must be considered.

Another issue that has a major impact on the distribution strategy and network structure is the product flow requirements of the supply chain. Two options are available: (1) direct shipment of goods from the manufacturer to retailer or retailer to consumer or (2) movement of goods through distribution facilities to customers.

On the downside, it is expensive to deliver small quantities to buyers (reduced transportation efficiencies), and there is no safety stock readily available to protect against demand surges. Properly planned distribution facilities can address the shortcomings of direct shipping. It is necessary to analyze the inventory, transportation, and service tradeoffs before choosing between direct shipping and the use of distribution facilities.

### Network Design Issues

This phase of strategic planning involves the determination of inventory positioning, the number and location of distribution facilities, and the ownership of facilities in the network. Inventory positioning focuses on the issue of where inventory is located within the supply chain. The drawback of centralized inventory is the long distance to customers, which typically produces longer lead times and higher transportation costs.

The alternate inventory positioning strategy is to hold product in multiple customer-facing positions.

The decentralized inventory strategy is not without challenges:

- More facilities are required to stock the product, leading to higher handling costs,

- Average inventory levels will rise as each facility will have to hold safety stock to cover demand variation within the region.

There is no single answer to which inventory positioning strategy is best and many organizations use both strategies.

The second and third network design issues focus on the number and locations of distribution facilities within the supply chain. Determining the number of facilities needed for a supply chain involves the evaluation of cost tradeoffs with other functional areas.

- Transportation costs—Consolidation of inbound freight into truckload quantities achieves lower transportation rates per hundredweight and reduced transportation costs. On the outbound side, increasing the number of warehouses brings the warehouses closer to the customer and market area, reducing both transportation distance and costs.
- Cost of lost sales—an increase in the number of facilities improves customer proximity and inventory availability.
- Warehousing costs—these costs increase because the total amount of space increases with a larger number of warehouses.
- Inventory costs—as discussed earlier, an increased number of stocking points increases the overall safety stock levels and inventory carrying costs in the supply chain.

The final piece of a network design strategy is the facility ownership question—should an organization own and operate private distribution facilities or contract with third-party logistics providers for distribution services? Public warehousing rents out space to individuals or firms needing storage capacity. Contract warehousing is a customized version of public warehousing in which an external company provides a combination of distribution services that the organization itself has traditionally provided.

These external distribution services should be considered as buying the services on an as-needed basis alleviates capital investment in private distribution and short-term commitments for 3PL capacity maintain maximum distribution network flexibility. Choosing between private and 3PL distribution options requires significant planning.

Facility Considerations

Should an organization choose to outsource the distribution function to 3PL providers, facility design strategies shift to these service suppliers. However, when the facilities are privately owned and operated, a great deal of planning is required.

The first facility consideration is to determine the size of each operation within the network.

Demand forecasts for the region to be served by the facility will drive the sizing process as follows: 1) develop a demand forecast, 2) convert the units into cubic footage, and 3) add space needs for aisles and other fulfillment activities. After the facility size is determined, attention shifts to the layout of the operations within the distribution operation. Product protection is another key objective.

Proper use of automation and materials-handling equipment is an important goal. Another objective is process flexibility. Continuous improvement is the ultimate facility objective.

The final facility consideration is product placement within the facility. Before order fulfillment operations begin, goods must be located or slotted in the facility. Slotting is defined as the placement of product in a facility for the purpose of optimizing materials handling and space efficiency. Proper product slotting can improve labor productivity and generate other advantages for the organization and its customers.

## Distribution Execution

Distribution strategy and planning activities set the stage for day-to-day operation of the facility.

### Product Handling Functions

The primary facility operations focus on the movement and storage of product. However, maintaining proper product flows through efficient short-distance moves within the facility is a critical aspect of distribution. Product handling involves five primary processes including receiving, pt away, order picking, customer orders, replenishment and shipping.

There are two keys to achieving an accurate, productive flow of goods into the facility. First, receiving clerks must be well trained to evaluate incoming goods and match up product with carrier counts, vendor documentation, and the purchase order. Second, coordination of the receiving and put-away operations is needed. The final movement process occurs at the shipping operation.

For many organizations, order picking is the most labor-intensive and expensive distribution activity, accounting for 55 to 65 percent of DC operating costs. The replenishment operation plays an important supporting role for order picking, moving product from storage locations in the facility to the designated pick slots.

### Support Functions

Chief among these support functions are: (1) inventory control; (2) safety, maintenance, and sanitation; (3) security; (4) performance analysis and (5) information technology. Establishing a safe, clean working environment is not only a management obligation, but it is also a distribution productivity booster. The security function seeks to protect the organization from merchandise theft and fraud. The management team is also responsible for evaluating and improving facility performance. Organizations rely heavily on information technology to receive, fill, and distribute customer orders.

## Distribution Metrics

Distribution KPIs are objective measures of fulfillment performance that are critical to the success of the organization. KPIs can be used to evaluate current performance of internal and 3PL operations versus historical results, internal goals, and customer requirements which can also be used to benchmark results against those achieved by competitors, world-class organizations, and other links in the supply chain. The two primary categories of distribution KPIs include internal measures and customer facing measures. Internal measures focus on the resources required to fulfill customer orders.

### Customer Facing Measures

Customer facing KPIs must target reliability of the distribution processes to provide accurate, complete, and timely fulfillment of orders. Order accuracy and order completeness KPIs are important to both the customer and the organization. Order accuracy and order completeness KPIs are important to both the customer and the organization. Timeliness is a critical component of customer service.

Industry leading companies are now evaluating the combined impact of these KPIs via a metric called the perfect order index (POI). The right items must be (1) delivered to the right place; (2) at the right time; (3) in defect-free condition; and (4) with the correct documentation, pricing, and invoicing.

### Internal Measures

Distribution costs must be kept low in proportion to the value of the goods, and cost efficiency is critical, given the magnitude of warehousing and distribution-related costs—$119 billion in 2009. Asset utilization is a very important aspect of private distribution facilities. Resource productivity impacts distribution cost and the ability of the operation to maximize throughput on a consistent basis. Resource efficiency measures compare distribution activity completion time versus expected time.

## Distribution Technology

Software and information technology tools are available to support distribution control and decision making.

### Warehouse Management Systems

WMS is a software control system that improves product movement and storage operations through efficient management of information and completion of distribution tasks and is an integrated package whose components often include radio-frequency (RF) communications, dedicated localized computer hardware, and the necessary applications software. Beyond the main functionalities, WMS can also provide value-added capabilities and support a variety of supply chain activities.

Other value-added capabilities include the following:

- Labor management—the ability to link WMS with a related labor tracking module.
- Task interleaving—Task interleaving involves mixing dissimilar tasks such as put-away and replenishment.
- Systems integration—the ability to interface the WMS with the enterprise resource planning (ERP) system, order management systems, and transportation.
- Activity-based costing/billing—the financial functionality is an important WMS capability for understanding costs and assigning expenses to distribution customers.
- Multifunction distribution—a strong WMS will support a variety of distribution methods, shipment sizes, and the execution of value-added services.

### Automatic Identification Tools

Automatic identification (Auto-ID) describes technologies that help machines identify objects, such as barcodes, smart cards, voice recognition, biometric technologies, radiofrequency identification (RFID), and others. The WMS utilizes Auto-ID data capture technologies, such as barcode scanners, mobile computers, wireless local area networks (LANs), and RFID to accurately gather information and monitor the flow of products.

Barcodes and RFID are the tools of choice in distribution to help track, locate, and move product quickly—with near perfect accuracy rates to consumers. A barcode is a series of parallel black and white bars, both of varying widths, whose sequence represents letters or numbers that scanners can translate into important information. Radio-frequency identification tags, which consist of silicon chips and an antenna that can transmit data to a wireless receiver, are being used to track everything from jeans to cars.

## SUMMARY

Distribution managers play a critical role in the supply chain, focusing on the flow of product rather than storage. Fulfilling customer orders accurately and quickly while achieving the lowest possible cost is a balancing game that distribution managers must play daily. They must coordinate people, processes, capacity, and technology to achieve customer satisfaction, meet internal goals, and provide value-added services to the supply chain. Managing the distribution system for maximum supply chain impact requires considerable planning, coordination of fulfillment strategy with the execution of distribution operations, analysis of key metrics, and information sharing.

We also discussed following additional concepts:

- Distribution operations perform inventory handling, storage, and processing activities to create time and place utility for the supply chain.

- A variety of supply chain challenges—balancing supply and demand, protecting against uncertainty, and promoting transportation economies, among others—can be addressed by distribution facilities.

- Four primary functions are carried out by traditional distribution facilities: (1) accumulation, (2) sortation, (3) allocation, and (4) assortment.

- Distribution operations are taking on value-adding roles—assembly, kitting, product postponement, sequencing, etc.—to complement their basic functionality and to support evolving supply chain needs.

- Tradeoffs must be made between space, equipment, and people—the primary resources available to distribution managers.

- It is critical to match distribution processes to the items being handled to protect product integrity, promote customer service and satisfaction, and provide greater control of the inventory.

- Distribution network design issues involve centralization/decentralization of inventory, the number and location of facilities, and facility ownership.

- Effective facility planning—operational size, layout, and product placement—positively impacts labor productivity and response time.

- Distribution execution involves five primary processes related to the handling and storage of product: (1) receiving, (2) put-away, (3) order picking, (4) replenishment, and (5) shipping.

- Fulfillment support functions provide coordination between key processes and across the supply chain, protect the organization’s inventory investment, and improve working conditions within the facility.

- Distribution KPIs address asset utilization, labor productivity, and cost efficiency of the operation, as well as customer service quality issues and the ultimate goal of perfect order fulfillment.

- Warehouse management systems software solutions improve product movement and storage operations through efficient management of information and completion of distribution tasks.

- Barcodes and RFID are the automatic identification tools of choice in distribution to help track, locate, and move product quickly—with near-perfect accuracy rates to their consumers.

## TRANSPORTATION RISK MANAGEMENT

### Objectives:

1. Understand the nature of transportation risk and disruptions
2. Explain the concept of risk management
3. Describe the general process for managing transportation risk
4. Identify the primary categories and types of transportation risk
5. Understand the key factors in risk assessment
6. Discuss the four techniques for managing transportation risks

### Overview

With supply chains spanning the globe, the risk of disruptions has never been greater. Whether the problem is as major as a terrorist threat or as minor as a weather delay, any type of problem can create a harmful ripple effect across the supply chain. Complex supply chain networks with multiple suppliers, manufacturers, distributors, and logistics service providers also create interdependencies and difficulties that can hide vulnerabilities and problems. Thus, transportation managers must not idly stand by and hope for the best when they move freight. They must actively work to limit exposure to legitimate hazards.

### RISK CONCEPTS

Risk is an everpresent issue in transportation. When companies put freight in a container, railcar, or trailer and move it between distant origin and destination points, the freight can potentially be stolen, damaged, lost, or delayed while in motion or at rest in a port, trucking terminal, rail yard, or other intermediate facility. Transportation professionals (and students) must work to understand the nature of risk and be proactive in the prevention and management of risk.

To facilitate a stronger understanding of transportation risk, a few key concepts are identified and defined:

> Disruption—an event that results in a displacement or discontinuity; the act of causing disorder.
>
> Transportation Disruption—an unplanned or unanticipated event that interrupts the normal flow of goods and materials through the supply chain. These disruptions expose companies within the supply chain to operational and financial risks.

Risk—a hazard or a source of danger that has a possibility of incurring loss or misfortune.

Transportation Risk—a future freight movement event with a probability of occurrence and the potential for impacting supply chain performance.

Risk Management —the variety of activities undertaken by an organization to control and minimize threats to the continuing efficiency, profitability, and success of its operations.

Business Continuity Planning—the processes and procedures an organization puts in place to ensure that essential functions can continue during and after a disruption or disaster.

Why are these issues important? Simply stated, transportation and supply chain disruptions are common and costly. A 2008 Aberdeen Group study revealed that 99 percent of the companies surveyed had suffered a supply chain disruption in the past year, with 58 percent suffering financial losses as a result.

## TRANSPORTATION RISK MANAGEMENT PROCESS

Risk management and business continuity planning are not simple tasks. They demand significant time and expertise, involve financial investment, and require frequent revision. Hence, risk management activities must be driven by the top management of companies across a supply chain if transportation disruptions risks are to be minimized. They must view risk management as critical tool for protecting profitability and implement detailed, cyclical processes to control risk. A four-step risk management methodology is discussed in this section.
The objectives of the risk management process include the following:

- Define the key objectives and scope of the risk management process.
- Identify risk issues through structured brainstorming, data gathering exercises, and interviews.
- Allocate responsibilities for each identified risk, to provide further details of background, consequence, and management information.
- Assess each risk against an agreed consistent scale for likelihood and potential impact on operations.
- Compare risk significance to identify the top risks requiring urgent management attention.
- Develop detailed management action plans and responses for each risk.
- Provide a framework to implement actions and monitor their effectiveness.
- Provide a baseline for the process, allowing risks to be reevaluated and further threats to be identified.

### Step 1 - Risk Identification

Step 1 involves identification of the potential threats and disruptions to which the organization is susceptible. Structural and procedural changes may be required to execute the strategy.

Accurate and detailed risk identification is vital for effective risk management. This involves a concerted effort to discover, define, describe, document, and communicate risks before they become problems and adversely affect freight flows. Techniques such as brainstorming, interviews, and historical information analysis can be used to highlight risks.

This activity will likely produce a long list of transportation risks that must be managed. Students should become familiar with the primary categories of risk discussed in detail in this section:

- Product loss
- Product damage
- Product contamination
- Delivery delay
- Supply chain interruption
- Security breach

This section discusses 18 specific risks within these categories but students must understand that the list is not comprehensive. The perils of transportation are many and varied. Hazardous materials dangers, the corrosive nature of saltwater, border crossing issues, military conflicts, and a host of other issues constantly threaten to disrupt transportation operations. Managers must remain vigilant to possible threats and constantly analyze transportation risk.

## Step 2 - Risk Assessment

Step 2 focuses on evaluation and prioritization of the risks. The more vulnerable the organization's transportation process is to a potential risk, the more attention it should receive.

The objective of risk assessment is to evaluate the risks identified during Step 1 in order to determine how serious each risk is to the organization. In making this determination, two parameters are typically evaluated:

- Probability—the likelihood of the risk occurring
- Impact—the consequences if the risk does occur in terms of service time, cost, and/or quality

The time element of risk should also be studied. Risk proximity attempts to addresses the question: "when will the risk occur?"

Risk can be evaluated via qualitative or quantitative analysis. Each method can be time consuming but provide invaluable information regarding critical transportation challenges and primary disruption concerns. The effort also steers scarce resources toward the resolution of major issues.

## Step 3 - Risk Management Strategies

Step 3 requires the organization to develop proactive risk management and mitigation strategies.

Mitigation strategies identify specific efforts, actions, and procedural changes that must be taken by management to reduce high priority risks. The goal is to lower the probability of risk occurrence and/or minimize the negative impact if the risk occurs. A risk can never be totally eliminated, but its frequency and effect on the organization can be reduced if properly addressed.

An appropriate strategy seeks to address risk through one of four means:

- Risk avoidance - taking steps to eliminate or quell sources of disruptions
- Risk reduction - developing practices to reduce the likelihood of a disruption and/or limit the severity of financial loss (e.g., buffering, postponement, and hedging).
- Risk transfer - share responsibility for risk management with trading partner or reassign risk to third party such as an insurance company or 3PL firm.
- Risk retention - when risks have limited potential to negatively affect the supply chain, the organization may decide to "do nothing" and accept the consequences of occurrence.

### Step 4 - Risk Review and Monitoring

Step 4 promotes continuity, vigilance, and process improvement. Ongoing testing of strategies, evaluation of their success, and scanning for new risks are needed to achieve maximum protection.

The goal of the risk review stage is to establish a repeatable, measurable, verifiable validation process that can be run from time to time to continually verify the organization's ability to manage risk. Risk management and mitigation plans should be updated as deemed necessary by the monitoring process.

# THIRD PARTY LOGISTICS

Objectives:

1. Understand the concept of third party logistics and its role in the movement of goods
2. Identify the different types of third party logistics service providers
3. Describe the four types of transportation activities that are outsourced
4. Discuss the reasons why companies seek integrated third party logistics services
5. Understand the size and scope of the third party logistic market
6. Evaluate the reasons for outsourcing and the results achieved
7. Summarize the process for outsourcing transportation and logistics activities
8. Appreciate the current challenges and competitive issues in the third party logistics industry
9. Compare the coordination roles of various service provider types
10. Recognize the importance of information technology in managing outsourced activities

## Overview

Outsourcing continues to grow in the second decade of the 21st century. Reliance on external experts for non-core services and capabilities is commonplace as few organizations can afford to manage all business activities in-house. Transportation is another activity that is widely outsourced to external experts. Third party logistics service providers (3PLs) are experts in the management and flow of freight, allowing customers to focus their resources on other activities. Some of the larger 3PL organizations provide a one-stop shopping solution where customers can purchase all their transportation service needs, regardless of mode or geographic requirements.

Given the financial and service impact of transportation on a company's success, developing an effective transportation outsourcing strategy is critical. It is imperative to find a 3PL with a track record of providing quality transportation management and services that support execution excellence.

## Types of 3PL Providers

3PL segmentation can be based on the company's ownership of tangible assets - facilities and equipment. When a 3PL owns many or all of the assets necessary to run its customers' transportation and logistics activities, they are known as asset based providers. When a 3PL contracts with other firms to provide transportation and logistics service rather than owning the required equipment and facilities, it is called a non-asset based provider. Students are much more likely to be familiar with asset based providers like UPS, FedEx, and other transportation based 3PLs. Thus, it is important to help them understand the concept of a non-asset based provider, its roles, and benefits.

Also, most 3PLs have a core expertise in one or more logistics function. Thus, the initial segmentation of providers is based on functionality. 3PLs can be categorized as: transportation based, distribution based, forwarder based, financial based, or information based firms. Although some 3PLs may fit in more than one area, this discussion provides students with an idea of the scope of activities that may be outsourced.

- Transportation Based - these 3PLs trace their origins to freight movement via truck, rail, air, or other modes of transportation. As customer requirements expanded, these transportation companies developed 3PL subsidiaries or major divisions to provide a broader set of capabilities to serve the marketplace.

- Distribution Based - these 3PLs suppliers originated from the public or contract warehousing business and have expanded into a broader range of logistics services. Based on their traditional orientation, these types of organizations are heavily involved in logistics activities such as inventory management, warehousing, and order fulfillment.

- Forwarder Based - this group of 3PLs includes freight forwarders, brokers, and agents that primary facilitate the flow of goods on behalf of customers.

- Financial Based   This category of 3PL providers helps customers with monetary issues and financial flows in the supply chain. Their traditional roles include freight rating, freight payment, freight bill auditing, and accounting services.

- Information Based   The Internet has provided an excellent platform for the growth of information based 3PLs. These companies have digitized many activities that were previously performed manually or required the use of licensed software. Today, these information based 3PLs provide logistics information systems, online freight brokerage services as well as cargo planning, routing, and scheduling.

Within the transportation function, 3PLs provide four primary types of services: freight movement, freight management, intermediary services, and specialty services.

- Surface freight forwarding
- Air freight forwarding
- Freight brokerage
- Intermodal marketing companies
- Shippers associations
- Dedicated contract carriage
- Drayage
- Pool distribution

- Merge in transit
- Last mile delivery

The services section wraps up with a discussion of two key capabilities being developed by innovative 3PLs. First, they are developing integrated service offerings to accommodate customer desires for “one stop shopping” with a single service provider. Second, they are expanding service territories to meet the requirements of increasingly global customers.

### Reasons for Outsourcing

While outsourcing is popular among companies with few internal transportation capabilities, 3PL services are also used by companies with world class supply chain capabilities. They use 3PLs when it is appropriate to reduce costs, increase resource capacity, and fill gaps in expertise. Both groups leverage the knowledge, skills, networks, and resources of experienced 3PLs rather than building or extending internal capabilities. Table 12-4 provides a comprehensive list of reasons for outsourcing and against outsourcing.

### Primary Activities Outsourced

While the use of 3PLs has grown significantly, customer engagement patterns have not changed dramatically from year to year. Organizations predominantly use 3PL service providers for approximately three different services, led by transportation management as the most frequently used service, according to Armstrong and Associates. Their recent study of nearly 6,400 shipper-3PL relationships revealed that 81 percent remain “tactical” in nature, meaning 3PLs are mostly used for specific tasks such as transportation or warehousing. Only 19 percent of the relationships are classified as “strategic,” where a 3PL manages a customer’s entire logistics and supply chain operation on an integrated basis.

## ESTABLISHING AND MANAGING 3PL RELATIONSHIPS

The development of a 3PL relationship should involve significant planning and preparation. The development of a 3PL relationship should not happen by chance. A purchaser should carefully evaluate potential 3PL service providers and select the one whose capabilities, commitment level, and price match the buyer’s requirements. This can be a time consuming process but it will greatly increase the likelihood of a mutually beneficial relationship.

- Step 1: Perform Strategic Assessment - The first stage involves the process by which the manufacturer becomes fully aware of its transportation and logistics needs and the overall strategies that will guide its operations.

- Step 2: Decision to Form Relationship - The second stage focuses assessing internal competencies and weaknesses, in an effort to identify potential partners with strong capabilities that are needed by the customer.

- Step 3: Evaluate Alternatives - Another key activity that requires significant attention is conducting thorough assessments of the capabilities of each 3PL under consideration. This should involve capability and capacity reviews, performance evaluations, and interviews.

- Step 4: Select Partners - While this stage is of critical concern to the customer, the selection of a transportation or logistics partner should be made only following very close consideration of the credentials of the top candidate 3PLs.

- Step 5: Structure Operating Model - The fifth stage focuses on the "rules of engagement" and coordination of the 3PL relationship. This focuses on the activities, processes, and priorities that will be used to build and sustain the relationship.

- Step 6: Implementation and Continuous Improvement - The ongoing step of the process is to continuously monitor and evaluate performance, seek out improvement opportunities, and sustain a mutually beneficial, long-term relationship.

The ultimate goal of this six step process is to develop productive relationships between companies and 3PL service providers that create outstanding customer service and cost efficient operations. Like any relationships, both organizations must invest time and energy into its development and sustainment. Both parties must share information, trust their counterparts, and be open to new ideas and methods. The most successful, long term 3PL relationships occur when the organizations collaborate on a regular basis, adopt a team approach to problem solving, and leverage each other's capabilities.

## STRATEGIC NEEDS OF 3PL USERS

Although the industry is poised for future growth, 3PLs must prepare for future challenges and growing customer requirements. The continuous change taking place in supply chains and the ongoing need for improved service and relationships means that 3PLs cannot be complacent. Figure 12-7 highlights the capabilities needed by 3PLs to keep pace with the strategic needs of their customers.

Although the 3PLs bear primary responsibility for providing these capabilities, the customers must take an collaborative role in achieving maximum success. Among the most important needs of 3PL users are strategic innovation, technological strength, capacity access, talent availability, omni-channel agility, and sustainability expertise. Among the most important needs of 3PL users are strategic innovation, technological strength, capacity access, talent availability, omni-channel agility, and sustainability expertise.

- Strategic Innovation – to provide maximum value to the customer base, 3PLs must be innovative and collaborative in solutions development. Information sharing on changing requirements is essential for the two parties to understand the dynamics of the situation at hand. Then, the 3PL must have the willingness and capability to develop novel solutions. They also need to be more proactive in suggesting strategic solutions.

- Technological Strength – customers view technology as a critical capability of 3PL service providers to improve order management, cross-chain communication, enhance shipment visibility and event management, and manage day-to-day transportation operations. This need for strong, integrated technology capabilities from their service providers is essential for proactive control of freight as it moves across global supply chains.

- Capacity Access – when domestic and global economies are strong; the market for transportation services becomes very competitive. A solution to the capacity dilemma is to work with

3PL service providers such as freight forwarders and brokers that have ongoing relationships with multiple carriers. The combined volume of the 3PL's customer base can be leveraged for consistent access to much needed capacity at competitive rates.

- Talent Availability – at a time when SCM is gaining stature as a strategic driver of success, many organizations face a critical supply chain talent void due to years of headcount reduction, training budget cuts, and the retirement of highly skilled individuals. One way to address the talent crisis is to hire a 3PL with strong and stable talent. Top 3PLs have the strategic foresight to invest in training, development, and retention programs that help them maintain a strong pipeline of leaders who can diagnose customer needs, develop effective solutions, and manage the implementation process.

- Omni-channel Agility – the emergence of new distribution channels has created a much more complex working environment for transportation and logistics managers, particularly for retailers. These customers desire to work with 3PLs that can effectively handle a growing inventory base and e-commerce orders that vary in type, size, and delivery location. 3PLs must offer flexible solutions for rapidly moving inventory through these networks to customer and managing returns from customers.

- Sustainability Expertise – the execution of supply chain processes has a significant impact on the environment – delivery processes require heavy use refined oil products, generate carbon emissions, and contribute to congestion. 3PL users need to work with service providers that are committed to sustainable supply chain practices and have developed expertise over time.

To maintain pace with customers' future requirements, 3PLs will need to effectively expand their capabilities through internal growth, mergers, and strategic acquisition of competitors. As customers shift production from far away locations to nearby emerging markets where the cost of labor, shipping, and land is less expensive, 3PLs will need to establish a presence in these new regions. 3PLs will also need to enhance their breadth of capabilities and strategic services to serve customer desires for one stop shopping and lead logistics provider skills. Finally, 3PLs will need to be a driving force of transportation and logistics innovation to ensure that they can meet the cost-efficiency and service quality requirements of customers.

## MANAGING REVERSE FLOWS

## LEARNING OBJECTIVES

- Appreciate the importance of sustainable supply chains for the protection of the ecology of the planet.

- Understand how effective supply chain management can contribute to sustainability.

- Discuss why it is economically and politically important to manage supply chains as sustainably as possible.

- Appreciate why sustainability and social responsibility are the "new normal"

for managing supply chains.

- Understand the established frameworks for sustainable supply chains.

- Discuss the importance and challenges of reverse flows in supply chains.

- Understand why there has been a significant increase in the number and volume of items moving in reverse flows and supply chains.

- Explain the eight major categories of reverse flows and understand the three major forces that drive reverse supply chains.

- Discuss the differences between reverse logistics systems and closed-loop supply chains as well as value streams and waste streams for reverse logistics

## OVERVIEW

### Introduction

The description of a supply chain indicates that there are three important flows to manage: materials, information, and financials. Furthermore, the three flows can be two directional. Consequently, a number of terms including reverse logistics systems, product recovery systems, product return networks, enterprise returns management, and others have been used to indicate growth in the volume and importance of returns and the need for their efficient and effective management.

### Supply Chain Sustainability Framework

Supply chains are faced with a myriad of challenges to operate efficiently in ways that are also consistent with the objective of improving sustainability. The challenges range from global climate change to diminishing raw material resources and loss of habitat and species. There is a growing recognition of a universal need or mandate to address environmental actions among scientists, consumers, businesses, not-for-profit organizations and government agencies.

Production or operations functions include clean and lean production methodologies, designing for the environment, total quality environment management, and various product end-of-life practices. Transportation strategies can include mode selection (e.g., rail as opposed to truck), fuel sources, routing, scheduling to improve utilization, and so forth.

It is important to note that sustainability strategies are being designed today from a business-related or economic perspective as opposed to a public relations approach, as was frequently done in the past.

## Reverse Logistics Systems

Reverse flows can move back through the supply chain for a variety of reasons. Consequently, a number of terms including reverse logistics systems, product recovery systems, product return networks, enterprise returns management, and others have been used to indicate the growth in the volume and importance of returns and the need for their efficient and effective management.

Information and financials (cash) are also an important dimension of reverse logistics and closed-loop supply chains. Good information contributes to efficiency and effectiveness because it facilitates the flow through the supply chain and reduces uncertainty.

Global supply chains present challenges and opportunities for reverse flows. For example, European countries have been very proactive in passing so-called green laws, primarily for environmental reasons, e.g. requiring return of packaging materials. Complexity of global supply chains mandate a critical evaluation and analysis of the issues associated with global reverse flows.

## Importance and Magnitude of Reserve Flows

Reverse flows have been a part of logistics and supply chains for many years. Many additional traditional examples of reuse, recycling, etc. could be offered to make the case that reverse flows have been a part of the business operations of some companies for many years. The recent increased focus on reverse flows is attributable to the significant increase in the need for reverse flows. According to some experts, a large percentage of what is sold will be returned.

For analysis, the following eight categories of reverse flows are offered:

- Products that have failed; are unwanted, damaged, or defective; but can be repaired or remanufactured and resold

- Products that are old, obsolete, or near the end of their shelf life but still have some value for salvage or resale
- Products that are unsold from retailers, usually referred to as overstocks that have resale value
- Products being recalled due to a safety or quality defect that may be repaired or salvaged
- Products needing “pull and replace” repair before being put back in service
- Products that can be recycled such as pallets, containers, computer inkjet cartridges, etc.
- Products or parts that can be remanufactured and resold
- Scrap metal that can be recovered and used as a raw material for further manufacturing

## Reverse Logistics Systems versus Closed Loops

As indicated previously, many terms are used in describing the activities associated with managing reverse flows in a supply chain. Several of these terms are used more frequently and for the purposes of this text are defined as follows:

- Reverse logistics—The process of moving or transporting goods from their final destination for the purpose of capturing value or for proper disposal.

- Closed loop supply chains—Designed and managed to explicitly consider both forward and reverse flows activities in a supply chain.

While these two terms are sometimes used interchangeably as synonyms, they do have differences. Reverse logistics involves the processes for sending new or used products “back up stream” for repair, reuse, refurbishing, resale, recycling, or scrap/salvage. The items in a reverse logistics system are usually returned to a central location for processing.

The closed loop supply chain, on the other hand, is explicitly designed and managed for both flows. In the closed loop supply chain, the manufacturer is proactive in the processes, and the emphasis is on reducing cost and capturing value.

In contrast to closed loop supply chains, the reverse logistics process is frequently much more difficult to operate and/or it is harder to develop a viable value stream. For reverse logistics programs, the three major forces are customer returns, environmental issues, and economic benefits.

### Customer Returns

A variety of reasons for customer returns can be given, including defective or unwanted items, warranty problems, recalls, and mis-shipments. Given the potential magnitude of such returns, managing the product return process can have a substantial impact on a company's profit and loss statement.

### Environmental Challenges

Recycling and environmental concerns are frequently viewed simultaneously because of their association with regulatory policy at the local, state, and/or federal level. Social concerns stimulate the development of more environment-friendly products, new standards, and publicly provided recycling programs.

### Economic Value

In reverse logistics systems, as well as closed loop supply chains, economic benefits have become an important emphasis for businesses and even some nonprofit organizations. The potential for viewing reverse flows as a value stream as opposed to a waste stream was identified in a study published over 30 years ago and further amplified in a White Paper published by the Council of Logistics Management. Making reverse flows profitable, however, is a challenge as well as an opportunity. The mistake that is commonly made is the assumption that the processes are the same as forward flows and therefore the costs are the same.

## Achieving a Value Stream for Reverse Flows

The challenge indicated in the previous section of making certain that the proactive management of reverse flows represents an opportunity for enhancing profits through cost reduction and/or increased revenue is a consideration for both closed loop supply chains and reverse logistics systems.

Much of the additional cost is associated with the returns process. Time and distance are often the major cost contributors associated with capturing returns and their residual value. Interestingly, transportation expense is the largest cost component of reverse flows and frequently represents 25 percent or more of the total cost. Using transportation management tools and technology to improve and monitor the transportation network can lower this cost, through better scheduling of pickups and deliveries and/or consolidation of loads to achieve scale economies.

One of the major challenges is the estimation of the total cost of the return flow processes.

Some companies are using activity-based costing (ABC) as a tool to delineate the true costs associated with reverse flows. Accounting for the actual cost savings associated with the materials from reverse flows is important for the tradeoff analysis to determine the economic value added (or the lack thereof).

Once the evaluation for economic value has been completed, it is important to consider that the barriers may be internal or external and may including the following:

- Priority relative to other issues and potential projects or programs in the organization
- Inattention or lack of "buy-in" from top level management in the organization
- Financial resources necessary for operations and asset infrastructure
- Personnel resources required to develop and implement the reverse flows program
- Adequacy of material and information systems to support the returns program
- Local, state, and federal restrictions and/or regulations

The strategic and tactical issues identified earlier for making a reverse flows program a value stream, as opposed to a waste stream, have led some companies to consider a third-party logistics company once the potential program has been rationalized and economically justified. Since managing reverse flows may not be a "core competency" of an organization, it could be a natural candidate for outsourcing. Obviously, the economic value added of utilizing a 3PL has to be considered.

Total life cycle considerations (TLC) are figuring more prominently into reverse flows management programs and into the 3PL evaluation.

### Managing Reverse Flows in a Supply Chain

The effective and efficient management of reverse flows in a supply chain requires the careful consideration of a number of key activities or issues. The Reverse Logistics Educational Council has recommended careful consideration of the following:

- Avoidance—Producing high-quality products and developing processes to minimize or eliminate returns
- Gatekeeping—Checking and screening merchandise at the entry point into the reverse flows process to eliminate unnecessary returns or minimize handling
- Reducing reverse cycle times—Analyzing processes to enable and facilitate compression of time for returns to enhance value recapture
- Information systems—Developing effective information systems to improve product visibility, reduce uncertainty, and maximize economies of scale.
- Returns centers—Developing optimum locations and facility layouts for returns centers to facilitate network flow
- Remanufacture and/or refurbishment—Preparing and repairing a product for resale as is usually done in closed loop supply chains to maximize value recapture
- Asset recovery—Classifying and disposing of returned items, surplus, scrap, and obsolete items to maximize returns and minimize cost
- Pricing—Negotiating the best price for products being returned and resold
- Outsourcing—Considering a relationship with a third-party organization to handle and manage reverse flows in cases where existing personnel, infrastructure, experience, and/or capital may not be adequate to implement a successful program

- Zero returns—Developing a policy to exclude returns by giving a returns allowance and/or “destroying” the product in the field
- Financial management—Developing guidelines and financial procedures to properly account for charges against sales and related financial issues when items are returned by customers

## SUMMARY

- Sustainability has become an increasingly important objective for private-sector for-profit organizations in the twenty-first century.

- Initially organizations focused upon sustainability because of political and public pressure and their recognition of the importance of their social responsibility.

- In recent years there has been a growing recognition of the economic opportunity to reduce cost and improve profit positions.

- Sustainability is a challenging and complex issue because of the diversity of views on the topic, but some supply chain professionals have found it useful to consider sustainability on a broad functional basis—inbound functions, production and operation functions, and outbound or distribution functions.

- Transportation is frequently a critical part of a sustainability effort since it has the potential of leaving such a large carbon footprint. Various transportation strategies that are both cost efficient and ecologically sound can be used to mitigate this challenge.

- The so-called R’s of sustainability include: reuse, remanufacturing, refurbishing, and recycling. The R’s are unique but can be used in a comprehensive program where they are complimentary to each other.

- The R’s can be an important component of a recycling program to create a value stream for the organization to enhance profitability.

- Recycling is often part of a reverse flow logistics system or closed-loop logistics system, and both have grown in importance as reverse flow volumes have increased during the last two decades.

- The major forces impacting the growth in reverse flow volumes have been customer returns, environmental policies, and economic benefits for organizations.

- When designing an efficient and effective returns flow program, consideration must be given to the variety of the returns and the development of procedures and processes for each one.

- An analysis of the benefits of a reverse or return flows program is dependent upon the development of the true costs associated with such a program and comparing them to a realistic measure of the benefits.

# Overview

Overview of Transportation and logistics Management and its need.

# Overview

## Comparative GDP and Logistics Expenditures (billions of $, 1998)

| Region | Gross Domestic Product | Logistics Expenditure | Logistics % of GDP |
|---|---|---|---|
| North America | 8,495 | 915 | 10.8 |
| Europe | 7,981 | 941 | 11.8 |
| Pacific | 5,605 | 652 | 11.6 |
| Other | 7,080 | 916 | 12.9 |
| Total | 29,161 | 3,424 | 11.7 |

Source: D. Bowersox and R. Calantone, "Executive Insights: Global Statistics," *Journal of International Marketing*, Vol. 8, no. 4, 1998, pp 83-93.

# Overview

## Key Decision Areas

- Transportation
- Warehousing (and more generally, location)
- Packaging
- Material handling
- Logistics information systems

# Overview

## Key Decision Areas

- Logistics service providers
- Inventory

# What is Logistics Management

Process of planning, implementing and controlling the efficient, effective flow and storage of goods, …

# What is Logistics Management

services and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirement.

# What is Logistics Management

- Logistics management includes the design and administration of systems to control the flow of material, work-in-process, and finished inventory to support business strategy.

# What is Logistics Management

Transportation 1

Storage 2

Industrial packaging 3

Materials handling 4

Inventory control 5

Order fulfillment 6

Demand forecasting 7

Production planning & scheduling 8

Procurement 9

Customer service 10

Plant & warehouse site location 11

Others* 12

* Others include parts and service support, return goods handling, and salvage and scrap disposal.

# Objective of Logistics Management

- The overall objective is to achieve a targeted level of customer service at the lowest possible total cost.

# Objective of Logistics Management

- Logistics involves detailed and complex work and logistics managers are responsible for planning and administrating such activity.

# Objective of Logistics Management

## Logistics

### Manufacturing

- Length of the production run
- Available quantity of raw material and component
- Industrial packaging

### Marketing (4 Ps Marketing Mix)

- Price e.g. purchase quantity discounts
- Product e.g. size, shape, weight, packaging
- Promotion
- Place (distribution channel selection)

### Finance

- Inventory
- Warehouses & transportation fleet owned and/or outsourced
- Customer service

### Accounting

- Cost information for analysis of alternative logistics options
- Supply chain tradeoffs and performance measurement

# Objective of Logistics Management

| | |
|---|---|
| **Materials management vs. Physical distribution** | Examine logistics as inbound vs. outbound logistics. |
| **Cost Centers** | Examine logistics activities as cost centers, allowing tradeoffs between them to be analyzed. |
| **Nodes vs. Links** | Examine nodes (fixed spatial points where goods stop for storage or processing) vs. links (transportation network that connect the nodes in the logistics system). |
| **Logistics Channels** | Examine supply chain of network organizations engaged in transfer, storage, handling, communication, and other functions that contribute to product flow. |

# Logistical Competency

- Logistical competency involves the integration of information, transportation, inventory, warehousing, material handling and packaging.

# Logistical Competency

- Logistical competency requires a cross functional orchestration of logistical activity within  and beyond one firm, …

# Logistical Competency

e.g. Contemporary logistics which involves internal and external integration of the core competencies of an enterprise.

# Logistical Competency

- Purchasing departments are responsible for supplying (outsourcing) direct materials, which are core to a company's product offering (i.e., raw materials, parts, components, subassemblies, and machinery).

# Logistical Competency

- The purchasing departments are also responsible for outsourcing indirect materials required to operate a business.

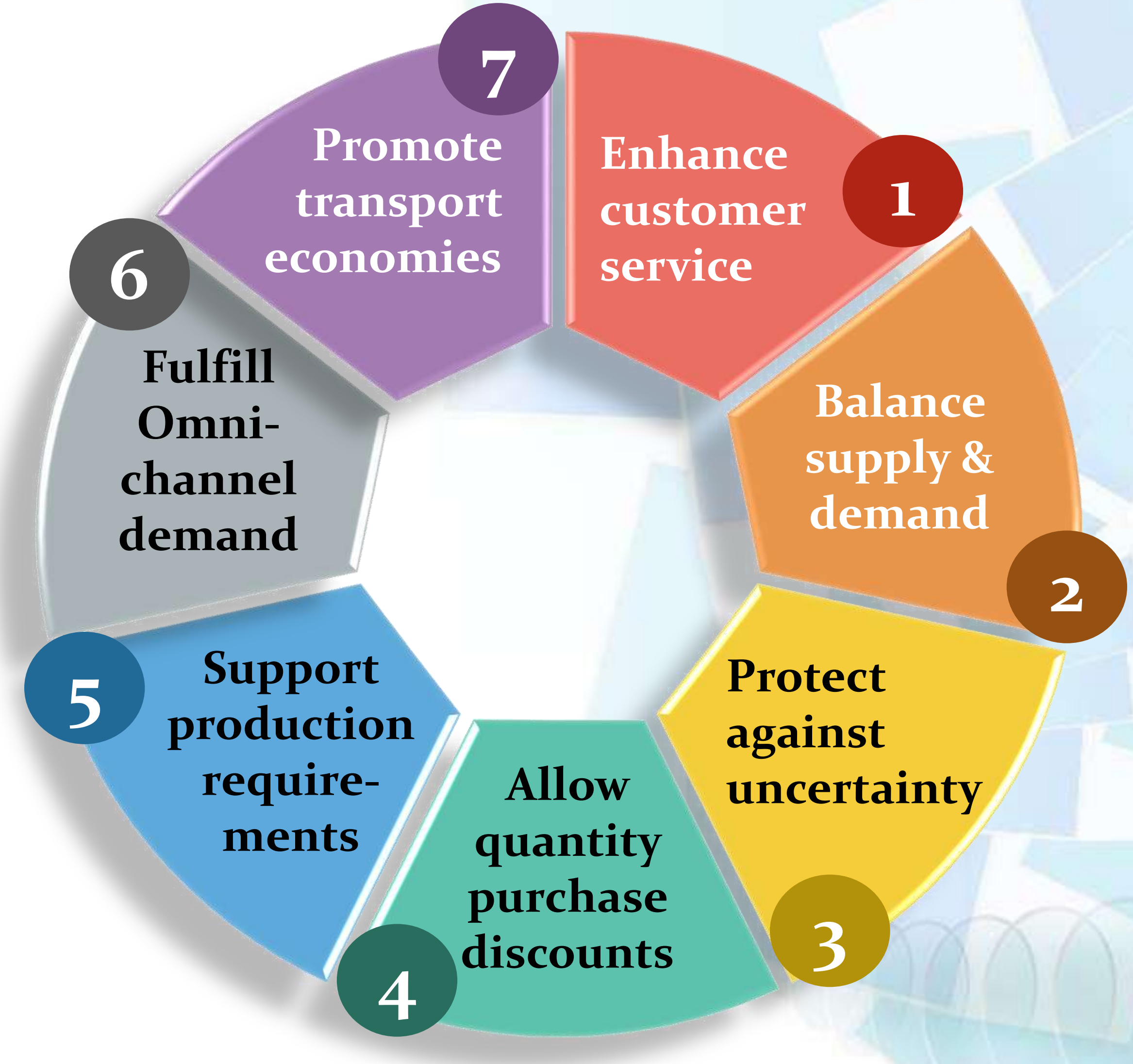
# Logistical Competency

The indirect materials include various office equipment and supplies; parts, materials, and tools for use in maintenance, repair, and operations (MRO).

# Logistical Mission

- Transportation, Warehousing, Information, Pricing, Inventory, Sourcing.
- Logistics of an enterprise is an integrated effort aimed at helping create customer value at the lowest total cost.

# Logistical Mission



1 Enhance customer service

2 Balance supply & demand

3 Protect against uncertainty

4 Allow quantity purchase discounts

5 Support production requirements

6 Fulfill Omni-channel demand

7 Promote transport economies

# Logistical Service Measurement

- Basic Logistical service is measured in terms of (1) availability, (2) operational performance, (3) service reliability.

# Logistical Service Measurement

- Availability means having inventory to consistently meet customer material or product requirement.

# Logistical Service Measurement

- Operational performance deals with the elapsed time from order receipt to delivery. It involves delivery speed and consistency.
- Service reliability involves the quality attributes of logistics.

# The Logistical Renaissance

- Prior to 1950s, no formal concept or theory of integrated logistics existed. Three factors were more important in evolution of contemporary logistics.

# The Logistical Renaissance

- Emerging information technology, economic necessity and quantification of reduced inventory costs through logistics.

# The Logistical Renaissance

- During the evolution of marketing, cross functional integration was not possible because of unavailability of computers and quantitative techniques.

# The Logistical Renaissance

- Volatile economic climate caused the untapped area of logistics to be neglected as pressure was on productivity improvement for profit maximization.

# The Logistical Renaissance

- Evolution of microprocessors and the usage of Electronic data interchange (EDI).
- Adoption of Total quality management (TQM).

# The Logistical Renaissance

- Logistical alliances were built around the competencies of specialized service firms that offered efficient operating systems to link buyers and sellers.

# Development Profile

- Mission of a logistical system is measured in terms of total cost and performance.
- Performance management is concerned with the availability of inventory, operational capability and quality of effort.

# Development Profile

- The key to effective logistical performance is to develop a balanced effort of service performance and total-cost expenditures.

# Logistical Operation Integration

- The work of logistics is functional in nature. Three primary operational areas are: physical distribution, manufacturing support and procurement.

# Logistical Operation Integration

- Logistical competency is achieved by coordinating 1) network design, 2) information, 3) transportation, 4) inventory, 5) warehousing 6) material handling and packaging.

# Logistical Operation Integration

- Location redesign. The case of Laura Ashley, UK based company with five major warehouses, eight principal carriers and ten unconnected management system.

# Importance of Logistical Information

- Benefits of Information sharing. Forecasting and order management are two areas of logistical work that depends on information.

# Importance of Logistical Information

- Wrong forecast causes wrong inventory positioning whereas inaccurate order processing information creates higher logistics cost.

# Importance of Logistical Information

- Control concepts such as just-in-time (JIT), quick response (QR), and continuous replenishment (CR). The basic goal is to achieve maximum turnover while satisfying customer commitments.

# Transportation

- Transportation is carried out in three basic ways: private, contract, and common carriage. Three factors are important: cost, speed and consistency.

# Transportation

- Consistency in transportation decreases inventory safety stock
- Speed and consistency combine to create a quality transportation service.

# Inventory

- Five aspects of selective deployment: customer segmentation, product requirements, transport integration, time-based requirements, and competitive performance.

# Inventory

- 80/20 rule
- (R,Q) policy or (s,S) policy?

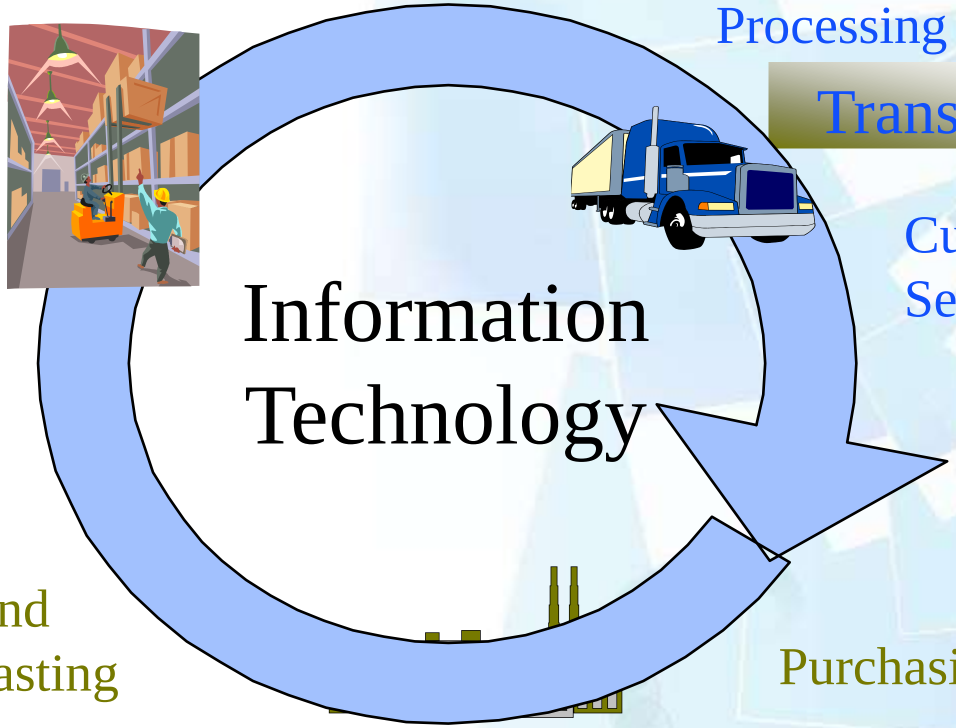
# A Case study

- Hewlett-Packard (HP), Time postponement

# Logistical Integration

- Integration depends on product nature.

# Logistical Integration



**Warehousing**

Inventory

Materials Handling

Industrial Packaging

Distribution Planning

Order Processing

**Transportation**

Customer Service

Information Technology

Demand Forecasting

Production Planning

Requirements Planning

Purchasing

Manufacturing Inventory

# Logistical Integration

- A seamless functional integration

# Integrated Logistics

- Procurement performance cycle, Manufacturing support performance cycle, Physical distribution performance cycle.

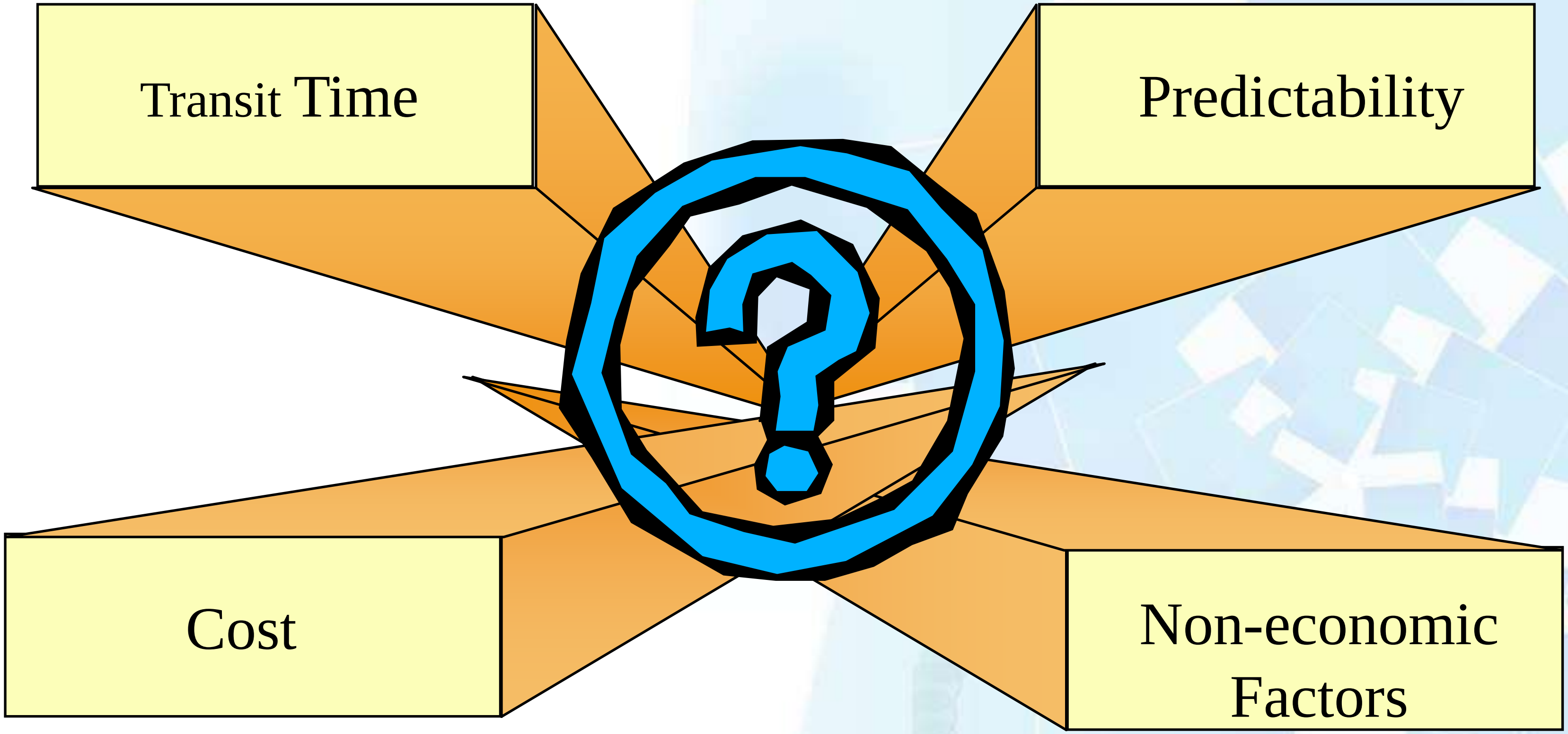
# Integrated Logistics

- Firm needs to achieve at least six different operational objectives which are the primary determinants of logistical performance.

# Integrated Logistics

- Rapid response
- Minimum variance
- Minimum inventory
- Movement consolidation
- Quality attribute
- Life Cycle Support

# Operational objectives Framework



Transit Time

Predictability

Cost

Non-economic Factors

# Operational Objectives

- Rapid response is concerned with a firm's ability to satisfy customer service requirements in timely manner.

# Operational Objectives

- Minimum variance is about establishing a tradeoff between safety stock inventory or use of high-cost premium transportation.

# Operational Objectives

- Minimum inventory involves reducing inventory deployment like zero inventory and maximizing rate of inventory usage over time (Turn velocity)…

# Operational Objectives

and total commitment is the financial value of inventory deployed though out the logistical system.

# Operational objectives

- Movement consolidation is a tradeoff between premium transportation and consolidated transportation.

# Operational objectives

- Achieving continuous quality improvement and life cycle support such as reversing the value added flow to the end customers, i.e. product recall and reverse logistics.

# Operational objectives

- Cradle-to-cradle logistical support.
- Logistical performance cycle is based on base stock policy and safety stock.
- Measured in terms of system output, efficiency and effectiveness

# Physical distribution performance cycle

- Physical distribution performance cycle is integral to marketing and sales.
- Timely and economical product availability.

# Physical distribution performance cycle

- Five activities order transmission, order processing, order selection, order transportation and delivery.

# Physical distribution performance cycle

- The conflictive interface of marketing and manufacturing is resolved by flexibility.
- Manufacturing support performance cycle is about production logistics.

# Physical distribution performance cycle

- Operational consistency to manage uncertainty.

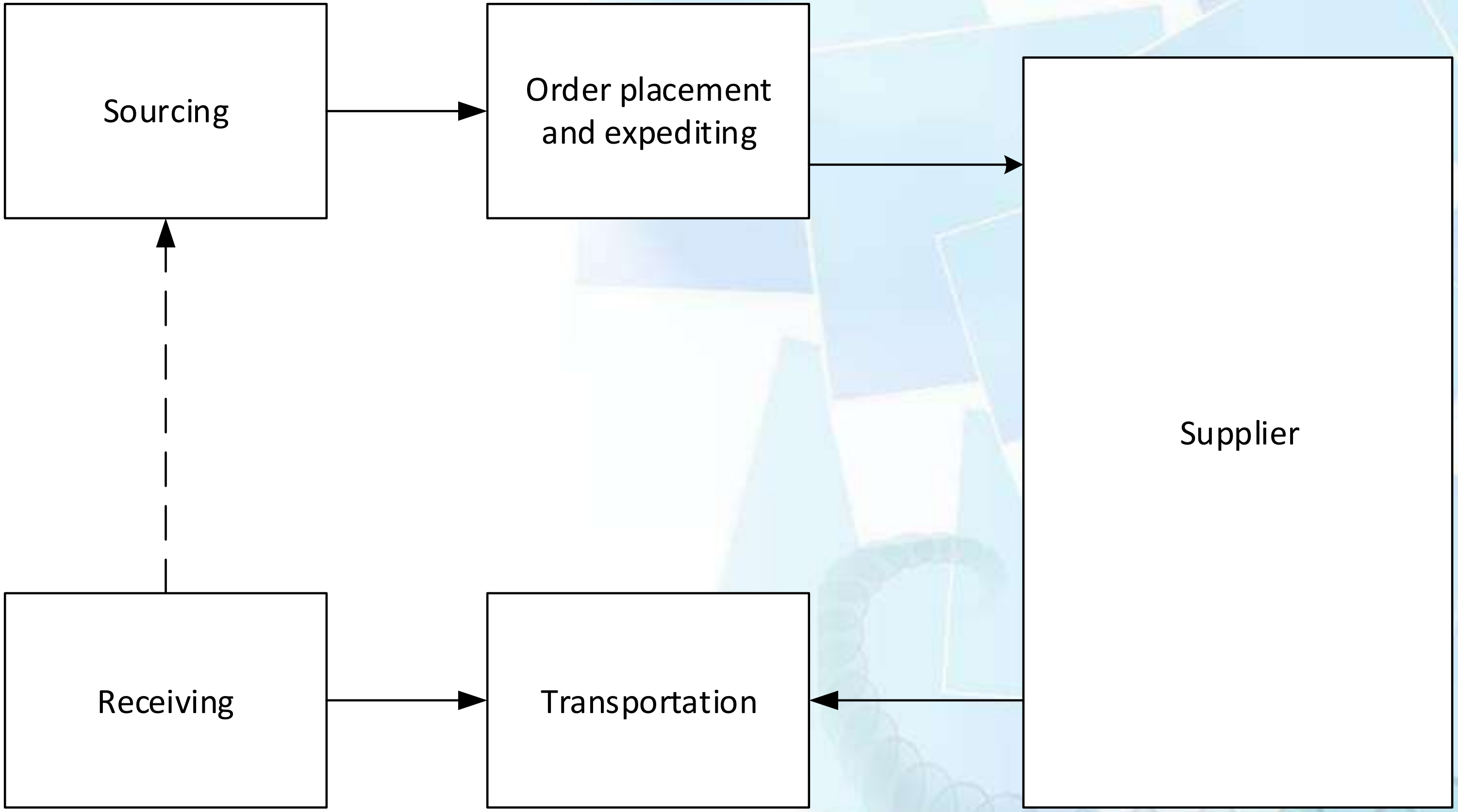
# Procurement Performance Cycle

- Orderly flow of materials, parts or finished inventory into a manufacturing or distribution complex.

# Procurement Performance Cycle

- Three important differences from customer order processing cycle.
- Delivery time, size of shipment and method of transport.

# Procurement Performance Cycle



Sourcing

Order placement and expediting

Supplier

Receiving

Transportation

# Procurement Performance Cycle

- Number of suppliers are typically less than customer base.

# Manufacturing Support Performance Cycle

- No behavioral uncertainty as it is typically captive to a firm.
- Even for contract manufacturing to augment internal capacity, overall control is greater…

# Manufacturing Support Performance Cycle

Other two performance cycles.

Manufacturing support operations, as contrasted to either physical distribution or procurement are limited to movement under internal management control.

# Manufacturing Support Performance Cycle

- When a firm has multiple specialized production activities, manufacturing support system may require vast network of performance cycles.
- Logistics operations are limited to dock-to-dock movement…

# Manufacturing Support Performance Cycle

- Within the firm and any intermediate storage required.

# Managing Operational Uncertainty

- Major objective of logistics management is to reduce performance-cycle uncertainty.
- Magnitude of variance is high  for finished goods and inventory delivery.

# Managing Operational Uncertainty

- Time distributions reflect the statistical history related to performance of each work task.
- Minimum and maximum time required and resulting tome distribution is important

# Managing Operational Uncertainty

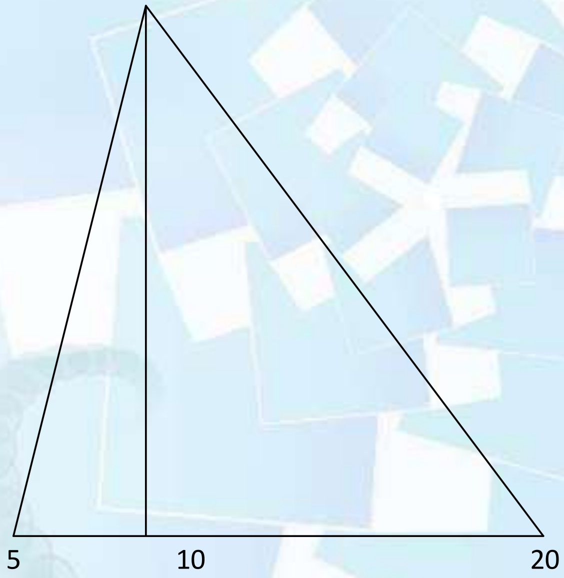
- Time and variance related to order processing are a function of workload, degree of automation and policies related to order approval.

# Managing Operational Uncertainty

- Order selection, speed and associated delays are directly related to capacity, material handling and human resource availability.
- The goal is to conform to expected or standard time.

# Managing Operational Uncertainty

- Triangular distributions are more acceptable.



# Customer Focused Marketing

- How does logistics fit into overall objective of customer focused marketing?
- Logistical competency is a strategic resource that supports product life cycle.

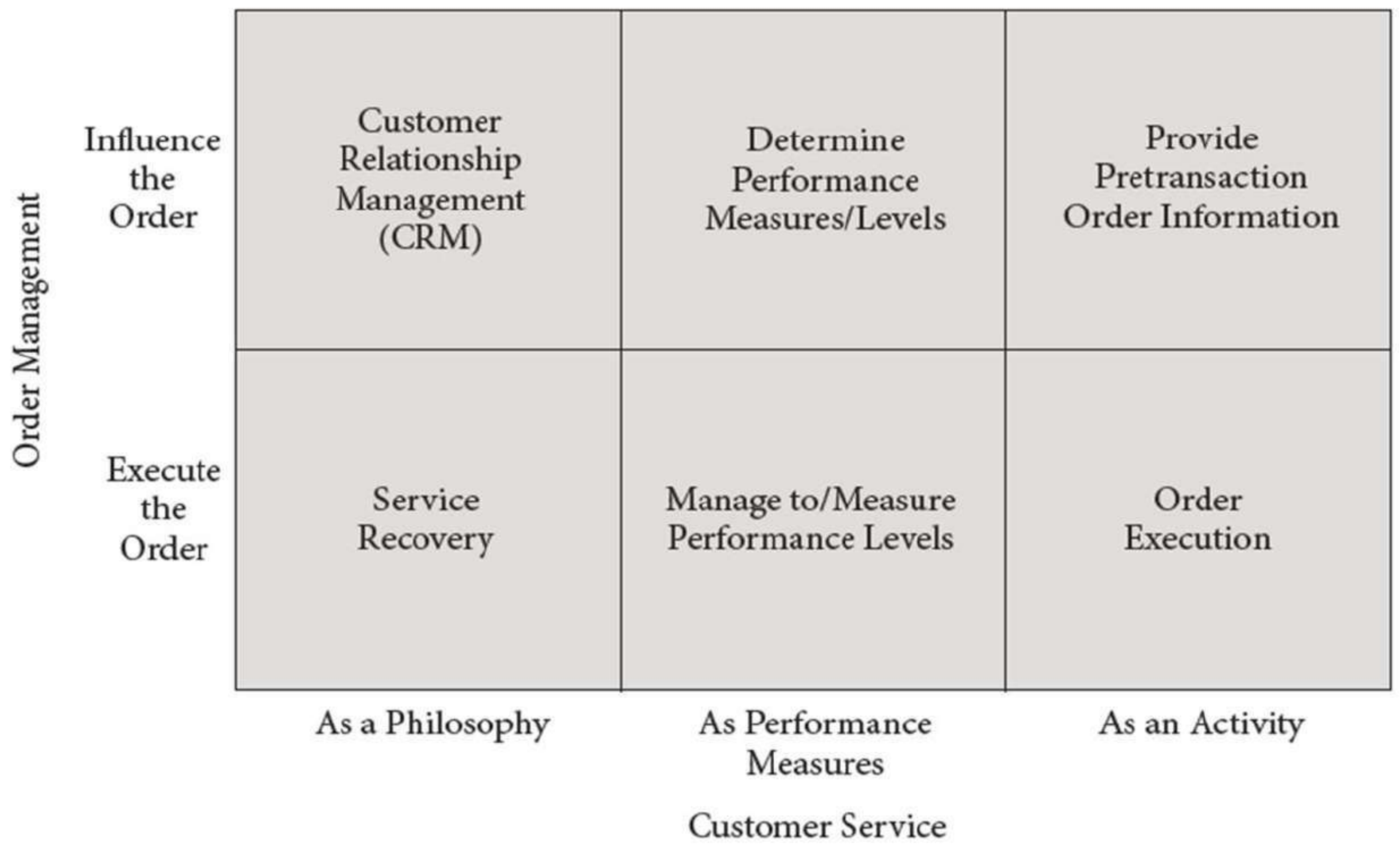
# Customer Focused Marketing

- Basic customer service is measured in terms of availability, performance, and reliability.
- Firms’ continued commitment to high-quality basic customer service.

# Customer Focused Marketing

- Anything that touches the customer. This includes all activities that impact information flow, product flow, and cash flow between the organization and its customers.

# Customer Focused Marketing



| Order Management | As a Philosophy | As Performance Measures | As an Activity |
|---|---|---|---|
| Influence the Order | Customer Relationship Management (CRM) | Determine Performance Measures/Levels | Provide Pretransaction Order Information |
| Execute the Order | Service Recovery | Manage to/Measure Performance Levels | Order Execution |

Customer Service

# Customer Focused Marketing

- Influence the customers though logistical competency.

# The Marketing Concept

- Advocates the identification of specific customer needs and then responds to those needs by focusing available resources to uniquely satisfying those customer requirements.

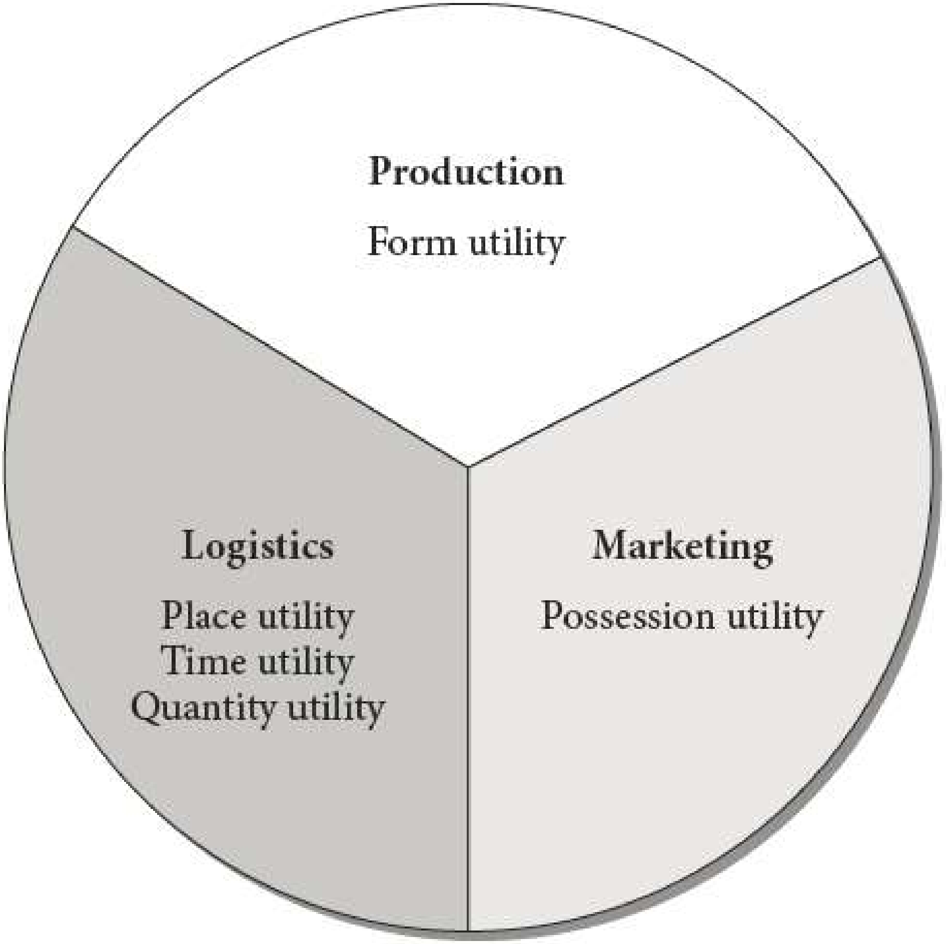
# The Marketing Concept

- Three fundamental ideas: customer needs are more basic than products or services, products or services become meaningful only when available and positioned from customer’s perspective.

# The Marketing Concept

- Five economic utilities add product or service value to customers: form, possession, quantity time and place.
- Form Utility
- Time Utility
- Place Utility
- Quantity Utility
- Possession Utility

# The Marketing Concept



# The Marketing Concept

- Stresses on profitability as contrasted to sales volume.

# Logistics as a core strategic competency

- Effective mix strategy is to integrate resources committed to generic marketing activities into an effort that maximizes customer impact.

# Logistics as a core strategic competency

- Impact needs not to be passive.
- Logistical competency is a tangible way to attract customers that place a premium on time and place related performance.

# Logistics as a core strategic competency

- Wal-Mart the best practices in terms of distribution and transportation.

# Customer Relationship Management

- Is the art and science of strategically positioning customers to improve the profitability of the organization and enhance its relationships with its customer base.

# Customer Relationship Management

- Has not been widely used in the business-to business environment until lately.
- Why did manufacturers and distributers not used CRM?

# Customer Relationship Management

Customer action affects firm’s cost

- how customers order
- how much customers order
- what customers order
- when customers order an order

# How to influence order?

- Step 1: Segment the Customer Base by Profitability.
- Most firms allocate direct materials, labor, and overhead costs to customers using a single allocation criterion. However, firms today are beginning to use techniques such as activity-based costing.

# How to influence order?

- Step 2: Identify the Product/Service Package for Each Customer Segment.
- The challenge here is how to “package” the value-adding products and services for each customer segment. One solution is to offer the same product/service offering to each customer segment…

# How to influence order?

- while varying the product quality or service levels. Another solution to this part of the CRM process is to vary the service offerings for each customer segment.

# How to influence order?

- Step 3: Develop and Execute the Best Processes.
- Organizations many times go through elaborate processes to determine customer needs and set target performance levels, only to fail when it comes to executing on those customer promises

# How to influence order?

- Step 4: Measure Performance and Continuously Improve.
- Once the CRM program has been implemented, it must be evaluated to determine….

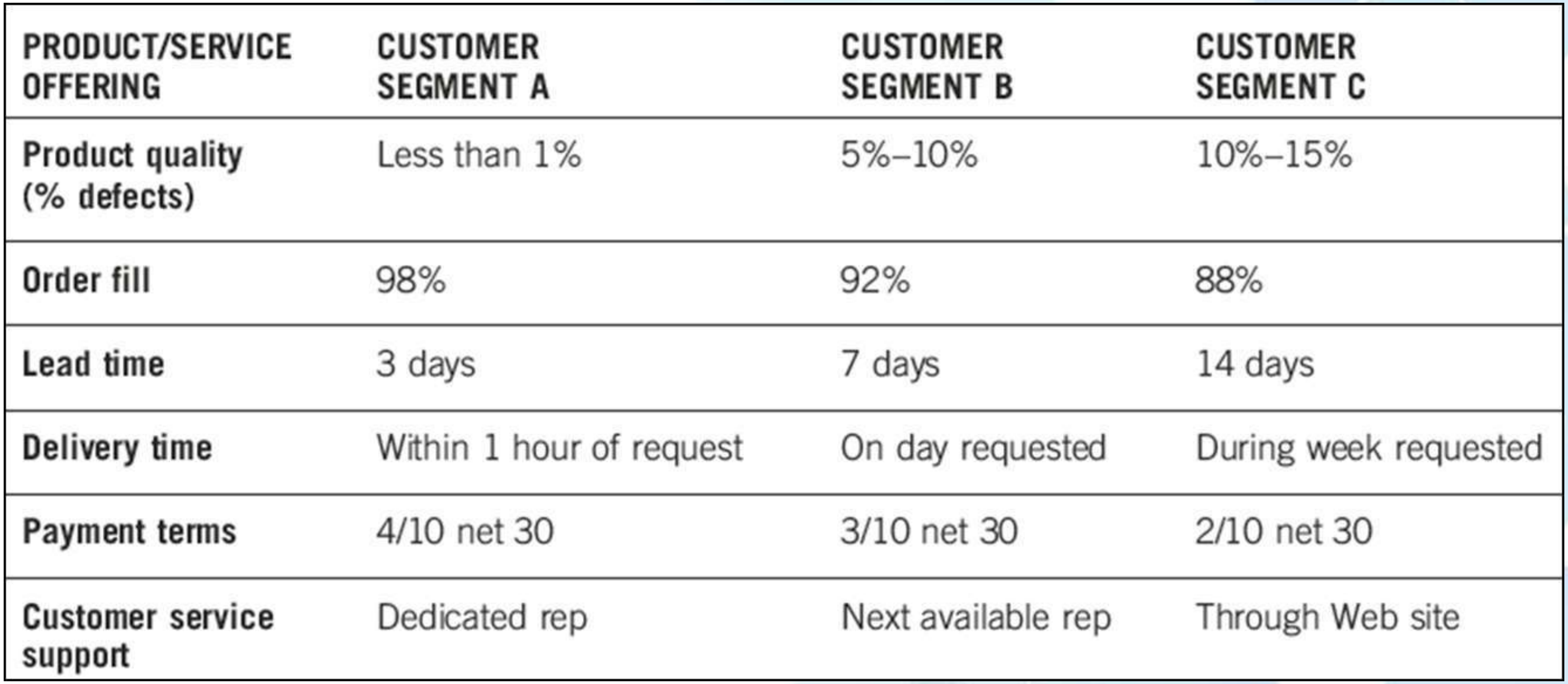
# How to influence order?

- if (1) the different customer segments are satisfied and (2) the supplier’s overall profitability has improved.

# Customer Profitability

- Example

# Customer Profitability



| PRODUCT/SERVICE OFFERING | CUSTOMER SEGMENT A | CUSTOMER SEGMENT B | CUSTOMER SEGMENT C |
|---|---|---|---|
| **Product quality (% defects)** | Less than 1% | 5%–10% | 10%–15% |
| **Order fill** | 98% | 92% | 88% |
| **Lead time** | 3 days | 7 days | 14 days |
| **Delivery time** | Within 1 hour of request | On day requested | During week requested |
| **Payment terms** | 4/10 net 30 | 3/10 net 30 | 2/10 net 30 |
| **Customer service support** | Dedicated rep | Next available rep | Through Web site |

# Customer Profitability

- Protect Zone
- Those customers who fall into the “Protect” segment are the most profitable.

# Customer Profitability

- Danger Zone
- Customers in the “Danger Zone” segment are the least profitable and incur a loss.
- The firm has three alternatives for danger zone customers….

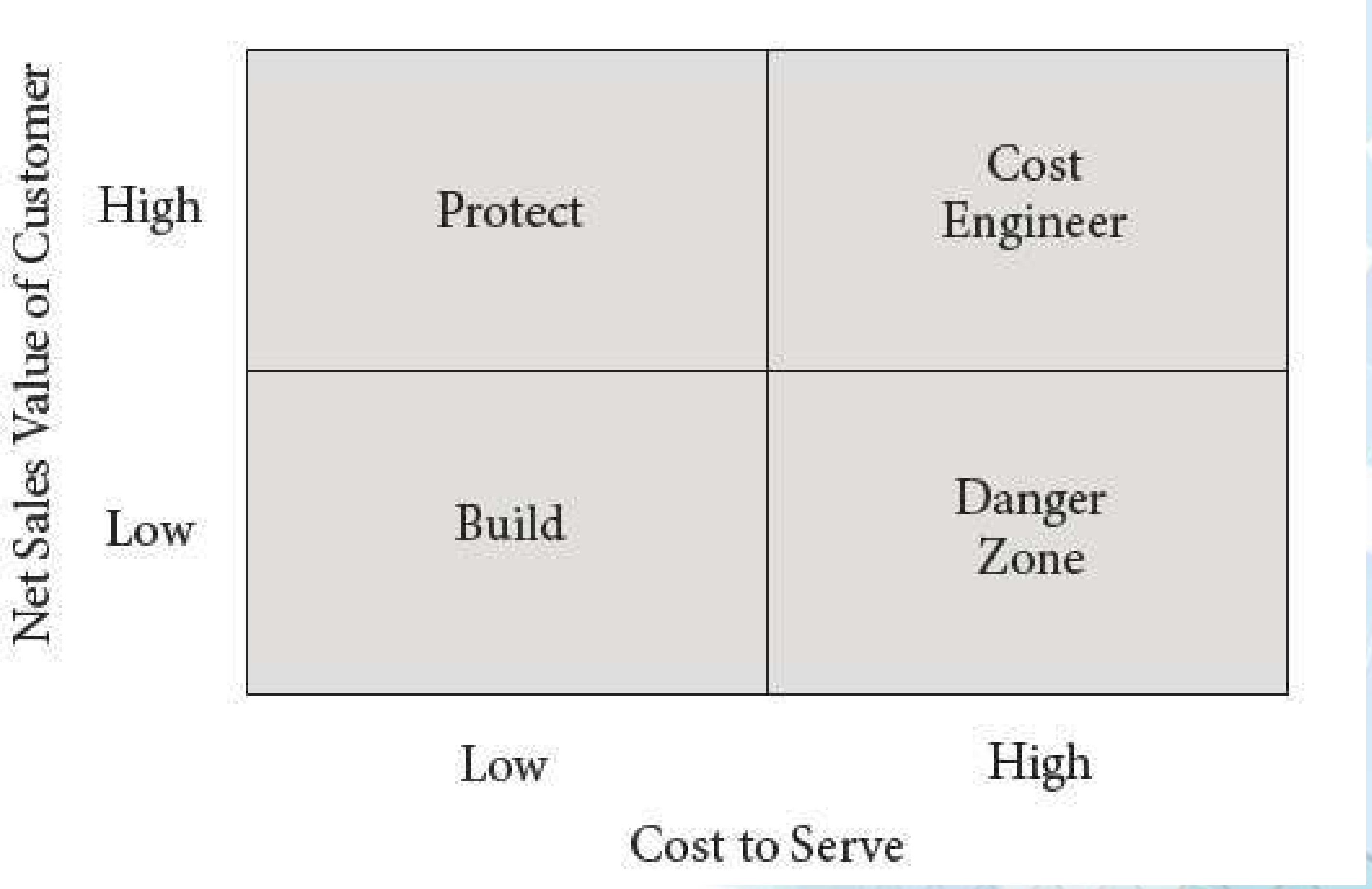
# Customer Profitability

- Change customer interaction with firm so the customer can move to another segment
- charge the customer the actual cost of doing business
- switch the customer to an alternative distribution channel

# Customer Profitability

- Build Zone
- These customers have a low cost to serve and a low net sales value, so the firm should maintain the cost to serve and build net sales value to help drive the customer into the “Protect” segment.

# Customer Profitability



# Customer Profitability

- “Cost Engineer” segment have a high net sales value and a high cost to serve

# Executing the Order

- Order cycle
- All activities that occur from when an order is received until the product is received.

# Executing the Order

- Replenishment cycle
- Refers to acquisition of additional inventory
- One firm's order cycle is another's replenishment cycle

# Executing the Order

- When referring to outbound-to-customer shipments, the term order to cash (or order cycle) is typically used…

# Executing the Order

- The term replenishment cycle is used more frequently when referring to the acquisition of additional inventory, as in materials management.

# Order-to-Cash (OTC) Cycles

- Thirteen principle activities constitute the OTC cycle:
- 1) Process Inquiry and Quote. This step in the process precedes the actual placement of the order by the customer.

# Order-to-Cash (OTC) Cycles

- 2) Receive, Enter, and Validate Order. This step involves the placement and receipt of the order.

# Order-to-Cash (OTC) Cycles

- 3) Reserve Inventory and Determine Delivery Date. This step in the process has traditionally been referred to as order processing. In the case where the seller has inventory to fill the order, the delivery date is based on the concept of available to deliver (ATD).

# Order-to-Cash (OTC) Cycles

- If the seller does not have the inventory but knows when it will be produced internally or delivered from a supplier to the seller’s distribution centers, the delivery date is based on the concept of available to promise (ATP).

# Order-to-Cash (OTC) Cycles

- 4) Consolidate Orders. This step examines customer orders to determine opportunities for both freight consolidation as well as…

# Order-to-Cash (OTC) Cycles

- for batch warehouse picking schedules. Both of these consolidation opportunities offer cost efficiencies for the seller.

# Order-to-Cash (OTC) Cycles

- 5) Plan and Build Loads. This step takes the freight consolidation opportunities identified in 4) and the delivery date given in 3) and develops a transportation plan.

# Order-to-Cash (OTC) Cycles

- 6) Route Shipments. This step can follow or be concurrent with 5) Here, the “load” (usually a transportation vehicle) is assigned to a specific route for delivery to the customer.

# Order-to-Cash (OTC) Cycles

- 7) Select Carriers and Rate Shipments.
- 8) Receive Product at Warehouse. This step gains importance when an ATP has been given to a customer’s order. In this step, product is received at the distribution center…

# Order-to-Cash (OTC) Cycles

- and the order management system is checked to see if there are any orders outstanding that need this particular product.

# Order-to-Cash (OTC) Cycles

- 9) Pick Product. This step uses the outputs from 3), 4), and 5) to determine the order picking schedules in the distribution center.

# Order-to-Cash (OTC) Cycles

- 10) Load Vehicle, Generate Shipping Documents, Verify Credit, and Ship.
- 11) Receive and Verify Product at Customer Site

# Order-to-Cash (OTC) Cycles

- 12) : Install Product. If an order involves a product that must be installed at the customer location, it is at this point in the OTC cycle where installation takes place.

# Order-to-Cash (OTC) Cycles

- 13) Invoice. This step is the culmination of the OTC cycle for the buyer and seller.

# Basic service capability : Availability

- The capacity to have inventory when it is desired by a customer.
- Different stocking strategies for different items.

# Basic service capability : Availability

- Two groups of inventory: base stock determined by forecast to support basic availability and safety stock to cover demand that exceeds forecast.

# Basic service capability : Availability

- Many firms use back up warehouses which are less efficient and operational.

# Basic service capability : Availability

- Stock-out frequency is the probability that a stock-out will occur.
- It measures how many times demand for a specific product exceeds availability.

# Basic service capability : Availability

- Fill rate measures the magnitude or impact of stock-outs over time.
- Typical measure of customer service level.

# Basic service capability : Availability

- Frequent replenishment orders of small quantities increases stock-out frequency and decreases fill rate.
- Inversely related to each other.

# Activity Based Costing

- ABC measures the cost and performance of activities, resources, and cost objects. Resources are assigned to activities, then activities are assigned to cost objects based on their use.

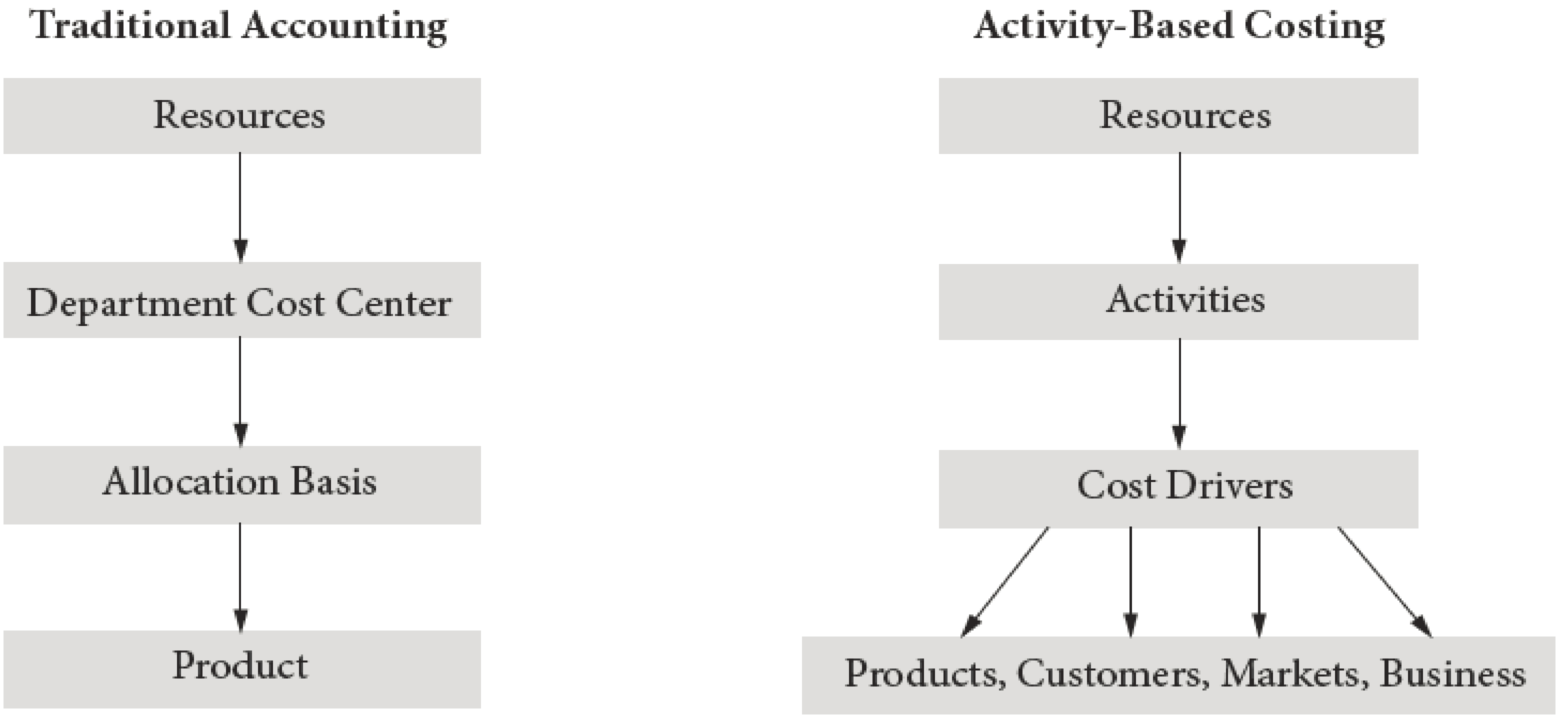
# Activity Based Costing

- Traditional cost accounting is well suited to situations where an output and an allocation process are highly correlated.

# Activity Based Costing

- Traditional cost accounting is not very effective in situations where the output is not correlated with the allocation base.

# Activity Based Costing



Traditional Accounting

Resources

Department Cost Center

Allocation Basis

Product

Activity-Based Costing

Resources

Activities

Cost Drivers

Products, Customers, Markets, Business

- Accounting Cost <> Actual Cost
- Cost pools mirror organization chart
- Sometimes little correlation between allocation bases and consumption
- Some costs driven to incorrect level

- Accounting Cost = Actual Cost
- Cross-functional
- Drivers trigger resources consumption
- Drives costs to appropriate level

# Activity Based Costing

- Traditional customer profitability analyses would start with gross sales less returns and allowances (net sales) and subtract the cost of goods sold to arrive at a gross margin figure…

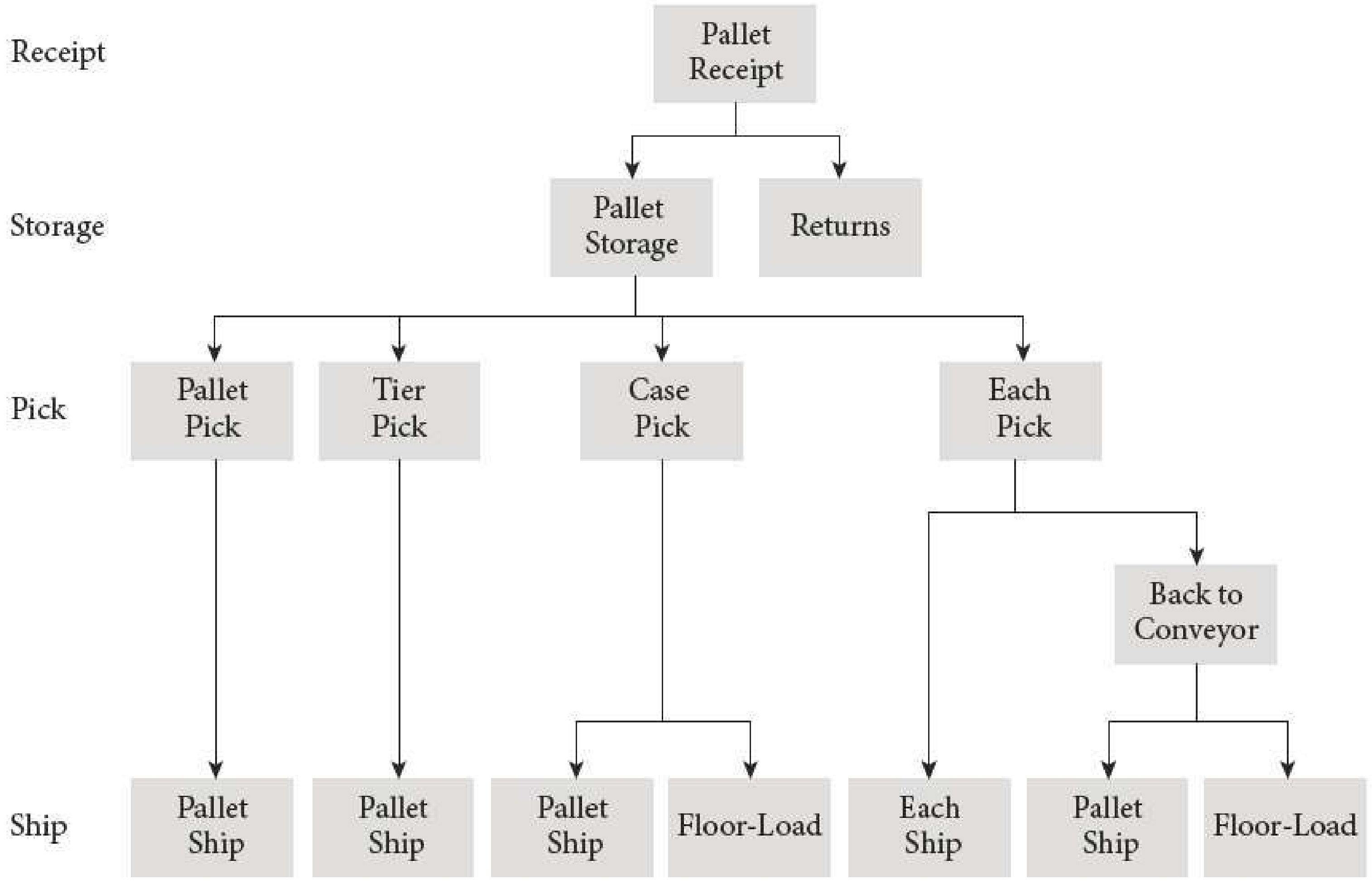
# Activity Based Costing

- Although this number might provide a general guideline for the profitability of a customer, it falls short on capturing the real costs of serving a customer.

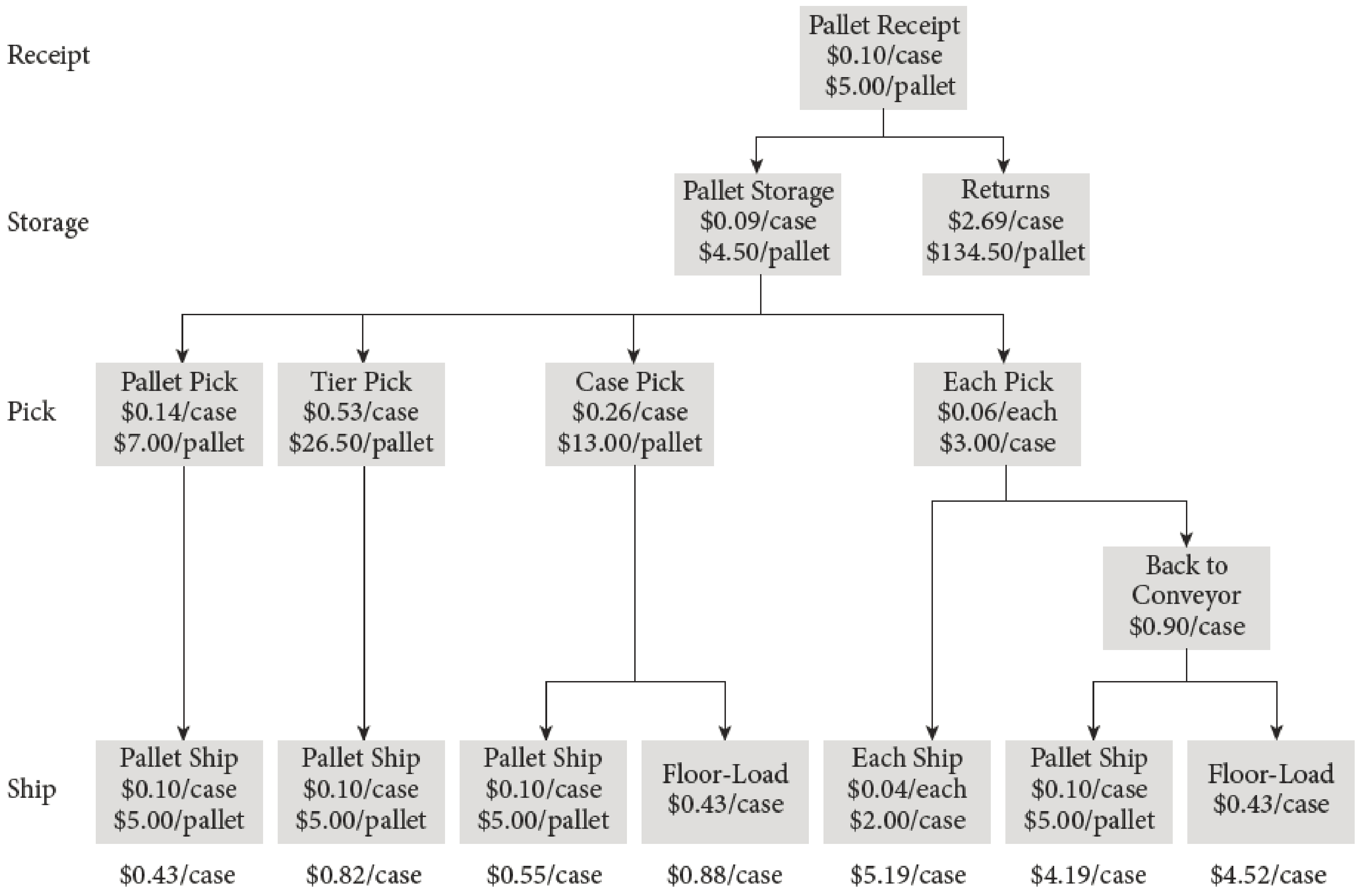
# Activity Based Costing: Example

- How to do it?

# Activity Based Costing: Example



# Activity Based Costing: Example



Receipt

Pallet Receipt
$0.10/case
$5.00/pallet

Storage

Pallet Storage
$0.09/case
$4.50/pallet

Returns
$2.69/case
$134.50/pallet

Pick

Pallet Pick
$0.14/case
$7.00/pallet

Tier Pick
$0.53/case
$26.50/pallet

Case Pick
$0.26/case
$13.00/pallet

Each Pick
$0.06/each
$3.00/case

Back to Conveyor
$0.90/case

Ship

Pallet Ship
$0.10/case
$5.00/pallet

Pallet Ship
$0.10/case
$5.00/pallet

Pallet Ship
$0.10/case
$5.00/pallet

Floor-Load
$0.43/case

Each Ship
$0.04/each
$2.00/case

Pallet Ship
$0.10/case
$5.00/pallet

Floor-Load
$0.43/case

$0.43/case
$0.82/case
$0.55/case
$0.88/case
$5.19/case
$4.19/case
$4.52/case

# Activity Based Costing: Example

- Resource- activity- cost.

# Channel Structure

- American Marketing Association defines distribution channel as the structure of intracompany organizational units and extra-company agents and dealers, wholesale and retail…

# Channel Structure

- Through which a commodity, product, or service is marketed.
- A group of business that take the ownership…

# Channel Structure

- Title to products or facilitate exchange during the marketing process from original owner to final buyer.
- Three marketing functions are performed by distribution function…

# Channel Structure

| Group | Function |
|---|---|
| Exchange | Selling |
| | Buying |
| Logistics | Transportation |
| | Storage |
| Facilitation | Financing |
| | Standardization |
| | Market Information |
| | Risk bearing |

# Market-Distribution Strategy

- 1) Number of levels present in the channel
- Channel length
- “Direct Vs indirect”

2) Number of intermediaries at each level

- Intensive
- Exclusive
- selective

# Market-Distribution Strategy

3) Types of intermediaries at each level

- agents/merchants
- specialized/general
- wholesalers/retailers

# Market-Distribution Strategy

A channel map is a picture of current channels used to reach all end-user segments. Completing a channel map requires:

1. Identification of all end-user segments served.

# Market-Distribution Strategy

2. Isolating the paths used to reach each segment.
3. Specifying the functions/processes performed in each path.

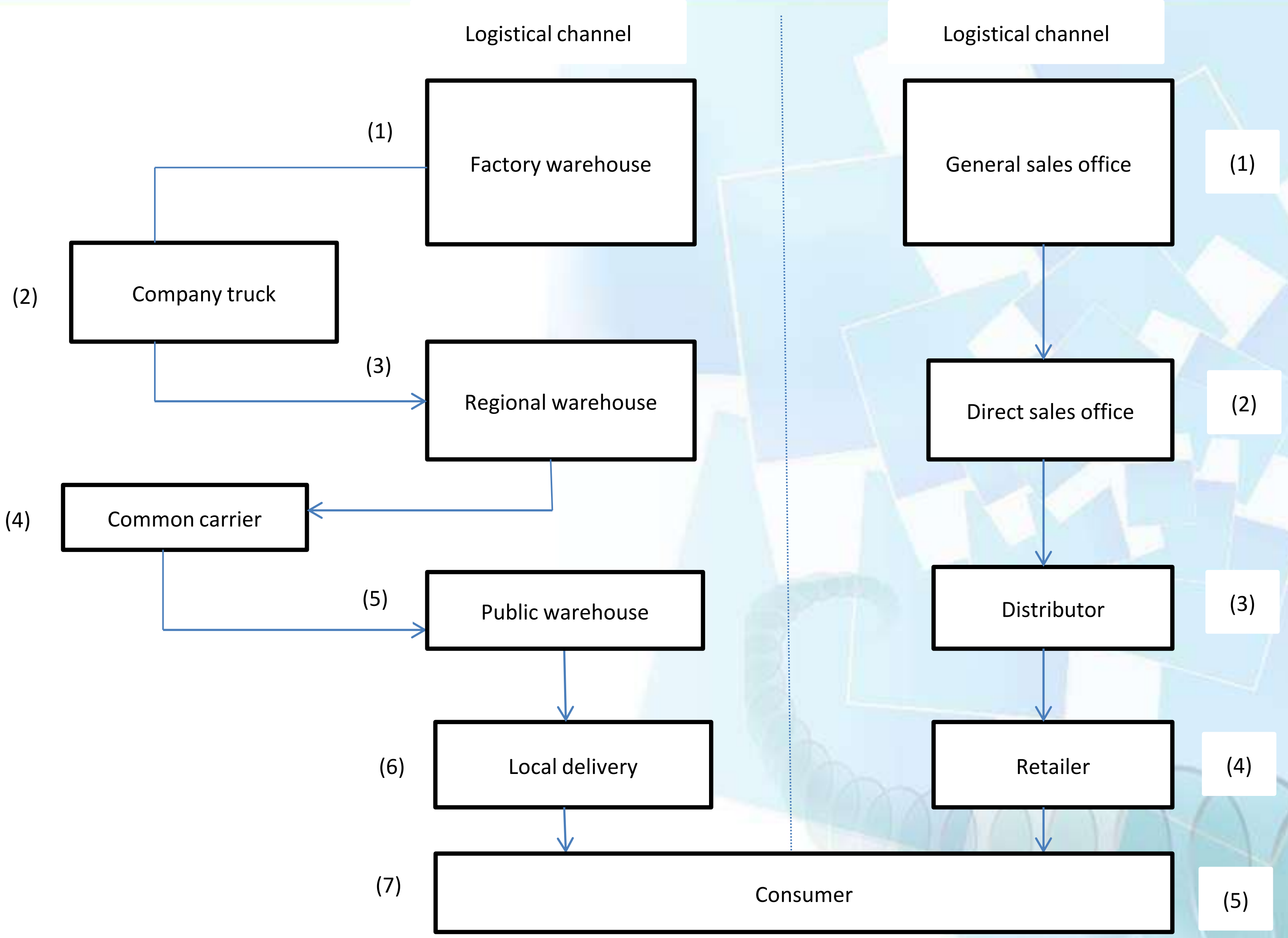
# Market-Distribution Strategy

4. Specifying how the functions/processes are performed by the firm and external organizations.

# Market-Distribution Strategy

5. Specifying the economics at each stage in each path (volumes, revenues, margins, discounts, costs)

# Market-Distribution Strategy



Logistical channel

(1) Factory warehouse

(2) Company truck

(3) Regional warehouse

(4) Common carrier

(5) Public warehouse

(6) Local delivery

(7) Consumer

Logistical channel

General sales office (1)

Direct sales office (2)

Distributor (3)

Retailer (4)

Consumer (5)

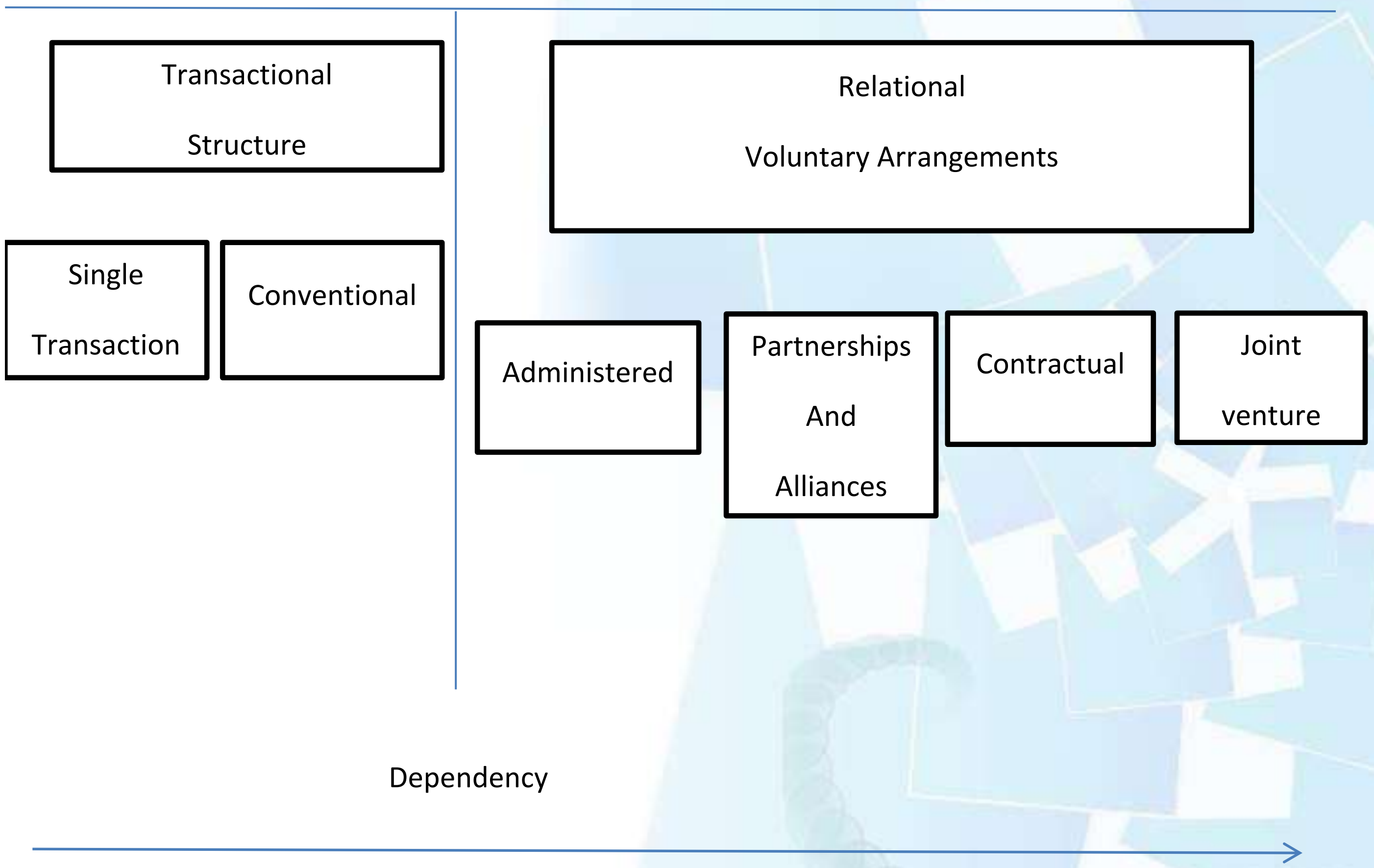
# Market-Distribution Strategy

- Tasks to be performed drive appropriate structure, not the other way around

# Classification of Channel Relationships

Based on acknowledged dependency.

# Classification of Channel Relationships



Transactional

Structure

Single

Transaction

Conventional

Relational

Voluntary Arrangements

Administered

Partnerships

And

Alliances

Contractual

Joint

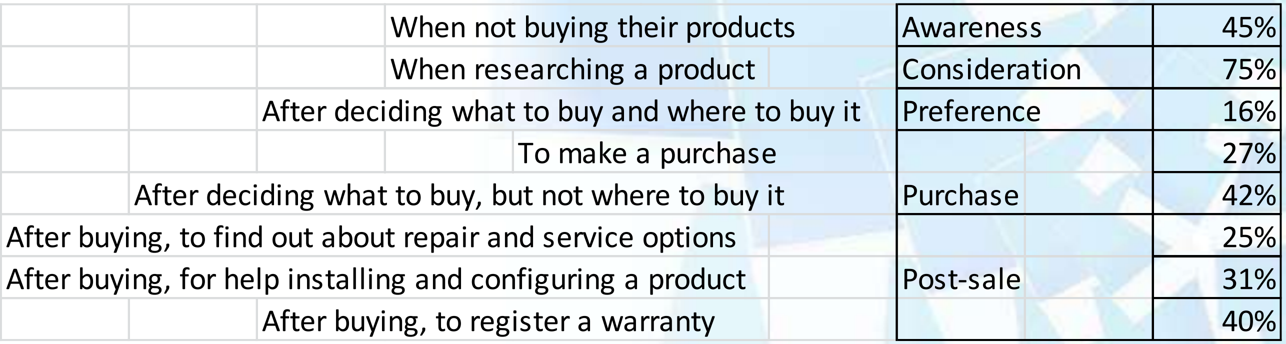
venture

Dependency

Increased formalization, information-sharing and connectivity

# Classification of Channel Relationships

**“When in the purchase process are you likely to visit a manufacturer’s web site.”**



| | | |
|---|---|---|
| When not buying their products | Awareness | 45% |
| When researching a product | Consideration | 75% |
| After deciding what to buy and where to buy it | Preference | 16% |
| To make a purchase | Purchase | 27% |
| After deciding what to buy, but not where to buy it | | 42% |
| After buying, to find out about repair and service options | Post-sale | 25% |
| After buying, for help installing and configuring a product | | 31% |
| After buying, to register a warranty | | 40% |

# Classification of Channel Relationships

- **Empowered consumers Look At Manufacturers as Retailers.**

# Classification of Channel Relationships

- Specialization is a fundamental driver of distribution efficiency.
- Some businesses can introduce economies because they perform some function better….

# Classification of Channel Relationships

- The logic of specialization is based on economies of scale and scope.
- Assortment is more efficiently achieved through specialization.

# Classification of Channel Relationships

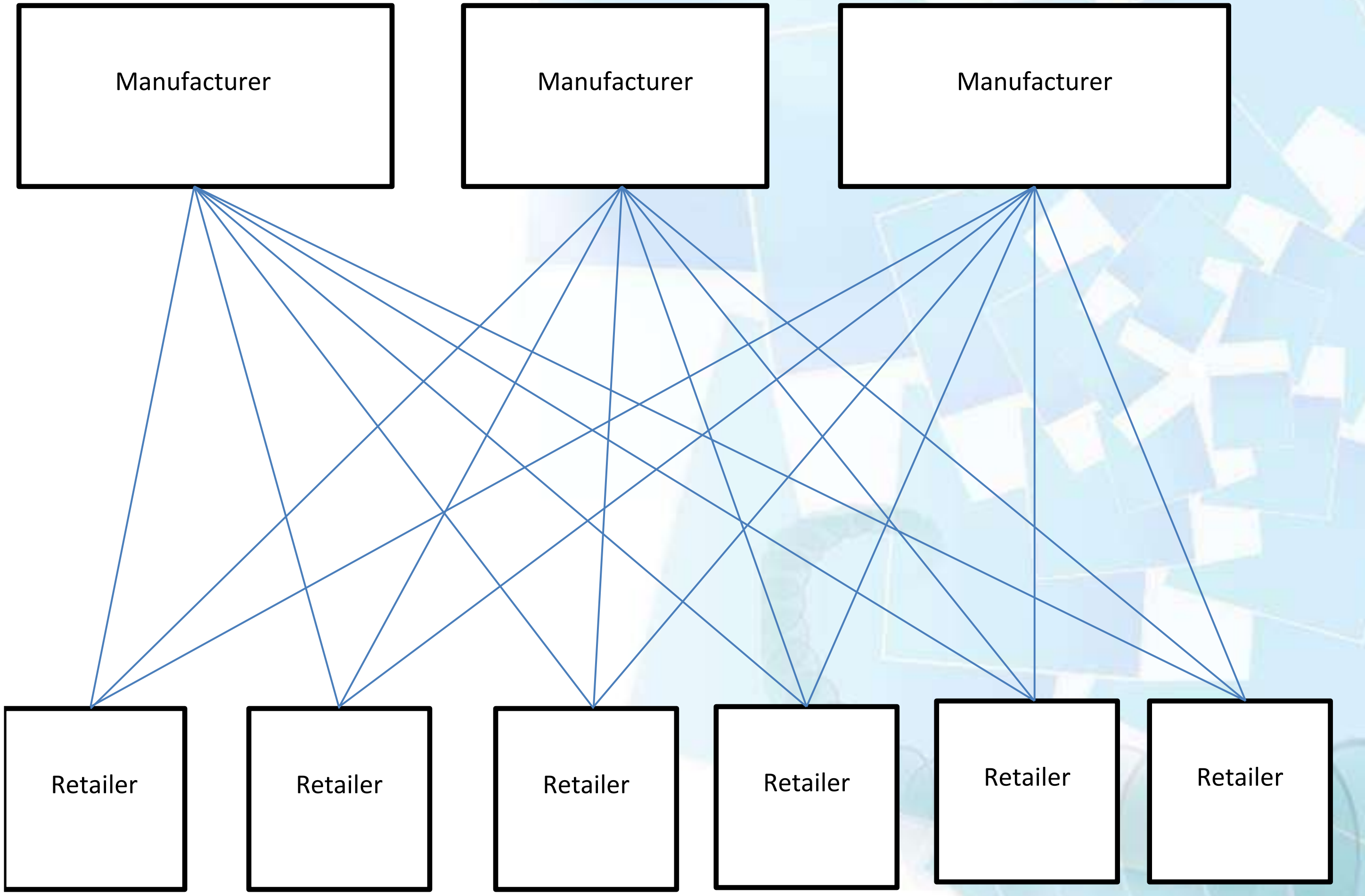
- Assortment is the process of creating and positioning a mix of products desired by a customer.
- Three basic steps:
- Concentration, customization and dispersion.

# Classification of Channel Relationships

- Concertation refers to the collection of large quantities of a single product or several different products so that they can ultimately be sold as a group. e.g. wholesalers.

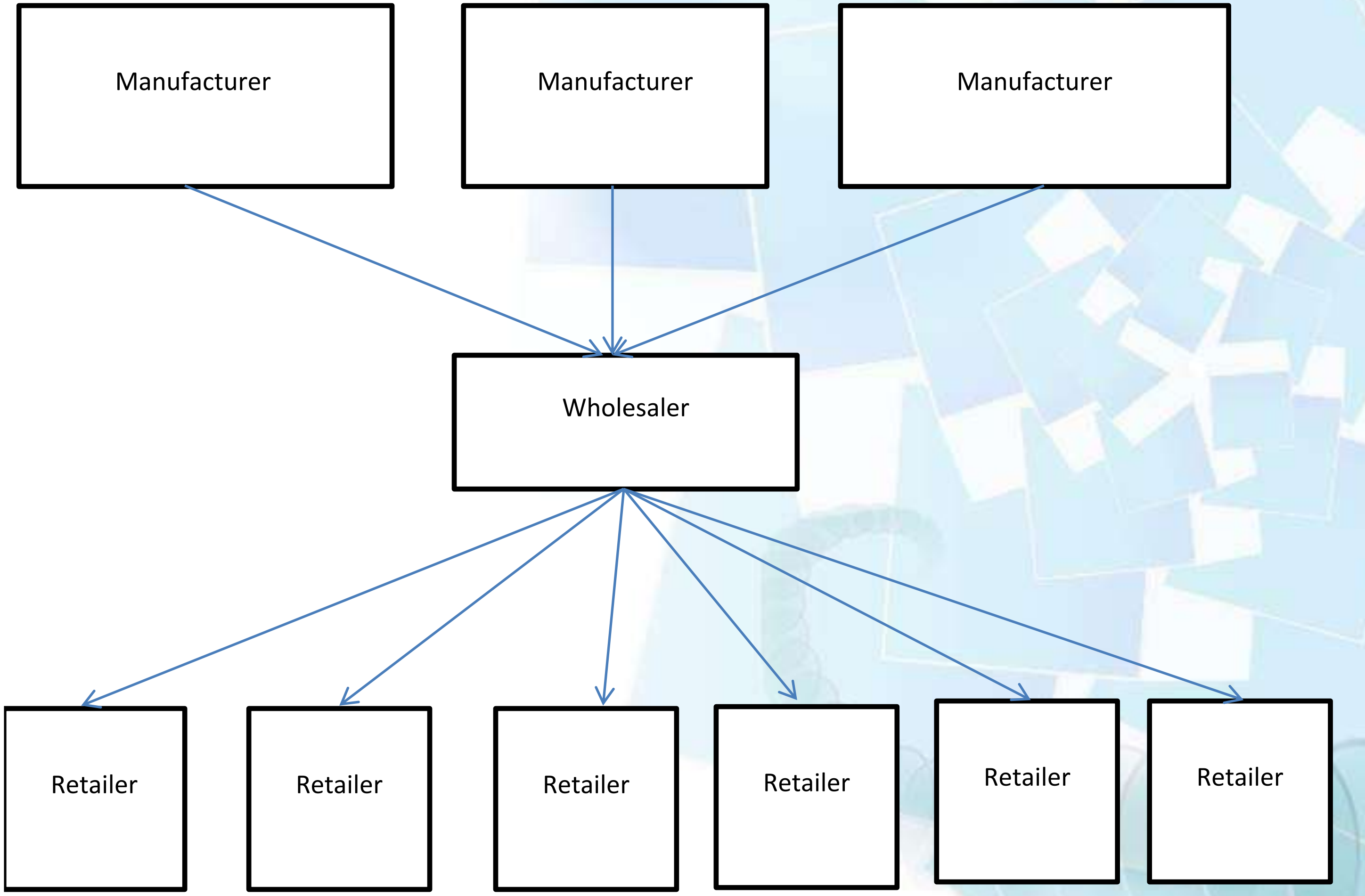
# Classification of Channel Relationships

**No intermediaries**



# Classification of Channel Relationships

**One Intermediary**



# Classification of Channel Relationships

- Customization is the process of sorting and grouping products into unique combinations.
- Beneficial as it has lower transportation cost.

# Classification of Channel Relationships

- Dispersion consist of shipping unique assortments to customers when and where required.

# Logistics Relationships

- Types of relationships
- Vertical relationships
- These refer to the traditional linkages between firms in the supply chain such as retailers, distributors manufacturers and parts and materials suppliers.

# Logistics Relationships

- Horizontal relationships
- Includes those business agreements between firms that have “parallel” or cooperating positions in the logistics process.

# Logistics Relationships

- Ranges from vendor to strategic alliance
- Transactional
- Both parties in a vendor relationship are said to be at “arm’s length”

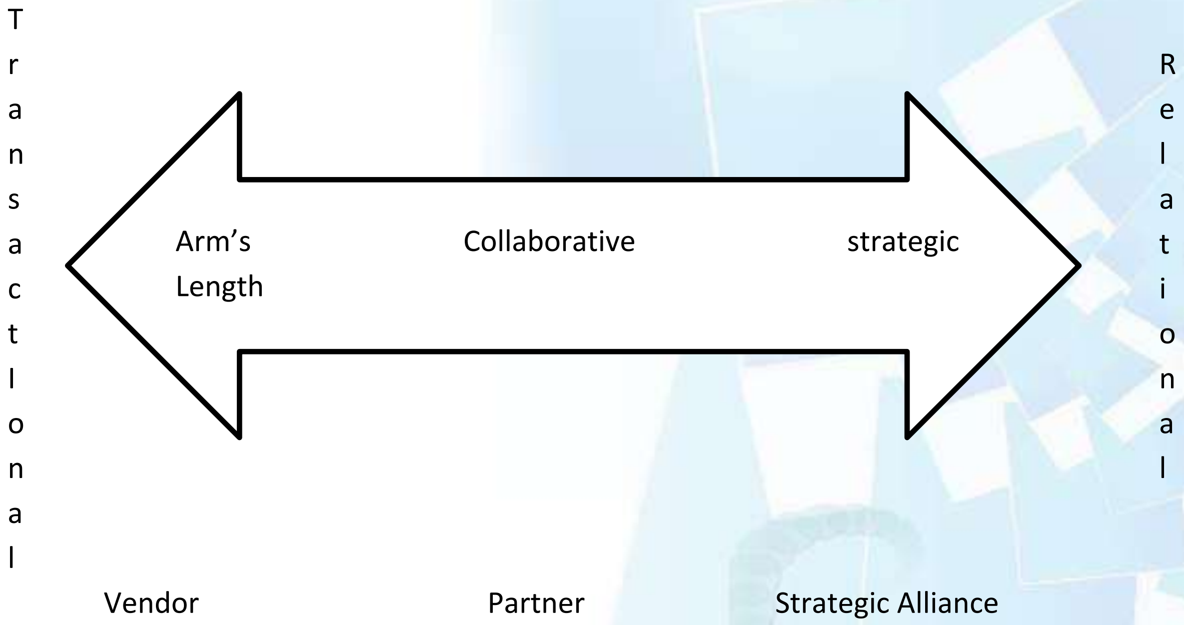
# Logistics Relationships

- Collaborative
- The relationship suggested by a partnership is one in which two or more business organizations cooperate and willingly modify their business objectives and practices to help achieve long-term goals and objectives

# Logistics Relationships

- Strategic
- Represents an alternative that may imply even greater involvement than the partnership.

# Logistics Relationships



TransactIonal

Arm's Length

Collaborative

strategic

Relational

Vendor

Partner

Strategic Alliance

# Logistics Relationships

- Different intensity of involvement.

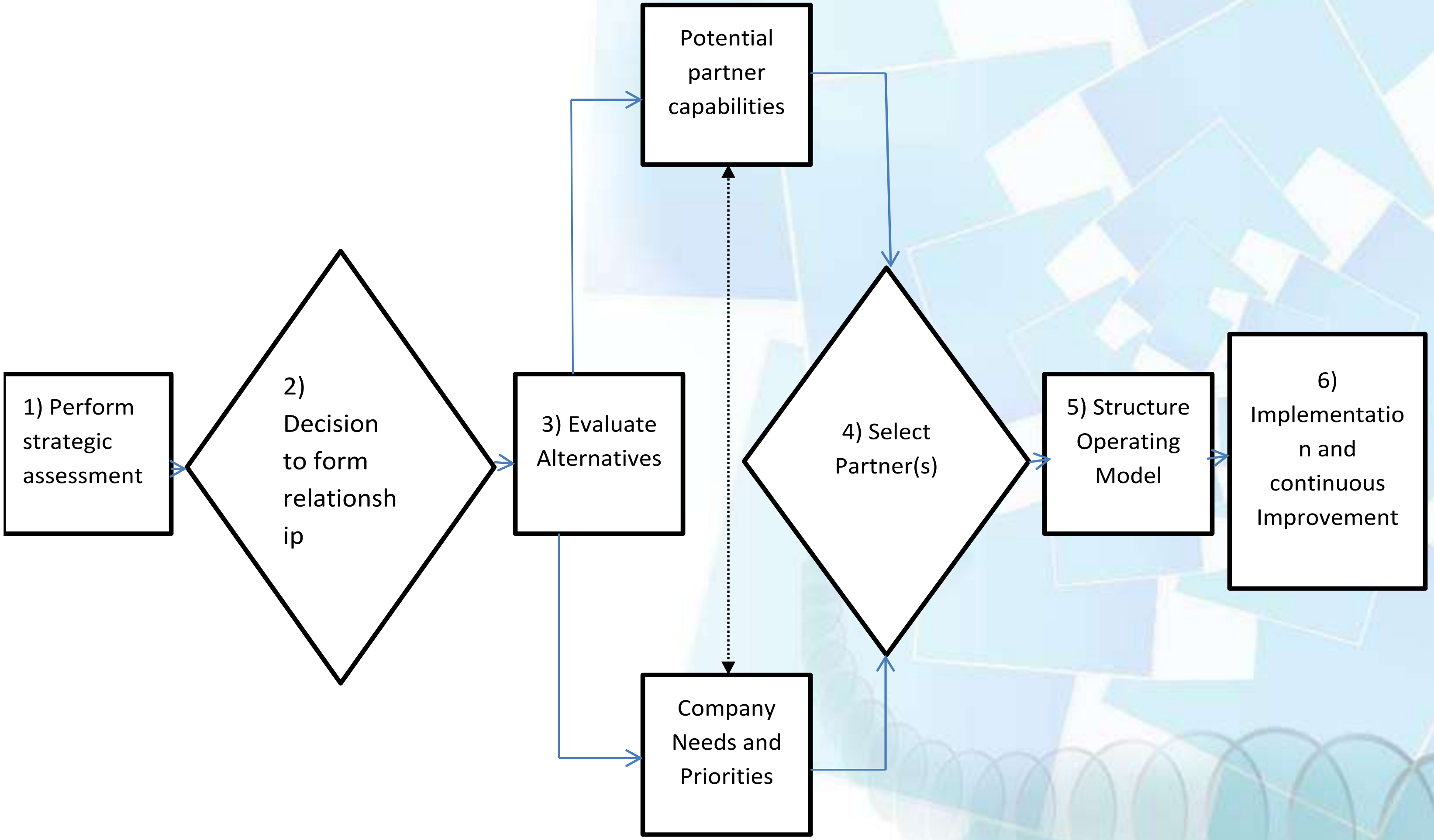
# Channel Relationships

- Relationships may differ in numerous ways, a partial list includes:
- Duration
- Obligations
- Expectations….

# Channel Relationships

- Interaction/Communication
- Cooperation
- Planning
- Goals
- Performance analysis
- Benefits and burdens

# Channel Relationships



1) Perform strategic assessment

2) Decision to form relationship

3) Evaluate Alternatives

Potential partner capabilities

Company Needs and Priorities

4) Select Partner(s)

5) Structure Operating Model

6) Implementation and continuous Improvement

# Channel Relationships

- Always a room for improvement in terms of relationships.

# Successful Supply chain Relationships

- Step 1: Perform strategic assessment
- Step 2: Decision to form relationship
- Step 3: Evaluate alternatives
- Step 4: Select partners
- Step 5: Structure operating model

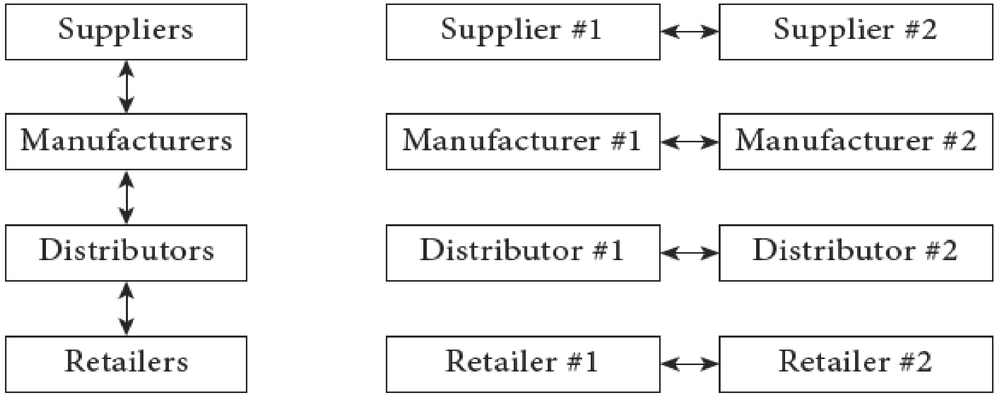
# Successful Supply chain Relationships

- Vertical collaboration refers to the relationship between buyer and supplier in the supply chain.
- Horizontal collaboration refers to buyer-buyer or seller-seller relationships….

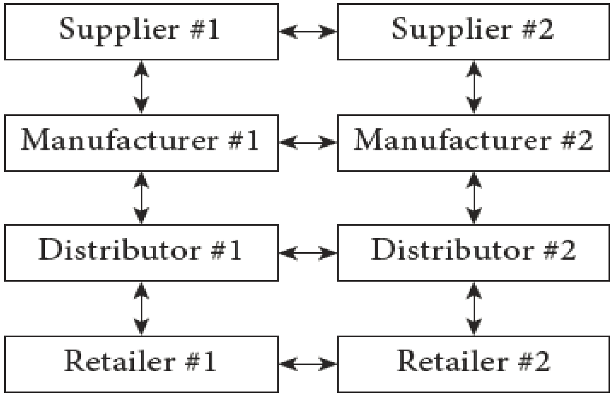
# Successful Supply chain Relationships

- Full collaboration is the dynamic combination of both vertical and horizontal collaboration.

# Successful Supply chain Relationships



(a) Vertical Collaboration (b) Horizontal Collaboration



(c) Full Collaboration

# Successful Supply chain Relationships

- Creates supply chain value .

# Collaborative Logistics

- Collaborative Logistics Networks Must Support:
- Real and recognized benefits to all members
- Dynamic creation, measurement, and evolution of collaborative partnerships….

# Collaborative Logistics

- Co-buyer and co-supplier relationships
- Flexibility and security
- Collaboration across all stages of business process integration….

# Collaborative Logistics

- Open integration with other sources
- Collaboration around essential logistics flows

# Collaborative Logistics

# Collaborative Logistics

- Required for core competency.

# Third Party Logistics

- Essentially, a third-party-logistics firm may be defined as an external supplier that performs all or part of a company's logistics functions…

# Third Party Logistics

- Among these, multiple logistics activities are included, those that are included are "integrated" or managed together, and they provide "solutions" to logistics/supply chain problems.

# Third Party Logistics

- Types of 3PL providers
- Transportation-based
- Warehouse/distribution-based
- Forwarder-based
- Financial-based
- Information-based firms

# Third Party Logistics

- 3PL market size and scope
- Total NA revenue $143.3 billion
- Global revenue $539.1 billion

# Third Party Logistics

- Types of 3PL providers
- Transportation-based
- Warehouse/distribution-based
- Forwarder-based
- Financial-based
- Information-based firms

# Third Party Logistics

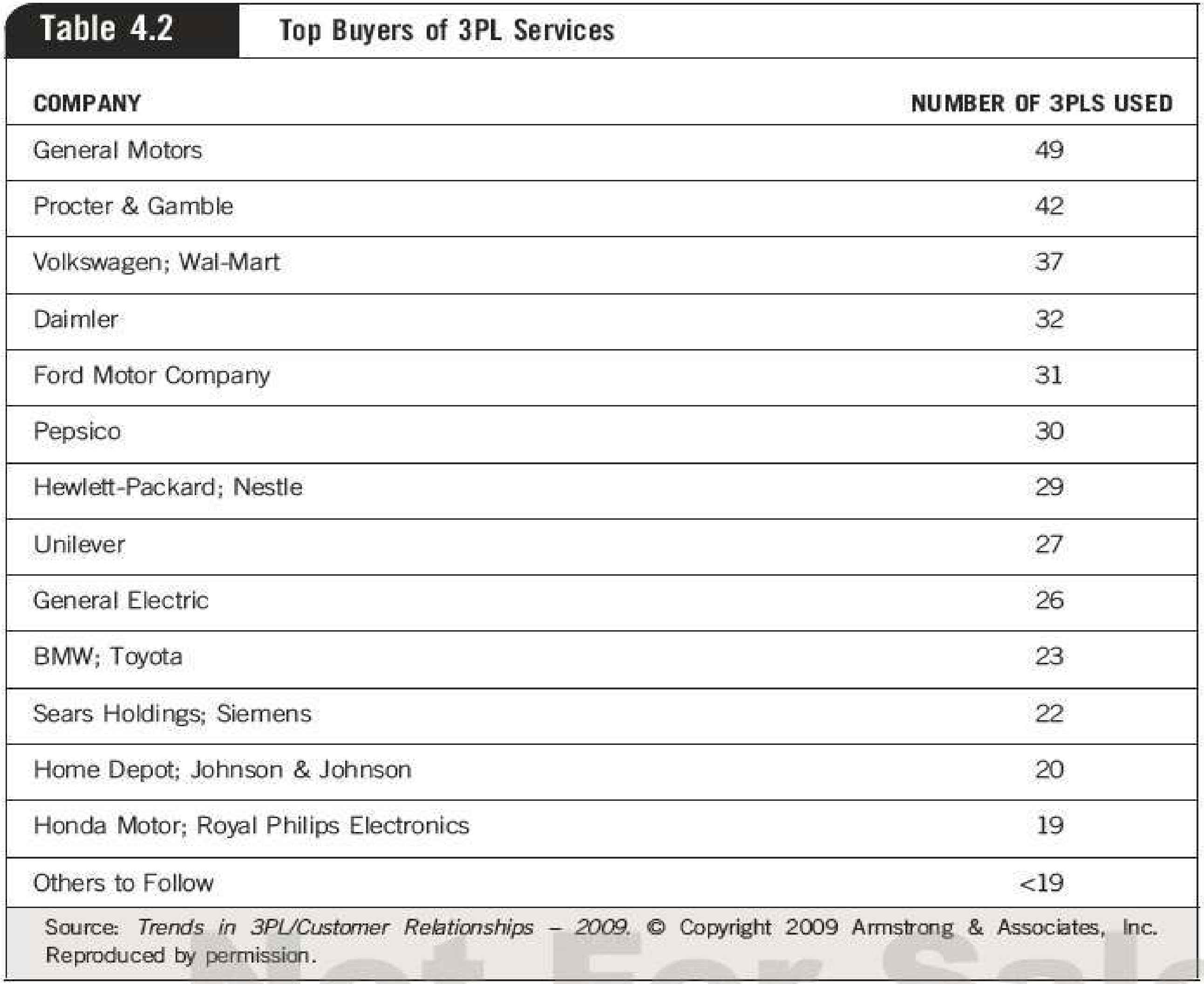


**Table 4.2** Top Buyers of 3PL Services

| COMPANY | NUMBER OF 3PLS USED |
|---|---|
| General Motors | 49 |
| Procter & Gamble | 42 |
| Volkswagen; Wal-Mart | 37 |
| Daimler | 32 |
| Ford Motor Company | 31 |
| Pepsico | 30 |
| Hewlett-Packard; Nestle | 29 |
| Unilever | 27 |
| General Electric | 26 |
| BMW; Toyota | 23 |
| Sears Holdings; Siemens | 22 |
| Home Depot; Johnson & Johnson | 20 |
| Honda Motor; Royal Philips Electronics | 19 |
| Others to Follow | <19 |

Source: *Trends in 3PL/Customer Relationships – 2009.* © Copyright 2009 Armstrong & Associates, Inc. Reproduced by permission.

Not For Sale

# Third Party Logistics

**Table 4.3** Global 3PL Market 2010 Revenue Estimate

| REGION | YEAR 2010 ESTIMATE US $BILLIONS |
|---|---|
| United States | 121.6 |
| Canada and Mexico | 21.7 |
| **Total North America** | 143.3 |
| Europe | 164.7 |
| Asia Pacific | 147.3 |
| Central America | 1.7 |
| South America | 27.7 |
| Australia | 10.0 |
| UAE (Dubai) | 2.9 |
| Remaining Regions/Countries | 41.5 |
| **Total Global 3PL Market** | 539.1 |

Source: *Predictions and Major Trends for Third Party Logistics – 2011.* © Copyright 2011 Armstrong & Associates, Inc. Reproduced by permission.

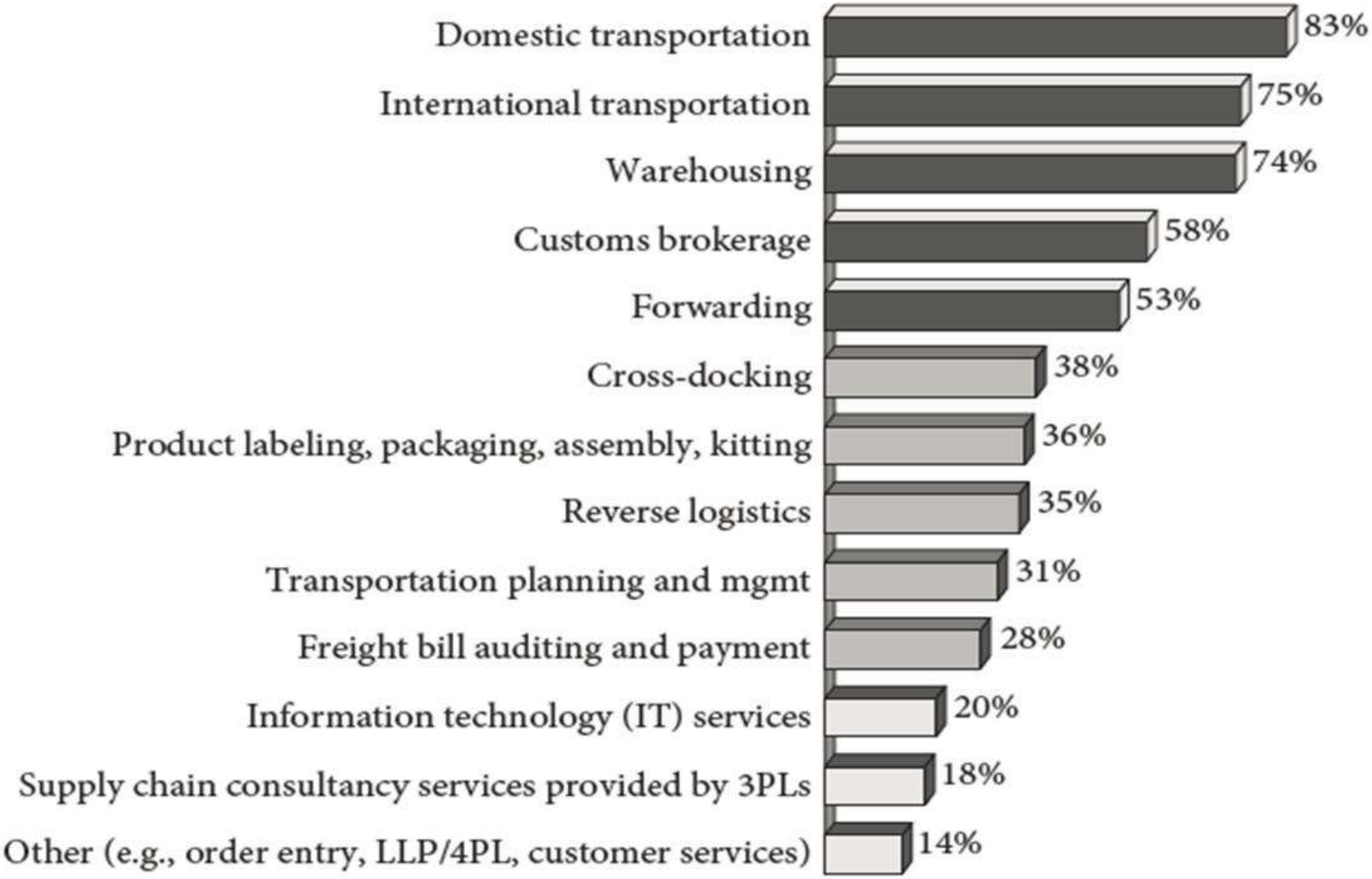
# Third Party Logistics

- Operational, transactional, and repetitive services were the most likely to be outsourced.
- Most frequently used services were transportation and warehouse management systems.

# Strategic View of Logistics

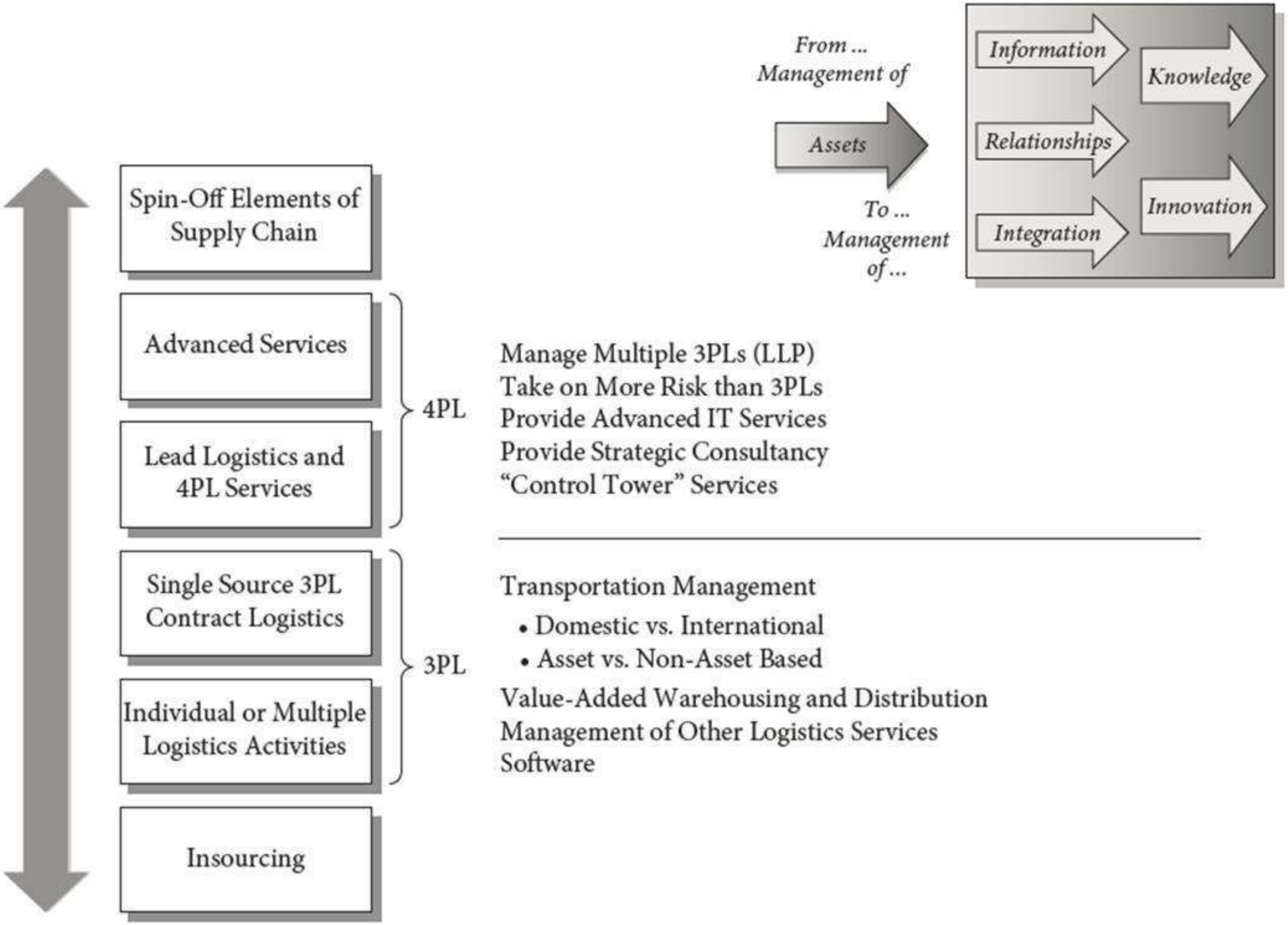
- Fourth-party relationships
- Logistics outsourcing model for the future
- Proprietary provision evolving through stages to lead logistics provider

# Strategic View of Logistics



% Respondents by Logistics Services that Use a 3PL (Global Results)

# Strategic View of Logistics



# Strategic View of Logistics

- Customers generally have high aspirations for their strategic use of 3PLs and consider their 3PLs as keys to their supply chain success….

# Strategic View of Logistics

- There is a growing need for fourth-party logistics relationships that provide a wide range of integrative supply chain services.

# Globalization

- Three eras of globalization
- The first era was initially driven by countries (1400–1800) seeking materials and goods not available in their own land.

# Globalization

- The second era of globalization (1800–2000) was driven by companies seeking goods and materials, labor, economies of scale, and markets.

# Globalization

- In the third era of globalization, said to have begun around the year 2000, the significant characteristic is that it is being powered by individuals and smaller organizations

# Globalization

- From supply chain perspective, globalization creates competitive advantage.

# Logistics in a Global Economy

- Economies and companies could improve their “wealth” by allowing specialization of tasks.

# Logistics in a Global Economy

- The advantage is true as long as you can sell the increased volume that is produced. It is an important role of logistics…

# Logistics in a Global Economy

- to help extend the market area of countries or companies through improved efficiency to lower the "landed cost" in new market areas.

# Logistics in a Global Economy

- The ability to connect to individuals and companies across the globe and to connect computer information systems on a 24/7 basis has provided…

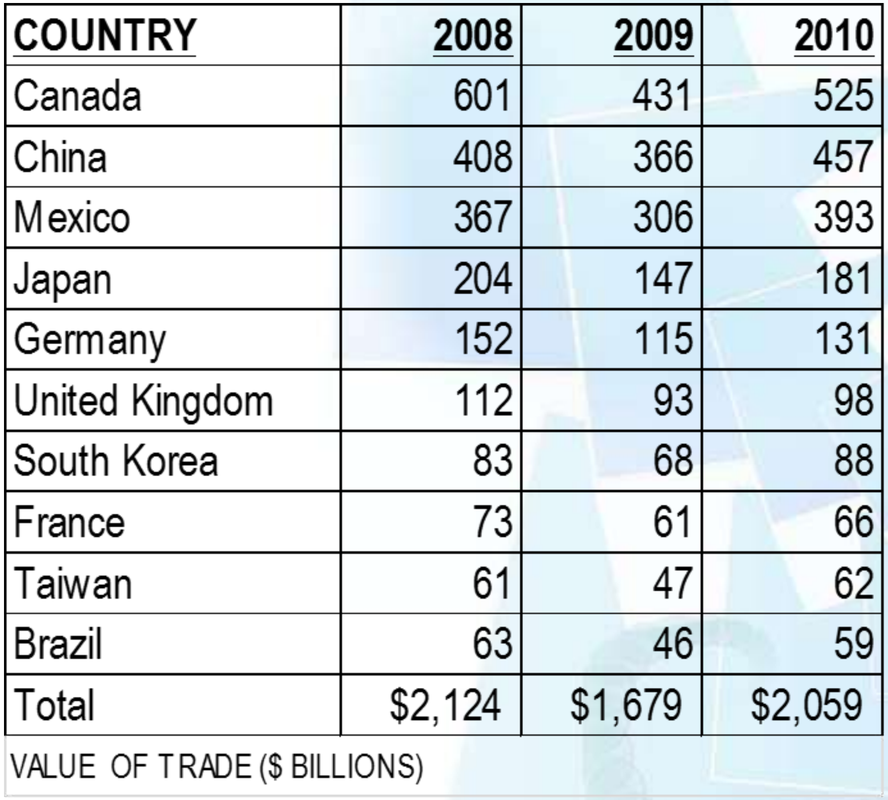
# Logistics in a Global Economy

- unparalleled opportunity for collaboration horizontally and vertically in supply chains.

# Logistics in a Global Economy

- The trade volume with China was 18.2 percent of the total of the top 10 for 2006, and it increased its trade volume by 20 percent…

# Logistics in a Global Economy



| COUNTRY | 2008 | 2009 | 2010 |
|---|---:|---:|---:|
| Canada | 601 | 431 | 525 |
| China | 408 | 366 | 457 |
| Mexico | 367 | 306 | 393 |
| Japan | 204 | 147 | 181 |
| Germany | 152 | 115 | 131 |
| United Kingdom | 112 | 93 | 98 |
| South Korea | 83 | 68 | 88 |
| France | 73 | 61 | 66 |
| Taiwan | 61 | 47 | 62 |
| Brazil | 63 | 46 | 59 |
| Total | $2,124 | $1,679 | $2,059 |

VALUE OF TRADE ($ BILLIONS)

# Logistics in a Global Economy

- Increasing worth

# Global Logistics Strategy

- The global business environment has changed significantly and become much more conducive to business activity between and among different countries.

# Global Logistics Strategy

- Success in the global market place requires developing a cohesive strategy, including product development, technology, marketing, manufacturing, and supply chains.

# Global Logistics Strategy

- Global markets and strategy have four important characteristics:
- standardization reduces complexity
- global competition reduces the product life cycle

# Global Logistics Strategy

- traditional organizational structures and business models frequently change
- globalization introduces more volatility

# Global Logistics Strategy

- traditional organizational structures and business models frequently change
- globalization introduces more volatility.

# Global Transportation Options

- Ocean
- The most pervasive and important global shipment method, accounting for two-thirds of all international movements. …

# Global Transportation Options

- Major advantages are low rates and the ability to transport a wide variety of products and shipment size.
- Three major categories:
- Liner service
- Charter vessels
- Private carriers

# Global Transportation Options

- Air
- Fast transit times
- An advantage in packaging
- Disadvantage of air carriage is high rates

# Global Transportation Options

- Motor
- standardization reduces complexity
- Use motor transport when shipping goods to between the United States and Mexico or Canada…

# Global Transportation Options

- It is very common in Europe
- Motor also plays a large part in intermodal shipments

# Global Transportation Options

- Rail
- International railroad use is also highly similar to domestic rail use
- Intermodal container shipments by rail are increasing
- Maritime bridge concepts
- Land bridge ..

# Global Intermediaries

- **Foreign Freight Forwarders**
- Supplies expertise to international shippers
- Consolidate small shipments into more economical sizes
- Derives income from fees for service

# Global Intermediaries

- **Airfreight Forwarders**
- Same services as surface forwarders but only for air shipments

# Global Intermediaries

- **Non-Vessel-Operating Common Carriers (NVOCC)**
- Consolidates and dispenses containers at inland points…

# Global Intermediaries

- Uses the shipping expertise that NVOCCs possess
- Ocean carrier gains from the increased market area

# Global Intermediaries

- **Export Management Companies**
- EMCs act as agents for domestic firms in the international arena…

# Global Intermediaries

- Obtain orders, selecting appropriate markets, distribution channels, and promotional campaigns.

# Global Intermediaries

- **Export Trading Companies**
- ETC exports goods and services to overseas buyers and handles most of the export arrangement…

# Global Intermediaries

- ETC allows small- to medium-size firms to engage in foreign trade

# Global Intermediaries

- **Customs House Brokers**
- Oversee the movement of goods through customs and ensure that the documentation accompanying a shipment is complete and accurate for entry into the country…

# Global Intermediaries

- Operate under power of attorney from the shipper to pay all import duties due on the shipment…

# Global Intermediaries

- The importer is ultimately liable for any unpaid duties
- Keeps abreast of the latest import regulations and specific requirements of individual products. .

# Storage Facilities and Packaging

- Storage Facilities
- Transit sheds provide temporary storage while the goods await the next portion of the journey…

# Storage Facilities and Packaging

- Carrier provided hold-on-dock storage free of charge until the vessel’s next departure date.
- Public warehouses are available for extended storage periods…

# Storage Facilities and Packaging

- Bonded warehouses operate under customs agency's supervision and are used to store, repack, sort, or clean imported merchandise entered for warehousing without paying import duties while the goods are in storage.

# Storage Facilities and Packaging

- **Packaging**
- Export shipments moving by ocean transportation require more stringent packaging than domestic shipments normally do…

# Storage Facilities and Packaging

- The shipper may find settling liability claims for damage to export goods very difficult. Usually, the freight handling involves many firms, and these firms are located in different countries. .

# Inventory Functionality

- Inventory is an asset on the balance sheet and a variable expense on the income statement.
- Inventories also have an impact on return on investment (ROI) for the firm.

# Inventory Functionality

- **Batching Economies or Cycle Stocks**
- Arises from three sources.
- procurement
- production
- transportation

# Inventory Functionality

- **Uncertainty and Safety Stocks**
- All organizations are faced with uncertainty.
- On the demand side, there is usually uncertainty in how much customers will buy and when they will buy it….

# Inventory Functionality

- On the supply side, there might be uncertainty about obtaining what is needed from suppliers and how long it will take for the fulfillment of the order.

# Inventory Management Concepts

- **Inventory management models**
- Generally classified as dependent demand and independent demand models.

# Inventory Management Concepts

- **Dependent Demand**
- Describes the internal demand for parts based on the demand of the final product in which the parts are used…

# Inventory Management Concepts

- Subassemblies, components, & raw materials are examples of dependent demand items.

# Inventory Management Concepts

- **Independent Demand**
- The demand for final products has a demand pattern affected by trends, seasonal patterns, & general market conditions.

# Types of Inventory

- **The primary functions of inventory are to** –
- Buffer from uncertainty in the marketplace &
- Decouple dependencies in the supply chain (e.g., safety stock)

# Types of Inventory

**Four broad categories of inventories**

- Raw materials- unprocessed purchase inputs.
- Work-in-process (WIP)- partially processed materials not yet ready for sales…

# Types of Inventory

- Finished goods- products ready for shipment.
- Maintenance, repair & operating (MRO)- materials used in production (e.g., cleaners & brooms).

# Inventory Costs

- Direct costs- directly traceable to unit produced (e.g., labor)
- Indirect costs- cannot be traced directly to the unit produced (e.g., overhead)..

# Inventory Costs

- Fixed costs- independent of the output quantity (e.g, buildings, equipment, & plant security)
- Variable costs- vary with output level (e.g., materials)..

# Inventory Costs

- Order costs- direct variable costs for making an order. In manufacturing, setup costs are related to machine setups
- Holding or carrying costs- incurred for holding inventory in storage.

# Inventory Costs

- Firms should diligently measure inventory investment to ensure that it does not adversely affect competitiveness. Measures include…

# Inventory Costs

- Absolute value of inventory (found on balance sheet)
- Inventory turnover or turnover ratio- how many times inventory “turns” in an accounting period.  More is better because its faster!

# Inventory Costs

$$\text{Inventory Turnover Ratio} = \frac{\text{Cost of Revenue}}{\text{Average Inventory}}$$

# Inventory Control System

- Determines which inventories should be counted and managed more closely than others
- Groups inventory as A, B, & C Items..

# Inventory Control System

- A items are given the highest priority with larger safety stocks. A items account for approximately 20% of the total items & about 80% of the total inventory cost..

# Inventory Control System

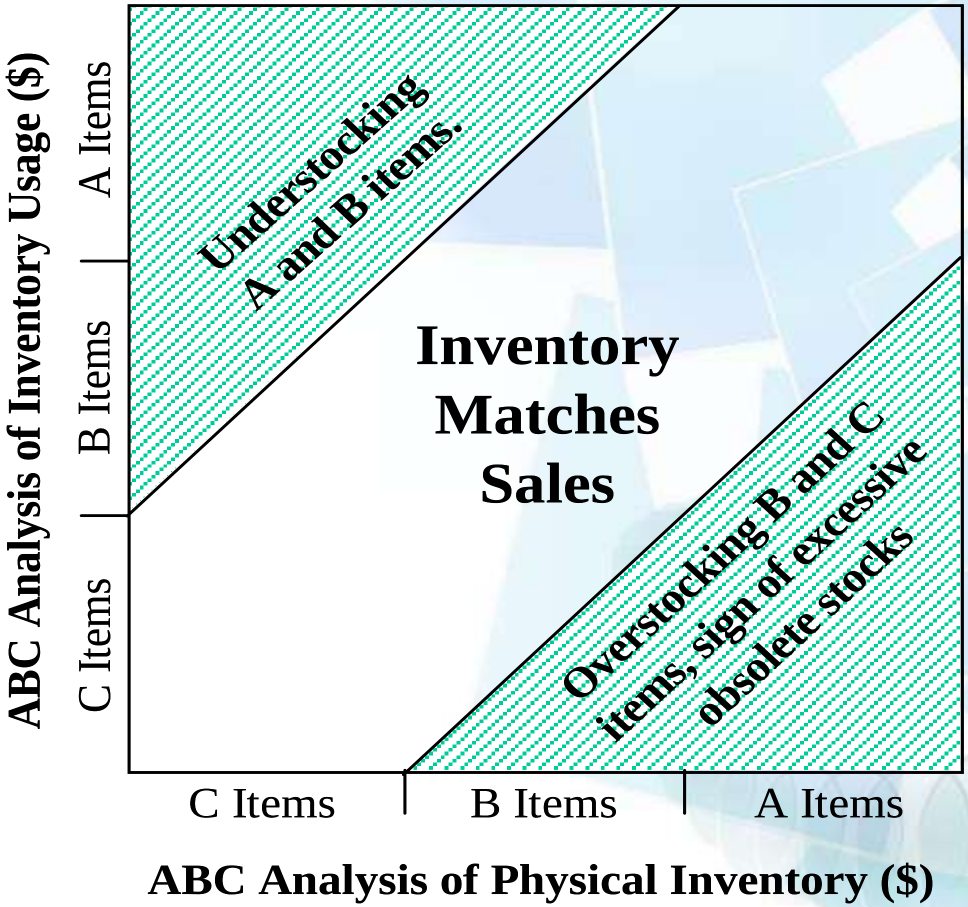
- B items account for the other about 40% of total items and 15% of total inventory cost…

# Inventory Control System

- C items have the lowest value and hence lowest priority. They account for the remaining 40% of total items and 5% of total inventory cost.

# Inventory Control System

## The ABC Inventory Matrix



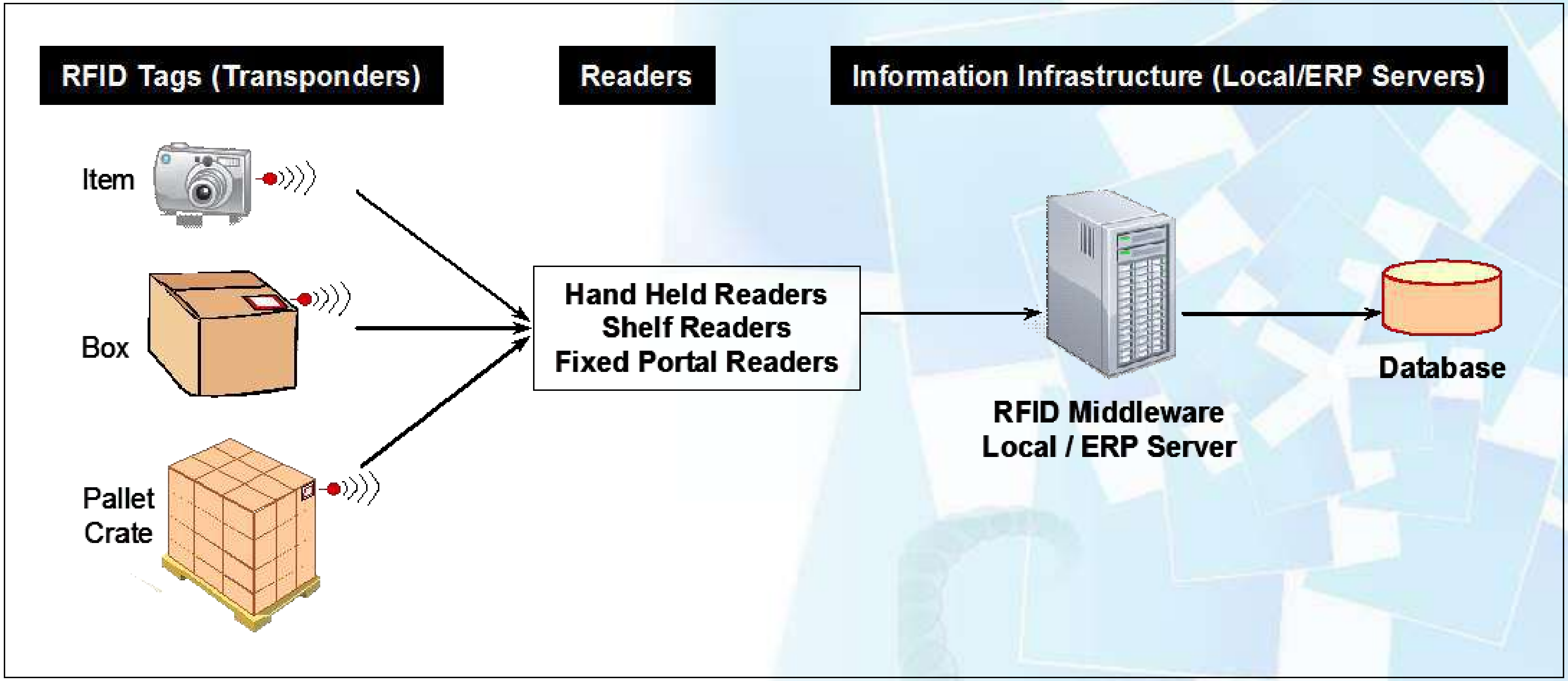
# Inventory Control System

Important for defining overall fill rate.

# Radio Frequency Identification (RFID)

- Successor to the barcode for tracking individual unit of goods.  RFID does not require direct line of sight to read a tag and information on the tag is updatable.

# Radio Frequency Identification (RFID)



RFID Tags (Transponders)

Readers

Information Infrastructure (Local/ERP Servers)

Item

Box

Pallet
Crate

Hand Held Readers
Shelf Readers
Fixed Portal Readers

RFID Middleware
Local / ERP Server

Database

# Radio Frequency Identification (RFID)

- **Components of Radio Frequency Identification System**
- Tag - computer chip and an antenna for wireless communication
- Reader - handheld or fixed-position RFID device that reads the tags…

# Radio Frequency Identification (RFID)

- Communication network - connects the readers to transmit inventory information to the enterprise information system…

# Radio Frequency Identification (RFID)

- RFID software - manages the collection, synchronization, and communication of the data with systems, and stores the information in a database

# Radio Frequency Identification (RFID)

- Automates the supply chain:
- Materials Management – goods automatically counted and logged as they enter the supply warehouse..

# Radio Frequency Identification (RFID)

- Manufacturing – assembly instructions encoded on RFID tag provide information to computer controlled assembly devices..

# Radio Frequency Identification (RFID)

- Distribution Center – shipment leaving DC automatically updates ERP to trigger a replenishment order and notify customer for delivery tracking…

# Radio Frequency Identification (RFID)

- Retail Store – no check out lines as scanners link RFID tagged goods in shopping cart with buyers credit card.

# Inventory Models-I

- **Fixed Order Quantity Models**
- Economic Order Quantity Model
- Quantity Discount Model
- Economic Manufacturing Quantity Model

# Inventory Models-I

- These models use fixed parameters to derive the optimum order quantity to minimize total inventory cost

# Inventory Models-I

- **The Economic Order Quantity (EOQ) Model**
- A quantitative decision model based on the trade-off between annual inventory holding costs & annual order costs

# Inventory Models-I

- The EOQ model seeks to determine an optimal order quantity, where the sum of the annual order cost & the annual inventory holding cost is minimized...

# Inventory Models-I

- Order Cost is the direct variable cost associated with placing an order. Sometimes called setup cost.
- Holding Cost is the cost incurred for holding inventory in storage. Sometimes called carrying cost.

# Inventory Models-I

- Total Annual Inventory Cost formula
- TAIC = Annual purchase cost + Annual holding cost + Annual order cost
- TAIC = APC + AHC + AOC = (R x C) + (Q/2 x (k x C)) + (R/Q x S)

# Inventory Models-I

- Where
- TAIC = total annual inventory cost
- C = purchase cost per unit
- APC = annual purchase cost
- S = cost of placing one order

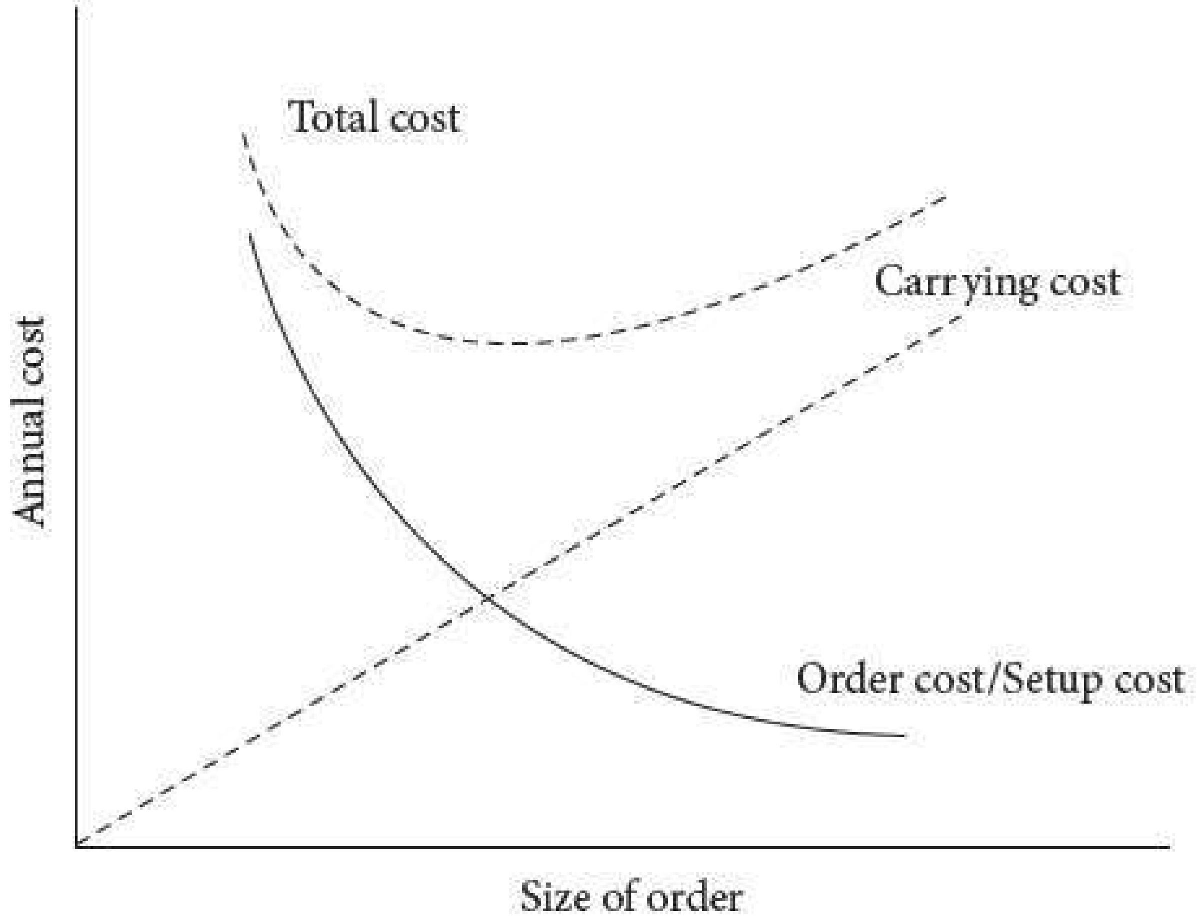
# Inventory Models-I

- AHC = annual holding cost
- R = annual demand
- AOC = annual order cost
- Q = order quantity
- k = holding rate, where annual holding cost per unit = k x C

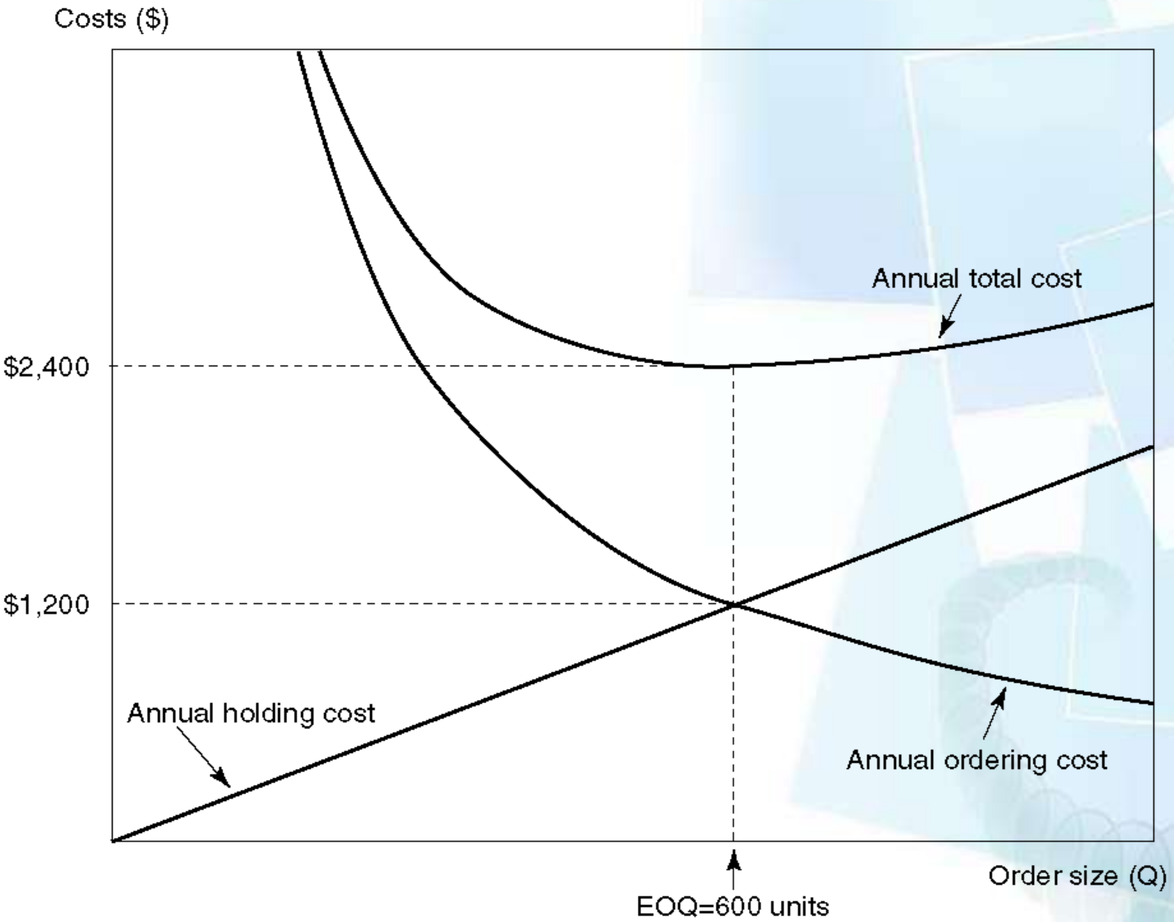
# Inventory Models-I

$$\textbf{EOQ} = \sqrt{\frac{2RS}{kC}}$$

# Inventory Models-I



# Inventory Models-I

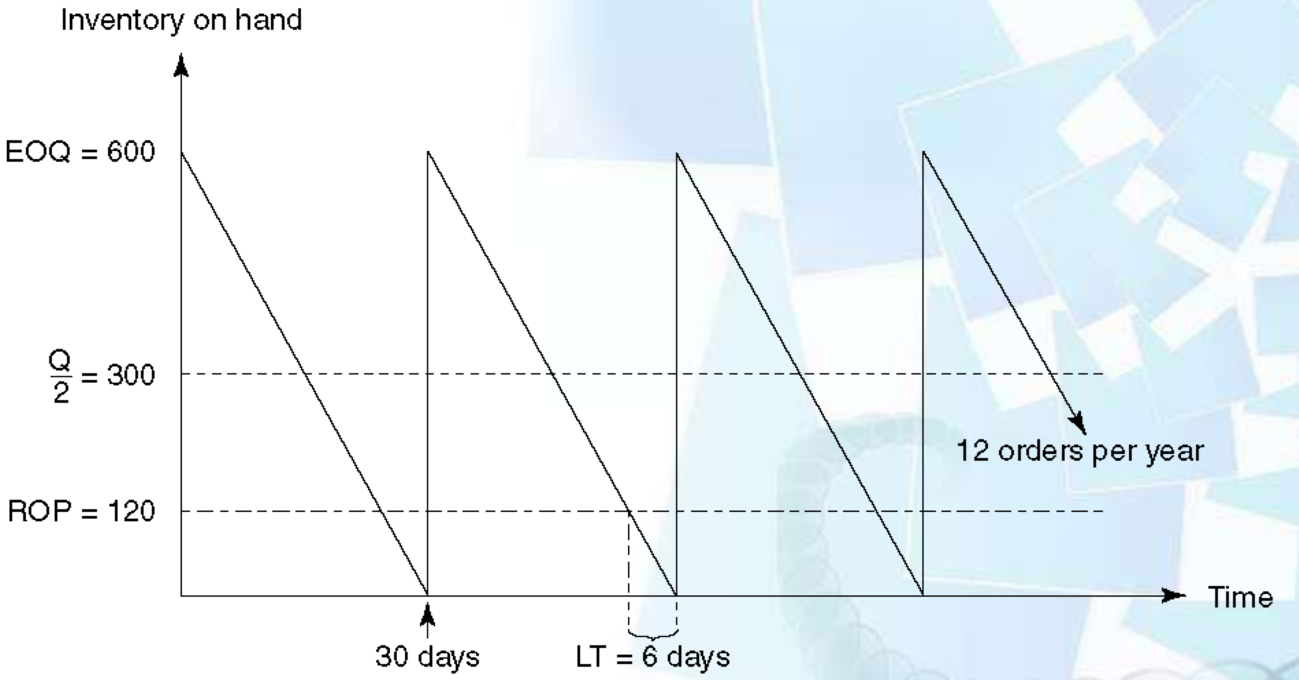


If order size is smaller than EOQ of 600 units

- annual holding cost is slightly lower
- annual order cost is slightly higher

# Inventory Models-I

Inventory on hand & relationships to – EOQ, average inventory, lead time, reorder point, & order cycle



# Inventory Models-I

Aggressive inventory management.

# EOQ Example

- Demand, R = 12,000 computers per year
- r = 1000 computers/month
- Unit cost, C = $500
- Holding cost fraction, k = 0.2

# EOQ Example

Annual demand = $R$

Number of orders per year = $R/Q$

Annual material cost = $CR$

Annual order cost = $(R/Q)S$

Annual holding cost = $(Q/2)H = (Q/2)kC$

Total annual cost = $TC = CR + (R/Q)S + (Q/2)kC$

# EOQ Example

$$\textbf{EOQ} = \sqrt{\frac{2RS}{kC}}$$

# EOQ Example

- Fixed cost, S = $4,000/order
- Q* = Sqrt[(2)(12000)(4000)/(0.2)(500)] = **980** computers
- Cycle inventory = Q/2 = 490

# EOQ Example

Annual ordering and holding cost =

$= (12000/980)(4000) + (980/2)(0.2)(500) = \$97{,}980$

# Implications of EOQ

- In deciding the optimal lot size, the tradeoff is between setup (order) cost and holding cost.

# Implications of EOQ

- If demand increases by a factor of 4, it is optimal to increase batch size by a factor of 2 and produce (order) twice as often. Cycle inventory (in days of demand) should decrease as demand increases.

# Implications of EOQ

- If lot size is to be reduced, one has to reduce fixed order cost. To reduce lot size by a factor of 2, order cost has to be reduced by a factor of 4

# EOQ and lower Lot size

- If desired lot size = Q* = 200 units, what would S have
  to be?
- R= 12000 units
- C = $500
- k = 0.2

# EOQ and lower Lot size

- Use EOQ equation and solve for S:
- $S = [kC(Q^*)^2]/2R = [(0.2)(500)(200)^2]/(2)(12000) = \$166.67$

# Quantity Discount Model

- **The Quantity Discount Model or price-break model**
- Relaxes the constant price assumption by allowing purchase quantity discounts…

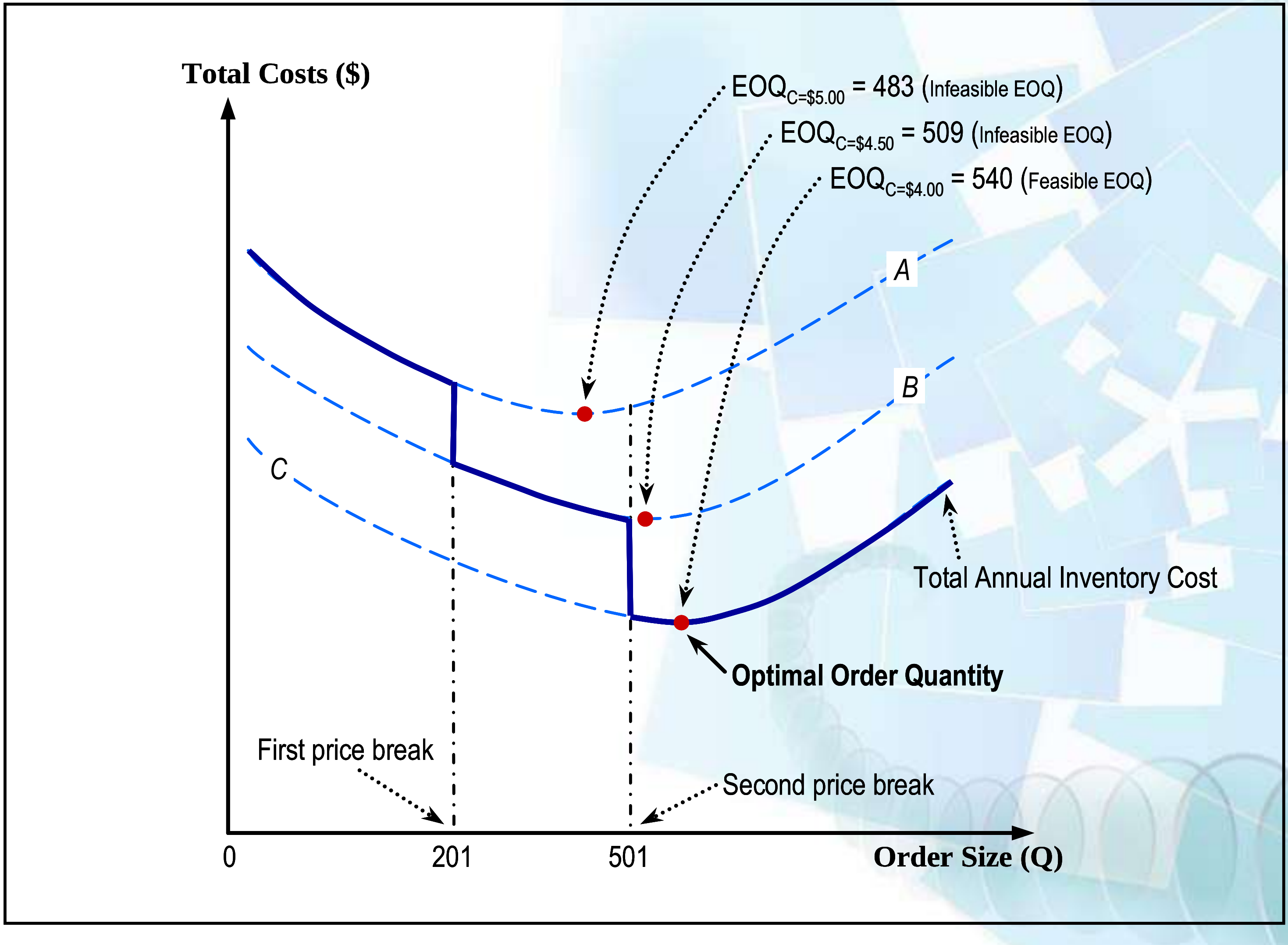
# Quantity Discount Model

- Considers the tradeoff between purchasing in large quantity to take advantage of the price discount and issuing fewer orders, against holding higher inventory…

# Quantity Discount Model

- Due to the step-wise shape of the total inventory cost curve, the optimal order quantity lies on either one of the feasible EOQs or at the price break point.

# Quantity Discount Model



# Quantity Discount Model

- Step 1: Calculate the EOQ for the lowest price. If it is feasible (i.e., this order quantity is in the range for that price), then stop. This is the optimal lot size. Calculate TC for this lot size.

# Quantity Discount Model

- Step 2: If the EOQ is not feasible, calculate the TC for this price and the smallest quantity for that price.
- Step 3: Calculate the EOQ for the next lowest price. If it is feasible, stop and calculate the TC for that quantity and price.

# Quantity Discount Model

- Step 4: Compare the TC for Steps 2 and 3. Choose the quantity corresponding to the lowest TC.
- Step 5: If the EOQ in Step 3 is not feasible, repeat Steps 2, 3, and 4 until a feasible EOQ is found.

# Quantity Discount Model

| Order quantity | Unit Price |
|---|---|
| 0-5000 | \$3.00 |
| 5001-10000 | \$2.96 |
| Over 10000 | \$2.92 |

q0 = 0, q1 = 5000, q2 = 10000

C0 = \$3.00, C1 = \$2.96, C2 = \$2.92

R = 120000 units/year, S = \$100/lot, k = 0.2

# Quantity Discount Model

Step 1: Calculate Q2* = Sqrt[(2RS)/kC2]

= Sqrt[(2)(120000)(100)/(0.2)(2.92)] = 6410

Not feasible (6410 < 10001)

Calculate TC2 using C2 = $2.92 and q2 = 10001

TC2 =
(120000/10001)(100)+(10001/2)(0.2)(2.92)+(120000)(2.92)

= $354,520

# Quantity Discount Model

Step 2: Calculate Q1* = Sqrt[(2RS)/kC1]

=Sqrt[(2)(120000)(100)/(0.2)(2.96)] = 6367

Feasible (5000<6367≤10000) ➔ Stop

TC1 = (120000/6367)(100)+(6367/2)(0.2)(2.96)+(120000)(2.96)

= $358,969

TC2 < TC1 ➔ The optimal order quantity Q* is q2 = 10001

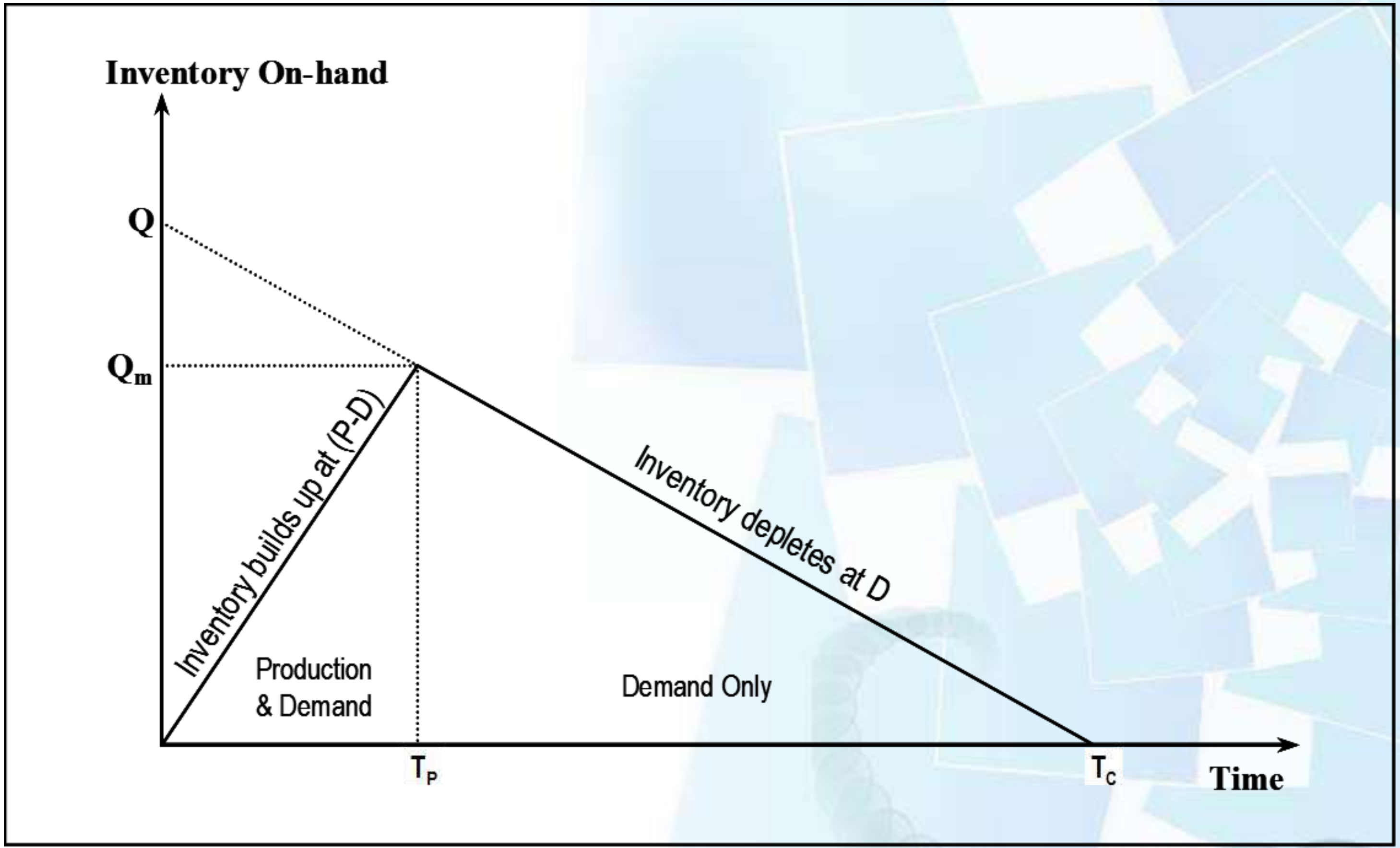
# Quantity Discount Model

- Retailers are encouraged to increase the size of their orders.
- Coordination in supply chains.

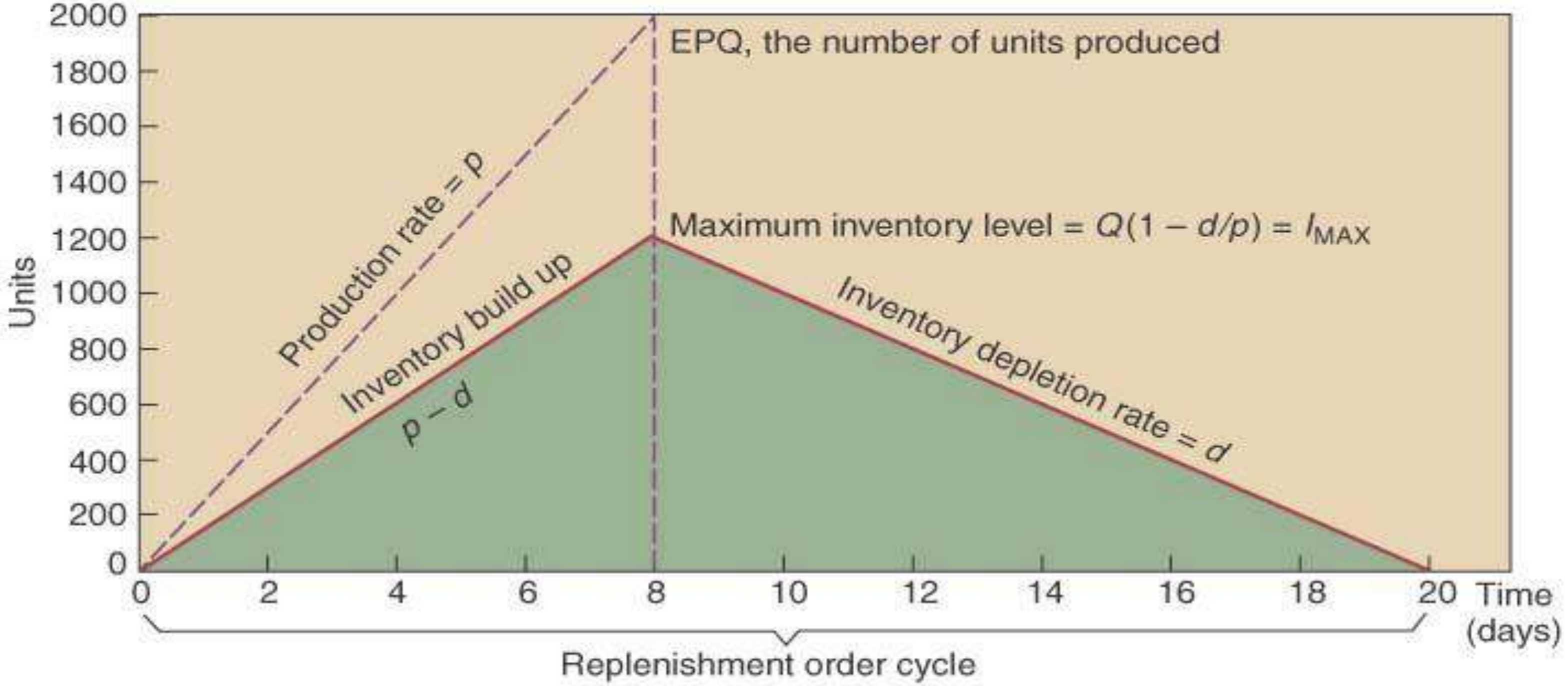
# Economic Manufacturing Quantity Model

- Same assumptions as the EOQ except: inventory arrives in increments & is drawn down as it arrives

# Economic Manufacturing Quantity Model



# Economic Manufacturing Quantity Model



Order quantity 2000 units
Daily demand ($d$) = 100 units
Daily production ($p$) = 250 units

# Economic Manufacturing Quantity Model

- **Total cost:**

$$TC_{EPQ} = \left(\frac{R}{Q}S\right) + \left(\frac{I_{MAX}}{2}H\right)$$

- **Maximum inventory:**
  - d=avg. daily demand rate
  - p=daily production rate

$$\mathbf{I_{MAX} = Q\left(1 - \frac{d}{p}\right)}$$

- **Calculating EPQ**

$$EPQ = \sqrt{\frac{2RS}{H\left(1 - \frac{d}{p}\right)}}$$

# Economic Manufacturing Quantity Model

- HP Ltd. Produces its premium plant food in 50 bags. Demand is 100,000 lbs. per week and they operate 50 wks. each year and HP can produce 250,000 lbs. per week.

# Economic Manufacturing Quantity Model

- The setup cost is $200 and the annual holding cost rate is $.55 per bag. Calculate the EPQ. Determine the maximum inventory level. Calculate the total cost of using the EPQ policy.

# Economic Manufacturing Quantity Model

- The setup cost is $200 and the annual holding cost rate is $.55 per bag. Calculate the EPQ. Determine the maximum inventory level. Calculate the total cost of using the EPQ policy.

# Economic Manufacturing Quantity Model

$$EPQ = \sqrt{\frac{2(50)(100{,}000)(200)}{.55\left(1-\frac{100{,}000}{250000}\right)}} = 77{,}850\ Bags$$

$$I_{MAX} = 77{,}850\left(1-\frac{100{,}000}{250{,}000}\right) = 46{,}710\ bags$$

$$TC = \left(\frac{5{,}000{,}000}{77{,}850}\right)(200) + \left(\frac{46{,}710}{2}\right)(.55) = \$25{,}690$$

# LTL and EOQ

- Transportation is a significant contributor to the fixed cost per order
- Can possibly combine shipments of different products from the same supplier
- same overall fixed cost..

# LTL and EOQ

- shared over more than one product
- effective fixed cost is reduced for each product
- lot size for each product can be reduced..

# LTL and EOQ

- Can also have a single delivery coming from multiple suppliers or a single truck delivering to multiple retailers

# LTL and EOQ

- Aggregating across products, retailers, or suppliers in a single order allows for a reduction in lot size for individual…

# LTL and EOQ

- products because fixed ordering and transportation costs are now spread across multiple products, retailers, or suppliers.

# LTL and EOQ

- **No Aggregation:** Each product ordered separately
- **Complete Aggregation:** All products delivered on each truck
- **Tailored Aggregation:** Selected subsets of products on each truck

# Example EOQ with LTL

- Demand per year
- RL = 12,000; RM = 1,200; RH = 120
- Common transportation cost, S = $4,000

# Example EOQ with LTL

- Product specific order cost
- sL = \$1,000; sM = \$1,000; sH = \$1,000
- Holding cost, h = 0.2
- Unit cost
- CL = \$500; CM = \$500; CH = \$500

# Example EOQ with LTL

| | *Litepro* | *Medpro* | *Heavypro* |
|---|---|---|---|
| **Demand per year** | **12,000** | **1,200** | **120** |
| **Fixed cost / order** | **$5,000** | **$5,000** | **$5,000** |
| **Optimal order size** | **1,095** | **346** | **110** |
| **Order frequency** | **11.0 / year** | **3.5 / year** | **1.1 / year** |
| **Annual cost** | **$109,544** | **$34,642** | **$10,954** |

**Total cost = $155,140**

# Example EOQ with LTL

- Cost comparison

# Example EOQ with LTL- 2nd option

$$Q^* = \sqrt{\frac{2RS}{kC}}$$

$$n^* = \sqrt{\frac{RKC}{2S}}$$

# Example EOQ with LTL- 2nd option

- S* = S + sL + sM + sH = 4000+1000+1000+1000 = $7000
- **n* = Sqrt[(RLkCL+ RMKCM+ RHkCH)/2S*]**
- = 9.75

# Example EOQ with LTL- $2^{nd}$ option

- $QL = RL/n^* = 12000/9.75 = 1230$
- $QM = RM/n^* = 1200/9.75 = 123$
- $QH = RH/n^* = 120/9.75 = 12.3$

# Example EOQ with LTL- 2nd option

| | *Litepro* | *Medpro* | *Heavypro* |
|---|---|---|---|
| **Demand per year** | **12,000** | **1,200** | **120** |
| **Order frequency** | **9.75/year** | **9.75/year** | **9.75/year** |
| **Optimal order size** | **1,230** | **123** | **12.3** |
| **Annual holding cost** | **$61,512** | **$6,151** | **$615** |

**Annual order cost = 9.75 × $7,000 = $68,250**

**Annual total cost = $136,528**

# Example EOQ with LTL- 2nd option

- Aggregation allows firm to lower lot size without increasing cost
- Complete aggregation is effective if product specific fixed cost is a small fraction of joint fixed cost

# EOQ with Tailored Aggregation-3rd Option

- **Step 1:** Identify the most frequently ordered product assuming each product is ordered independently

$$\overline{n}_i = \sqrt{\frac{kC_iR_i}{2(S+s_i)}}$$

# EOQ with Tailored Aggregation-3rd Option

- **Step 2:** For all products i ≠ i*, evaluate the ordering frequency

$$n_i = \sqrt{\frac{kC_iR_i}{2s_i}}$$

# EOQ with Tailored Aggregation-3rd Option

- **Step 3:** For all i ≠ i*, evaluate the frequency of product i relative to the most frequently ordered product i* to be mi

$$m_i = \left\lceil \bar{n} / \bar{n}_i \right\rceil$$

# EOQ with Tailored Aggregation-3rd Option

- **Step 4:** Recalculate the ordering frequency of the most frequently ordered product i* to be n

$$n = \sqrt{\frac{\sum_{i=1}^{l} kC_i m_i R_i}{2\left(S + \sum_{i=1}^{l} s_i / m_i\right)}}$$

# EOQ with Tailored Aggregation-3rd Option

- **Step 5:** Evaluate an order frequency of ni = n/mi and the total cost of such an ordering policy

$$TC = nS + \sum_{i=1}^{l} n_i s_i + \sum_{i-1}^{l} \left( \frac{R_i}{2n_i} \right) kC_1$$

# EOQ with Tailored Aggregation-3rd Option

- Tailored aggregation – higher-demand products ordered more frequently and lower-demand products ordered less frequently

# EOQ with Tailored Aggregation-Example

- Step 1:

$$\bar{n}_L = \sqrt{\frac{kC_L R_L}{2(S + s_L)}} = 11.0$$

$$\bar{n}_M = \sqrt{\frac{kC_M R_M}{2(S + s_M)}} = 3.5$$

$$\bar{n}_L = \sqrt{\frac{kC_H R_H}{2(S + s_H)}} = 1.1$$

$$\bar{n} = 11.0$$

# EOQ with Tailored Aggregation-Example

- Step 2:

$$\overline{\overline{n}}_M = \sqrt{\frac{kC_M R_M}{2s_M}} = 7.7 \text{ and } \overline{\overline{n}}_H = \sqrt{\frac{kC_H R_H}{2s_H}} = 2.4$$

Step 3:

$$m_M = \left\lceil \frac{\overline{n}}{\overline{\overline{n}}_M} \right\rceil = \left\lceil \frac{11.0}{7.7} \right\rceil = 2 \text{ and } m_H = \left\lceil \frac{\overline{n}}{\overline{\overline{n}}_H} \right\rceil = \left\lceil \frac{11.0}{2.4} \right\rceil = 5$$

# EOQ with Tailored Aggregation-Example

- Applying Step 4

$$n = 11.47$$

- Applying Step 5

$$n_L = 11.47 / \text{yr} \qquad n_M = 11.47/2 = 5.74 / \text{yr}$$

$$n_H = 11.47/5 = 2.29 / \text{yr}$$

Annual order cost

$$nS + n_L s_L + n_M s_M + n_H s_H = \$65{,}383.5$$

Total annual cost

\$130,767

# EOQ with Tailored Aggregation-Example

| | **Litepro** | **Medpro** | **Heavypro** |
|---|---|---|---|
| Demand per year ($D$) | 12,000 | 1,200 | 120 |
| Order frequency ($n*$) | 11.47/year | 5.74/year | 2.29/year |
| Optimal order size ($D/n*$) | 1,046 | 209 | 52 |
| Cycle inventory | 523 | 104.5 | 26 |
| Annual holding cost | $52,307 | $10,461 | $2,615 |
| Average flow time | 2.27 weeks | 4.53 weeks | 11.35 weeks |

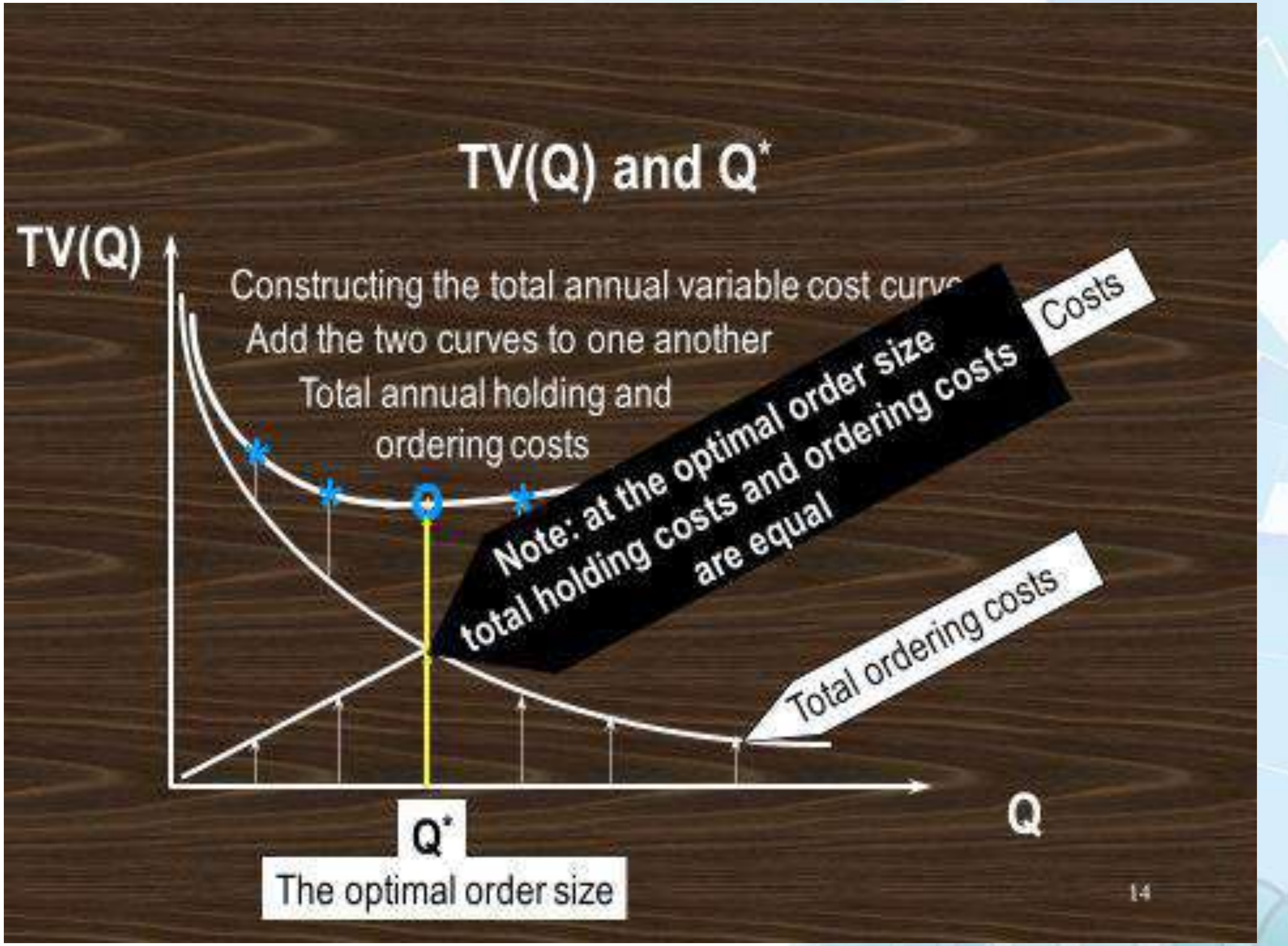
# EOQ with Tailored Aggregation-Example

- Compare the three Plans ! Which one is the best ?

# EOQ Sensitivity Analysis

- Recall the total cost function for EOQ !

# EOQ Sensitivity Analysis



TV(Q) and Q*

Constructing the total annual variable cost curv

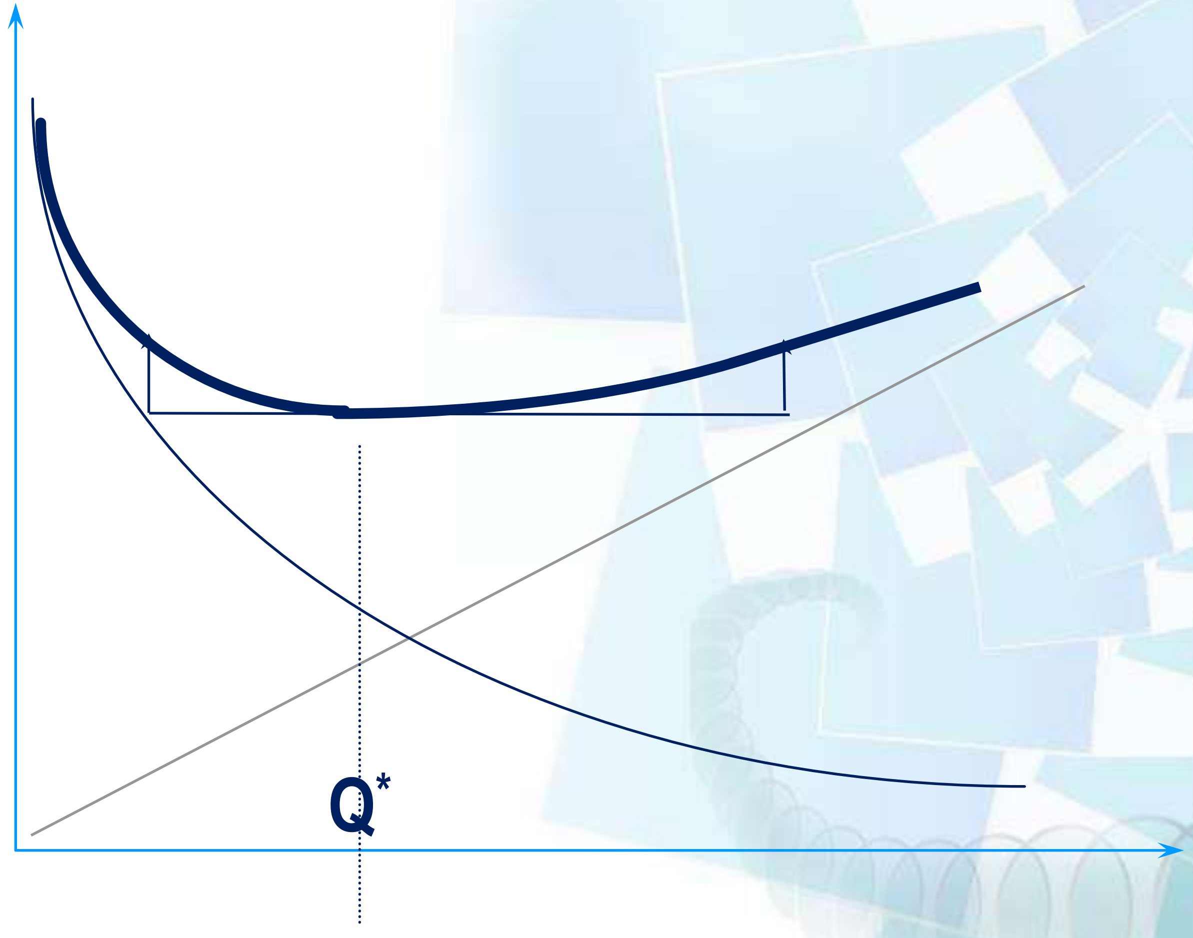
Add the two curves to one another

Total annual holding and ordering costs

Note: at the optimal order size total holding costs and ordering costs are equal

# EOQ Sensitivity Analysis

The curve is reasonably flat around $Q^*$.



# EOQ Sensitivity Analysis

- Deviations from the optimal order size cause only small increase in the total cost

# Inventory Uncertainty Factors

- **Cycle Time**
- The cycle time, T, represents the time that elapses between the placement of orders.

# Inventory Uncertainty Factors

- Note, if the cycle time is greater than the shelf life, items will go bad, and the model must be modified.
- T= Q/R

# Inventory Uncertainty Factors

- **Number of Orders per year**
- To find the number of orders per years take the reciprocal of the cycle time
- N= R/Q

# Inventory Uncertainty Factors

- Example: The demand for a product is 1000 units per year.
  The order size is 250 units under an EOQ policy.
- How many orders are placed per year?
  N = 1000/250 = 4 orders.

# Inventory Uncertainty Factors

- How often orders need to be placed (what is the cycle time)?
  T = 250/1000 = ¼ years.
- {Note: the four orders are equally spaced

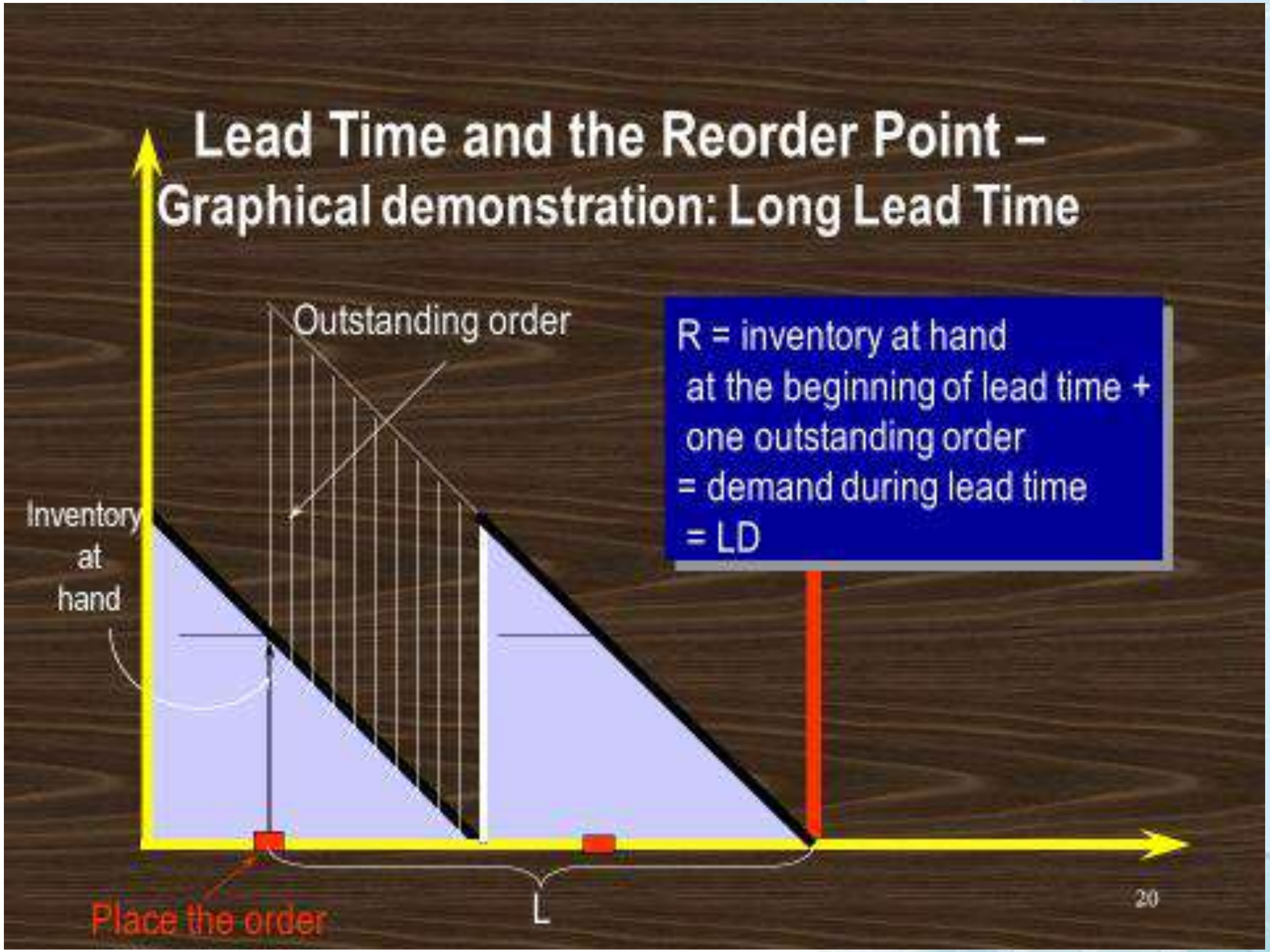
# Inventory Uncertainty Factors

- In reality lead time always exists, and must be accounted for when deciding when to place an order.
- The reorder point, RP, is the inventory position when an order is placed.

# Inventory Uncertainty Factors

- RP is calculated by
- RP=LD
- L and D must be expressed in the same time unit.

# Inventory Uncertainty Factors



## Lead Time and the Reorder Point –
## Graphical demonstration: Long Lead Time

R = inventory at hand
at the beginning of lead time +
one outstanding order
= demand during lead time
= LD

# Inventory Uncertainty Factors

Consistency !!

# Handling Uncertainty: Safety Stock

Safety stocks act as buffers to handle:

- Higher than average lead time demand.
- Longer than expected lead time.

# Handling Uncertainty: Safety Stock

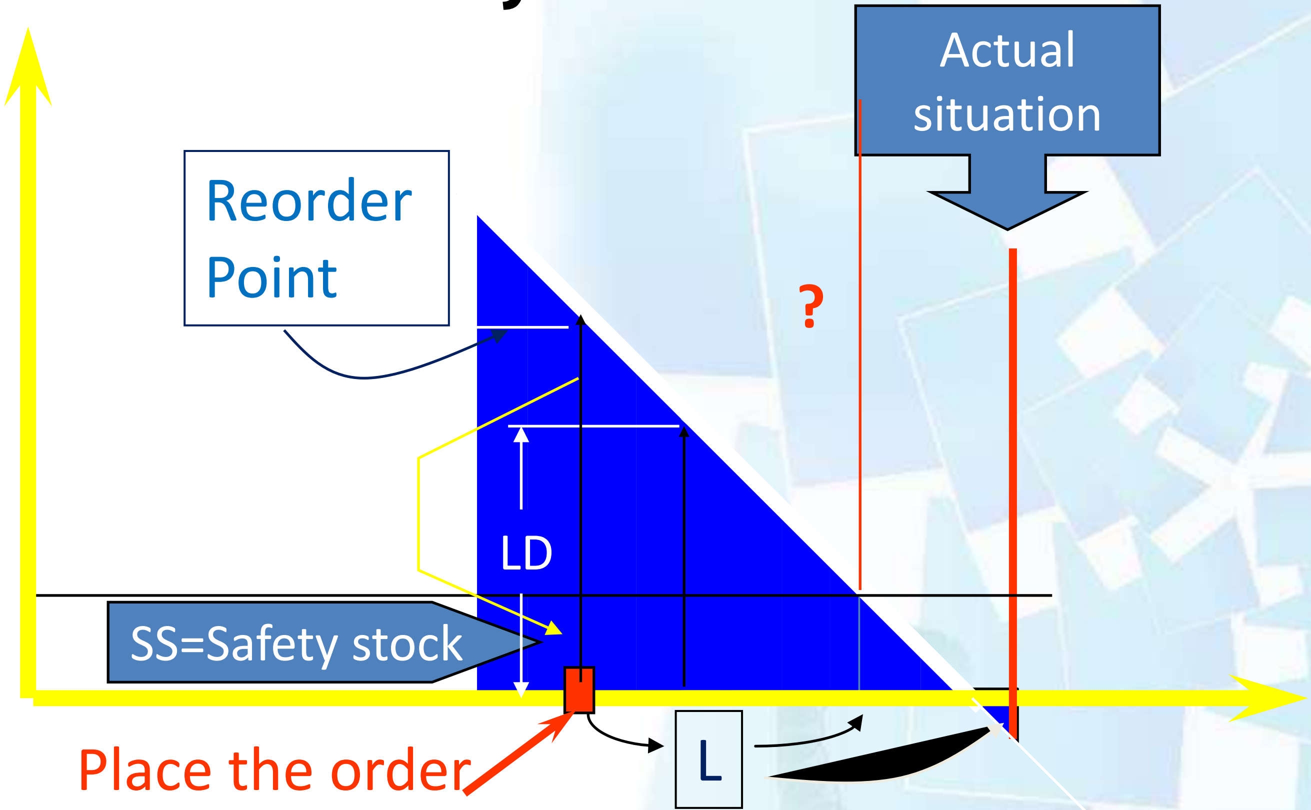
With the inclusion of safety stock (SS), RP is calculated by

RP=LD+SS

The size of the safety stock is based on having a desired service level.

# Handling Uncertainty: Safety Stock

## Safety stock



Actual situation

Reorder Point

SS=Safety stock

Place the order now

$$R = LD + SS$$

The safety stock prevents excessive shortages.

# Handling Uncertainty: Safety Stock

## **Inventory Costs**

Including safety stock

Total Annual Inventory Costs = Total Annual Holding Costs + Total Annual ordering Costs + Total Annual procurement Costs

$$TC(Q) = (Q/2)kC + (R/Q)S + RC + kCSS$$

Safety stock holding cost

# Handling Uncertainty: Safety Stock

Two-sword purpose

# Safety Stock- Example

AAC wholesales small appliances.

AAC currently orders 600 units of the Citron brand juicer each time inventory drops to 205 units.

Management wishes to determine an optimal ordering policy for the Citron brand juicer

# Safety Stock- Example

**Data**

S = \$12 (\$8 for placing an order) + (20 min. to check)(\$12 per hr)

H= \$1.40 [kC = (14%)(\$10)]

C = \$10.

# Safety Stock- Example

H = 14% (10% ann. interest rate) + (4% miscellaneous)

D = demand information of the last 10 weeks was collected:

# Safety Stock- Example

**Sales of Juicers over the last 10 weeks**

| | | | | | |
|---|---|---|---|---|---|
| **Week** | 1 | 2 | 3 | 4 | 5 |
| **Sales** | 105 | 115 | 125 | 120 | 125 |
| **Week** | 6 | 7 | 8 | 9 | 10 |
| **Sales** | 120 | 135 | 115 | 110 | 130 |

# Safety Stock- Example

The constant demand rate seems to be a good assumption.

Annual demand = (120/week)(52weeks) = 6240 juicers

# Safety Stock- Example

## EOQ and Total Variable Cost

**Current ordering policy calls for Q = 600 juicers.**

$TV(600) = (600 / 2)(\$1.40) + (6240 / 600)(\$12) = \$544.80$

**The EOQ policy calls for orders of size**

$$Q^* = \sqrt{\frac{2(6240)(12)}{1.40}} = 327.065 \rightarrow 327$$

**Savings of 16%**

$TV(327) = (327 / 2)(\$1.40) + (6240 / 327)(\$12) = \$457.89$

# Safety Stock- Example

Under the current ordering policy AAC holds 13 units safety stock (how come? Observe):

AAC is open 5 day a week.
The average daily demand = 120/week)/5 = 24 juicers…

# Safety Stock- Example

Lead time is 8 days. Lead time demand is (8)(24) = 192 juicers.

Reorder point without Safety stock = LD = 192.

Current policy: R = 205.

Safety stock = 205 – 192 = 13.

For safety stock of 13 juicers the total cost is

# Safety Stock- Example

**TC(327) = 457.89 + 6240($10) + (13)($1.40) = $62,876.09**

TV(327) + Procurement + Safety stock
cost holding cost

# Safety Stock- Example

- **Changing the order size**
  - Suppose juicers must be ordered in increments of 100 (order 300 or 400)
  - AAC will order Q = 300 juicers in each order.
  - There will be a total variable cost increase of $1.71.
  - This is less than 0.5% increase in variable costs.

# Safety Stock- Example

- **Changes in input parameters**
  - Suppose there is a 20% increase in demand. D=7500 juicers.
  - The new optimal order quantity is $Q^* = 359$.
  - The new variable total cost = TV(359) = $502
  - If AAC still orders Q = 327, its total variable costs becomes

**Only 0.4% increase**

**TV(327) = (327/2)($1.40) + (7500/327)($12) = $504.13**

# Safety Stock- Example

For an order size of 327 juicers we have:

T = (327/ 6240) = 0.0524 year.

0.0524(52)(5) = 14 days.

# Safety Stock- Example

This is useful information because:

Shelf life may be a problem.

Coordinating orders with other items might be desirable.

# Different Inventory Policies

- **Lot-for-lot**
- Order exactly what is needed
- **Fixed-order quantity**
- Specifies the number of units to order whenever an order is placed

# Different Inventory Policies

- ***Min-max system***
- Places a replenishment order when the on-hand inventory falls below the predetermined minimum level.
- **Order *n periods***
- Order quantity is determined by total demand for the item for the next ***n*** periods

# Different Inventory Policies

| **Lot for Lot Example** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Requirements | 70 | 70 | 65 | 60 | 55 | 85 | 75 | 85 |
| Projected-on-Hand (30) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Order Placement | 40 | 70 | 65 | 60 | 55 | 85 | 75 | 85 |

| **Fixed Order Quantity Example with Order Quantity of 200** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Requirements | 70 | 70 | 65 | 60 | 55 | 85 | 75 | 85 |
| Projected-on-Hand (30) | 160 | 90 | 25 | 165 | 110 | 25 | 150 | 65 |
| Order Placement | 200 | | | 200 | | | 200 | |

| **Min-Max Example with min.= 50 and max.= 250 units** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Requirements | 70 | 70 | 65 | 60 | 55 | 85 | 75 | 85 |
| Projected-on-Hand (30) | 180 | 110 | 185 | 125 | 70 | 165 | 90 | 165 |
| Order Placement | 220 | | 140 | | | 180 | | 160 |

| **Order *n* Periods with n = 3 periods** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Requirements | 70 | 70 | 65 | 60 | 55 | 85 | 75 | 85 |
| Projected-on-Hand (30) | 135 | 65 | 0 | 140 | 85 | 0 | 85 | 0 |
| Order Placement | 175 | | | 200 | | | 160 | |

# Different Inventory Policies

- Adaptive Logic

# Periodic Review Policy

- Orders are placed at specified, fixed-time intervals (e.g. every Friday), for a order size (Q) to bring on-hand inventory (OH) up to the target inventory (TI), similar to the min-max system.

# Periodic Review Policy

Advantages are:

- No need for a system to continuously monitor item
- Items ordered from the same supplier can be reviewed on the same day saving purchase order costs

# Periodic Review Policy

- Disadvantages:
- Replenishment quantities (Q) vary
- Order quantities may not qualify for quantity discounts
- On the average, inventory levels will be higher than Q system-more stockroom space needed

# Periodic Review Policy

**Targeted Inventory level:**

$TI = d(RP + L) + SS$

d = average period demand

RP = review period (days, wks)

L = lead time (days, wks)

SS = $z\sigma RP+L$

**Replenishment Quantity** (Q)=TI-OH

# Periodic Review Policy- Example

- An auto parts store calculated the EOQ for Drive Belts at 236 units and wants to compare the Total Inventory Costs for a Q vs. a P Review System.

# Periodic Review Policy- Example

- Annual demand (D) is 2704, avg. weekly demand is 52, weekly σ is 1.77 belts, and lead time is 3 weeks. The annual TC for the Q system is $229; H=$97, S=$10.

# Periodic Review Policy- Example

- **Review Period** $RP = \frac{Q}{D} \text{x } 52\text{weeks} = \frac{236}{2704} \text{x}52 = 5\text{wks}$
- **Target Inventory for 95% Service Level**

$$TI = d(RP + L) + SS = d(RP + L) + z\sigma_{RP + L}$$

$$TI = 52 \text{ units } (5 + 3) + (1.645)\left(1.77\sqrt{5 + 3}\right) = 416 + 8 = 424 \text{ belts}$$

- **Average On-Hand**

**$OH_{avg}$= TI-dL=424-(52belts)(3wks) = 268 belts**

- **Annual Total Cost (P System)**

$$TCp = \frac{52}{5}(\$10) + \frac{268}{2}(\$.97) = 115 + 130 = \$245$$

$$\text{Annual Cost Difference} = \$245 - \$229 = +\$16$$

# Periodic Review Policy- Example

- Need more inventory!

# Inventory Decision- Single Period

- The SPI model is designed for products that share the following characteristics:
- Sold at their regular price only during a single-time period
- Demand is highly variable but follows a known probability distribution

# Inventory Decision- Single Period

- Salvage value is less than its original cost so money is lost when these products are sold for their salvage value
- Objective is to balance the gross profit of the sale of a unit with the cost incurred when a unit is sold after its primary selling period

# Inventory Decision- Single Period

- T shirts are purchase in multiples of 10 for a charity event for $8 each. When sold during the event the selling price is $20. After the event their salvage value is just $2.

# Inventory Decision- Single Period

- From past events the organizers know the probability of selling different quantities of tee shirts within a range from 80 to 120

# Inventory Decision- Single Period

## Payoff Table

| **Prob. Of Occurrence** | **.20** | **.25** | **.30** | **.15** | **.10** | |
|---|---|---|---|---|---|---|
| **Customer Demand** | **80** | **90** | **100** | **110** | **120** | |
| **# of Shirts Ordered** | | | | | | **Profit** |
| 80 | $960 | $960 | $960 | $960 | $960 | $960 |
| 90 | $900 | $1080 | $1080 | $1080 | $1080 | $1040 |
| **Buy 100** | $840 | $1020 | $1200 | $1200 | $1200 | $1083 |
| 110 | $780 | $ 960 | $1140 | $1320 | $1320 | $1068 |
| 120 | $720 | $ 900 | $1080 | $1260 | $1440 | $1026 |

**Sample calculations:**

**Payoff (Buy 110)= sell 100($20-$8) –((110-100) x ($8-$2))= $1140**

**Expected Profit (Buy 100)= ($840 x .20)+($1020 x .25)+($1200 x .30) + ($1200 x .15)+($1200 x .10) = $1083**

# Inventory Decision- Single Period

- SPI model is based on predicted demand.

# Service Level Approach

- Businesses incorporate safety stock requirements when determining reorder points.
- A possible approach to determining safety stock levels is by specifying desired service level .

# Service Level Approach

- **The cycle service level**
- The probability of not incurring a stockout during an inventory cycle.
- Applied when the likelihood of a stockout, and not its magnitude, is important for the firm.

# Service Level Approach

- **The unit service level**
- The percentage of demands that are filled without incurring any delay.
- Applied when the percentage of unsatisfied demand should be under control.

# Cycle Service Level Approach

- In many cases short run demand is variable even though long run demand is assumed constant. Therefore, stockout events during lead time may occur unexpectedly in each cycle.

# Cycle Service Level Approach

- Stockouts occur only if demand during lead time is greater than the reorder point.

# Cycle Service Level Approach

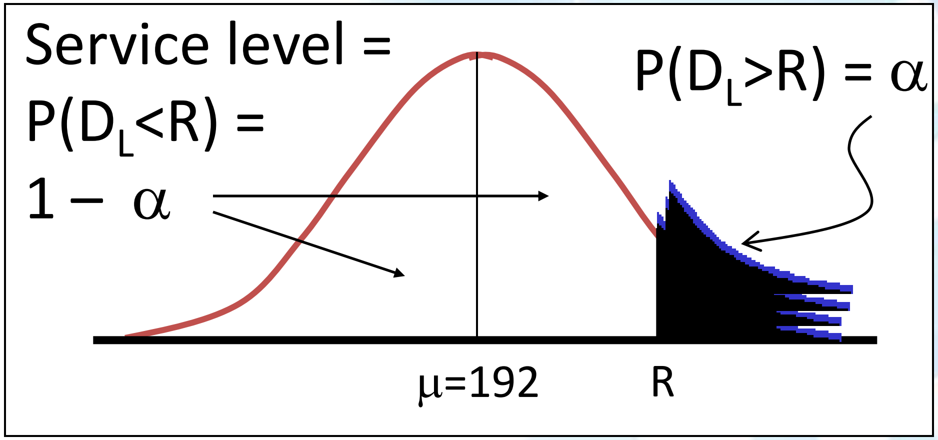
- To determine the reorder point we need to know:
  - The lead time demand distribution.
  - The required service level.

# Cycle Service Level Approach

- In many cases lead time demand is approximately normally distributed. For the normal distribution case the reorder point is calculated by $\boxed{R = \mu_L + z_\alpha \sigma_L}$

# The Cycle Service Level Approach

$1 - \alpha$ = service level



**$P(D_L > R) = P(Z > (R - \mu_L)/\sigma_L) = \alpha$. Since $P(Z > Z_\alpha) = \alpha$, we have $Z_\alpha = (R - \mu_L)/\sigma_L$, which gives…**

$$R = \mu_L + z_\alpha \sigma_L$$

# Cycle Service Level Approach

- Assume that lead time demand is normally distributed.
- Estimation of the normal distribution parameters:

# Cycle Service Level Approach

- Estimation of the mean weekly demand = ten weeks average demand = 120 juicers per week.

- Estimation of the variance of the weekly demand = Sample variance = 83.33 juicers

# Cycle Service Level Approach

- To find $\mu_L$ and $\sigma_L$ the parameters $\mu$ (per week) and $\sigma$ (per week) must be adjusted since the lead time is longer than one week.
  - Lead time is 8 days $=(8/5)$ weeks = 1.6 weeks.
- Estimates for the <u>lead time</u> mean demand and variance of demand

$$\mu_L \approx (1.6)(120) = 192; \quad \sigma^2_L \approx (1.6)(83.33) = 133.33$$

# Cycle Service Level Approach

- Let us use the current reorder point of 205 juicers.

$$205 = 192 + z\left(11.55\right) \Rightarrow z = 1.13$$

$$\sqrt{133.33}$$

- From the normal distribution table we have that a reorder point of 205 juicers results in an 87% cycle service level.

# Cycle Service Level Approach

- Management wants to improve the cycle service level to 99%.
- The z value corresponding to 1% right hand tail is 2.33.

$$R = 192 + 2.33(11.55) = 219 \text{ juicers.}$$

# Cycle Service Level Approach

- AAC is willing to run out of stock an average of at most one cycle per year with an order quantity of 327 juicers.

- What is the equivalent service level for this strategy?

# Cycle Service Level Approach

- There will be an average of 6240/327 = 19.08 lead times per year.
- The likelihood of stockouts = 1/19 = 0.0524.
- This translates into a service level of 94.76%

# Unit Service Level Approach

- When lead time demand follows a normal distribution

  service level can be calculated as follows:

- Determine the value of z that satisfy the equation

$$L(z) = \alpha Q^{*} / \sigma_L$$

# Unit Service Level Approach

- Solve for R using the equation

$$R = \mu_L + z\sigma_L$$

# Planned Shortage Model

- When an item is out of stock, customers may:
- Go somewhere else (lost sales).
- Place their order and wait (backordering).

# Planned Shortage Model

- In this model we consider the backordering case.
- All the other EOQ assumptions are in place.

# Planned Shortage Model

The parameters of the total variable costs function are similar to those used in the EOQ model.

In addition, we need to incorporate the shortage costs in the model.

# Planned Shortage Model

Backorder cost per unit per year (loss of goodwill cost) - Cs.

-Reflects future reduction in profitability…

-Can be estimated from market surveys and focus groups.

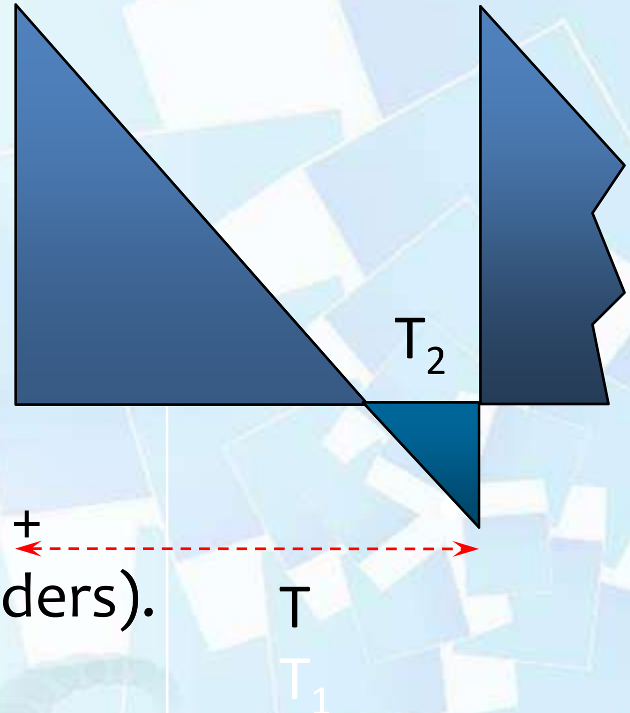
# Planned Shortage Model

Backorder administrative cost per unit - Cb.

Reflects additional work needed to take care of the backorder.

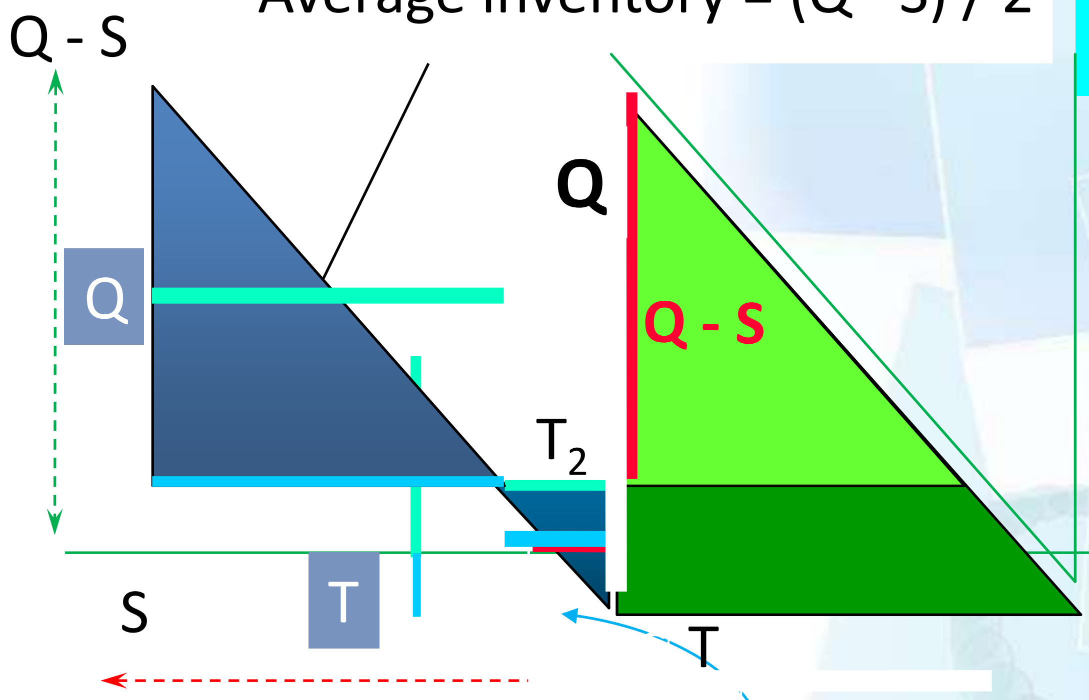
- In this model we consider the backordering case.
- All the other EOQ assumptions are in place.

# Planned Shortage Model



- The Annual holding cost = $C_h[T_1/T]$(Average inventory) = $C_h[T_1/T]\,(Q\text{-}S)/2$
- The Annual shortage cost = $C_b$(number of backorders per year) + $C_s(T_2/T)$(Average number of backorders).
- To calculate the annual holding cost and shortage cost we need to find
  - The proportion of time inventory is carried, $(T_1/T)$
  - The proportion of time demand is backordered, $(T_2/T)$.

# Planned Shortage Model



Average inventory = $(Q - S) / 2$

Proportion of time inventory exists $= T_1/T$

$= (Q - S) / Q$

Proportion of time shortage exists $= T_2/T$

$= S / Q$

Average shortage = $S / 2$

# Planned Shortage Model

- **Annual holding cost:**

  $C_h[T_1/T](Q\text{-}S)/2 = C_h[(Q\text{-}S)/Q](Q\text{-}S)/2$

  $= C_h(Q\text{-}S)^2/2Q$

- **Annual shortage cost:**

  $C_b$(Units in short per year) +

  $C_s[T_2/T]$(Average number of backorders) =

  $C_b(S)(D/Q) + C_s S^2/2Q$

# Planned Shortage Model

- The total annual variable cost equation

$$TV(Q,S) = \frac{(Q-S)^2}{2Q}C_h + \frac{D}{Q}(C_o + SC_b) + \frac{S^2}{2Q}C_S$$

Holding costs

Ordering costs

Time independent backorder costs

Time dependent backorder costs

# Planned Shortage Model

The optimal solution to this problem is obtained under the following conditions

$$C_s > 0 \; ;$$

$$C_b < \sqrt{2C_oC_h / D}$$

# Planned Shortage Model

The Optimal Order Size

$$Q^* = \sqrt{\frac{2DC_o}{C_h} \text{x} \frac{C_h + C_s}{C_s} - \frac{(DC_b)^2}{C_h C_s}}$$

The Optimal Backorder level

$$S^* = \frac{Q^* C_h - DC_b}{C_h + C_s}$$

Reorder Point

$R = L\,D - S^*$

# Planned Shortages Model- Example

- Scanlon distributes a portable sauna from Sweden.
- Data
- A sauna costs Scanlon \$2400.
- Annual holding cost per unit \$525.

# Planned Shortages Model- Example

- Fixed ordering cost $1250 (fairly high, due to costly transportation).
- Lead time is 4 weeks.
- Demand is 15 saunas per week on the average.

# Planned Shortages Model- Example

- Scanlon estimates a \$20 goodwill cost for each week a customer who orders a sauna has to wait for delivery.
- Administrative backordrer cost is \$10.

# Planned Shortages Model- Example

- Management wishes to know:
- The optimal order quantity.
- The optimal number of backorders.

# Planned Shortages Model- Example

Input for the total variable cost function

D = 780 saunas

[(15)(52)]

Co = $1,250

Ch = $525

Cs = $1,040

Cb = $10

# Planned Shortages Model- Example

$$Q^* = \sqrt{\frac{2(780)(1250)}{525} \text{ x } \frac{525+1040}{1040} \quad \frac{(780)(10)^2}{(525)(1040)}} \approx 74$$

$$S^* = \frac{(74)(525) - (780)(10)}{525 + 1040} \approx 20$$

$$R = (4 / 52)(780) - 20 = 40$$

# Review Systems – Continuous Review

- **(R, Q) Policies**
  - The EOQ, production lot size, and planned shortage models assume that
    - inventory levels are continuously monitored
    - Items are sold one at a time.

# Review Systems – Continuous Review

The above models call for order point (R) order quantity (Q) inventory policies.  Such policies can be implemented by

-A point-of-sale computerized system.

-The two-bin system.

# Review Systems – Continuous Review

**(R, M) policies**

When items are not necessarily sold one at a time, the reorder point might be missed, and out of stock situations might occur more frequently.

# Review Systems – Continuous Review

The order to level (R, M) policy may be implemented in this situation.

The R, M policy replenishes inventory up to a pre-determined level M.

# Review Systems – Continuous Review

The order to level (R, M) policy may be implemented in this situation.

The R, M policy replenishes inventory up to a pre-determined level M.

# Review Systems – Continuous Review

Order $Q = Q^* + (R - I) = (M - SS) + (R - I)$ each time the inventory falls to the reorder point R or below.

(Order size may vary from one cycle to another).

# Review Systems – Periodic Review

- It may be difficult or impossible to adopt a continuous review system, because of:
- The high price of a computerized system…

# Review Systems – Periodic Review

- Lack of space to adopt the two-bin system.
- Operations inefficiency when ordering different items from the same vendor separately….

# Review Systems – Periodic Review

- The periodic review system may be found more suitable for these situations.
- Under this system the inventory position for each item is observed periodically…

# Review Systems – Periodic Review

- Orders for different items can be better coordinated periodically.

# Review Systems – Periodic Review

- **(T,M) Policies**
- In a replenishment cycle policy (T, M), the inventory position is reviewed every T time units….

# Review Systems – Periodic Review

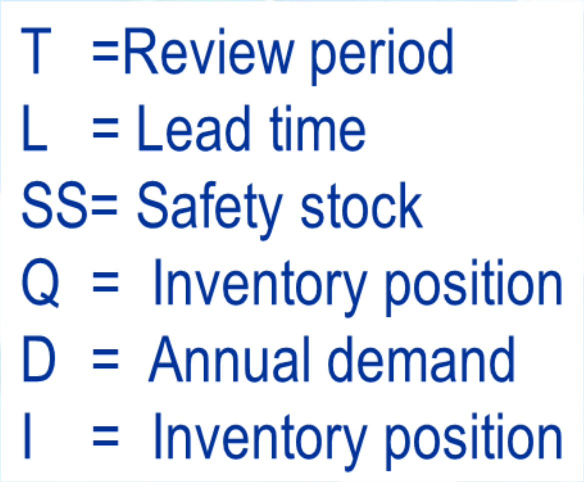
- An order is placed to bring the inventory level back up to a maximum inventory level M.
- M is determined by…

# Review Systems – Periodic Review

- Forecasting the number of units demanded during the review period T.
- Adding the desired safety stock to the forecasted demand…

# Review Systems – Periodic Review

- Calculation of the replenishment level and order size



T =Review period
L = Lead time
SS= Safety stock
Q = Inventory position
D = Annual demand
I = Inventory position

# Review Systems – Periodic Review

- M= TD+SS
- Q= M+LD - I

# Review Systems – Periodic Review

- Periodic or Continuous !

# TM Policy- Example

- Every three weeks AAC receives deliveries of different products from Citron.
- Lead time is eight days for ordering Citron’s juicers.

# TM Policy- Example

- AAC is now reviewing its juicer inventory and finds 210 in stock.
- How many juicers should AAC order for a safety stock of 30 juicers?

# TM Policy- Example

Review period T = 3 weeks = 3/52 = .05769 years

Lead time = L = 8 days = 8/260 = .03077 years,

# TM Policy- Example

Demand D = 6240 juicers per year,

Safety stock SS = 30 juicers,

Inventory position I = 210 juicers

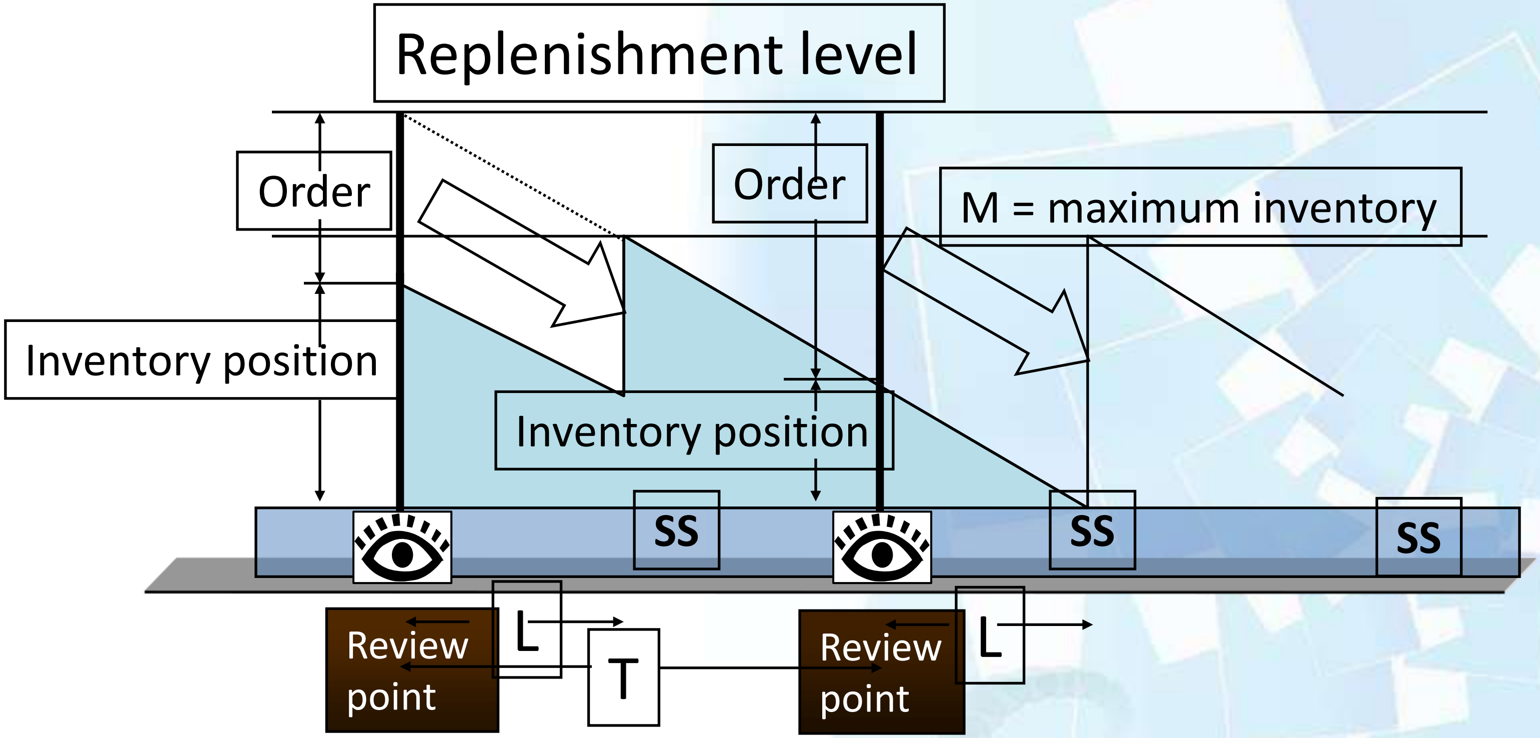
# TM Policy- Example

Review period demand = TD = ( 3/52)(6240) = 360 juicers,

M = TD + SS = 360 + 30 = 390 juicers,

Q = M + LD – I = 390 + .03077(6240) - 210 = 372 juicers.

# TM Policy- Example



Notice: I + Q is designed to satisfy the demand within an interval of T + L. To obtain the replenishment level add SS to I + Q.

# Single Period Inventory Model- Newsvendor

- Shelf life of the item is limited.
- Demand is stochastic and a known distribution.
- Inventory is saleable only within a single time period.
- Inventory is delivered only once during a time period.

# Single Period Inventory Model- Newsvendor

- At the end of each period, unsold inventory is disposed of for some salvage.
- The salvage value is less than the cost per item.
- Unsatisfied demand may result in shortage costs.

# Single Period Inventory Model- Newsvendor

- To find an optimal order quantity we need to balance the expected cost of over-ordering and under ordering.

- The expected profit is a function of the order size, the random demand, and the various costs.

# Single Period Inventory Model- Newsvendor

$$\text{Expected Profit} = \sum (\text{Profit when Demand=X})\,\text{Prob}(\text{Demand=X})$$

# Single Period Inventory Model- Newsvendor

- **Notation**
- p = per unit selling price of the good.
- c = per unit cost of the good.
- s = per unit salvage value of unsold good.
- K = fixed purchasing costs
- Q = order quantity.

# Single Period Inventory Model- Newsvendor

- EP(Q) = Expected Profit if Q units are ordered.
- **Scenarios**
- Demand X is less than the order quantity (X < Q).
- Demand X is greater than or equal to the order quantity (X >Q).

# Single Period Inventory Model- Newsvendor

- EP(Q) = Expected Profit if Q units are ordered.
- **Scenarios**
- Demand X is less than the order quantity ($X < Q$).
- Demand X is greater than or equal to the order quantity ($X \geq Q$).

# Single Period Inventory Model- Newsvendor

- **Scenario 1:** Demand X is less than the units stocked, Q.

Profit = pX + s(Q - X) - cQ - K

- Scenario 2: Demand X is greater than or equal to the units stocked.

# Single Period Inventory Model- Newsvendor

**Scenario 2:** Demand X is greater than or equal to the units stocked.

$$\text{Profit} = pQ - g(X - Q) - cQ - K$$

$$EP(Q) = \sum_{X<Q} [pX+s(Q - X) - cQ - K]P(X)$$

$$+\sum_{X\geq Q} [pQ - g(X - Q) - cQ - K]P(X)$$

# Single Period Inventory Model- Newsvendor

- To maximize the expected profit order $Q^*$
  - For the discrete demand case take the smallest value of $Q^*$

    that satisfies the condition

$$P(D \le Q^*) \ge (p - c + g)/(p - s + g)$$

  - For the continuous demand case find the $Q^*$ that solves

$$F(Q^*) = (p - c + g) /(p - s + g)$$

# Newsvendor Model- Example

- Management in Wendell's wishes to determine the number of donuts to prepare for sale, on weekday evenings
- Unit cost is $0.15.
- Unit selling price is $0.35.

# Newsvendor Model- Example

- Unsold donuts are donated to charity for a tax credit of \$0.05 per donut.
- Customer goodwill cost is \$0.25.
- Operating costs are \$15 per evening.

# Newsvendor Model- Example

- Demand is normally distributed with a mean of 120, and a standard deviation of 20 donuts.

p = $0.35

c = $0.15

s = $0.05

g = $0.25

K = $15.00

# Newsvendor Model- Example

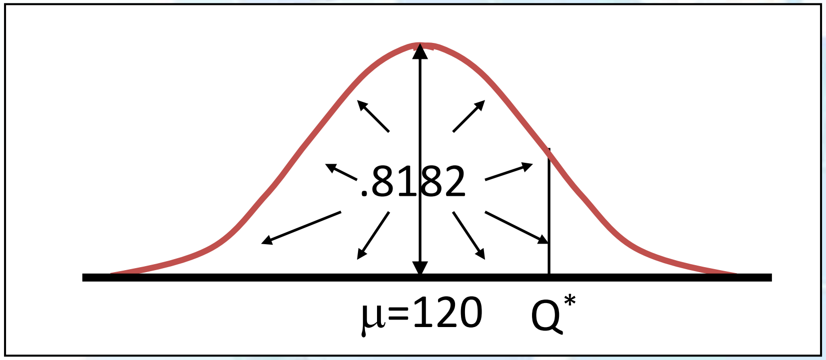
$$\text{The optimal service level} = \frac{p + g - c}{p + g - s}$$

$$= \frac{0.35 + 0.25 - 0.15}{0.35 + 0.25 - 0.05} = 0.8182$$

# Newsvendor Model- Example

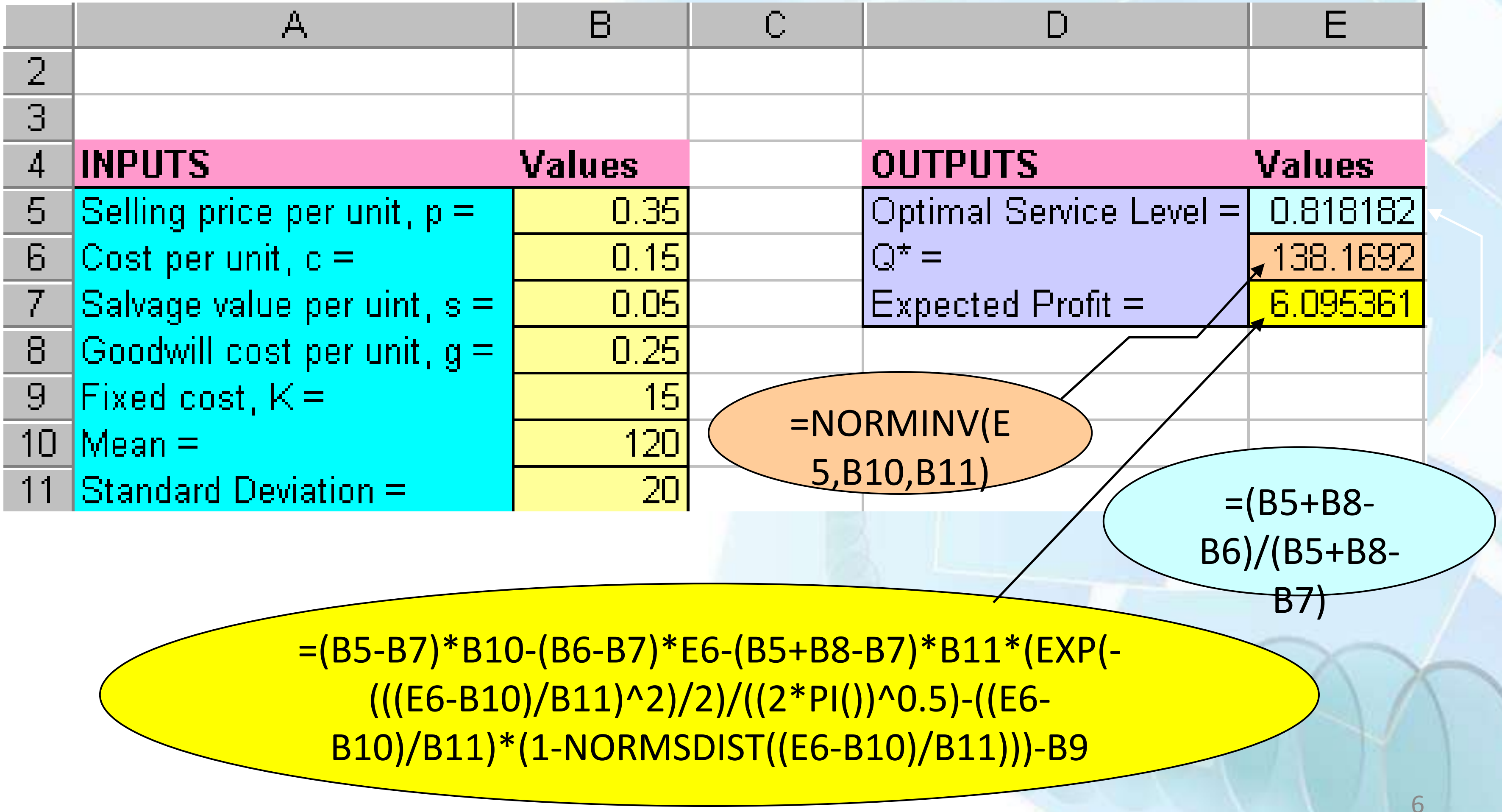
- From the relationship $F(Q^*) = 0.8182$ we find the corresponding z value.
- From the standard normal table we have $z = 0.3186$.
- The optimal order quantity is calculated by

$$Q^* = \mu + z\sigma$$



- For Wendell's $Q^* = 120 + (0.3186)(20)$ @ 138

# Newsvendor Model- Example



| | A | B | C | D | E |
|---|---|---|---|---|---|
| 2 | | | | | |
| 3 | | | | | |
| 4 | **INPUTS** | **Values** | | **OUTPUTS** | **Values** |
| 5 | Selling price per unit, p = | 0.35 | | Optimal Service Level = | 0.818182 |
| 6 | Cost per unit, c = | 0.15 | | Q* = | 138.1692 |
| 7 | Salvage value per uint, s = | 0.05 | | Expected Profit = | 6.095361 |
| 8 | Goodwill cost per unit, g = | 0.25 | | | |
| 9 | Fixed cost, K = | 15 | | | |
| 10 | Mean = | 120 | | | |
| 11 | Standard Deviation = | 20 | | | |

=NORMINV(E5,B10,B11)

=(B5+B8-B6)/(B5+B8-B7)

=(B5-B7)*B10-(B6-B7)*E6-(B5+B8-B7)*B11*(EXP(-(((E6-B10)/B11)^2)/2)/((2*PI())^0.5)-((E6-B10)/B11)*(1-NORMSDIST((E6-B10)/B11)))-B9

# Newsvendor Model- Example

- NORMINV(C.F, mean, standard deviation)

# Newsvendor: Behavioral Aspect

- Cachon et al (2000) emphasized on behavioral Newsvendor.

# Importance of Transportation

- Globalization has elevated transportation to a more strategic role and a source of competitive advantages in many organizational supply chains.

# Importance of Transportation

- The global economic landscape has changed significantly – The emergence of BRIC and VISTA countries.

# Importance of Transportation

- The global flow between countries of imports and exports continues to expand, fostered by:
- Population growth and age distribution
- Urbanization
- Land and resources
- IT and non-IT technologies

# Importance of Transportation

- Trade agreements among countries
- A reduction in tariffs
- Greater acceptance of importing finished products (vs. raw materials)

# Importance of Transportation

- **Absolute advantage**
- Access to certain materials or products not available domestically

# Importance of Transportation

- **Comparative advantage**
- Differences in the cost of producing products in different countries

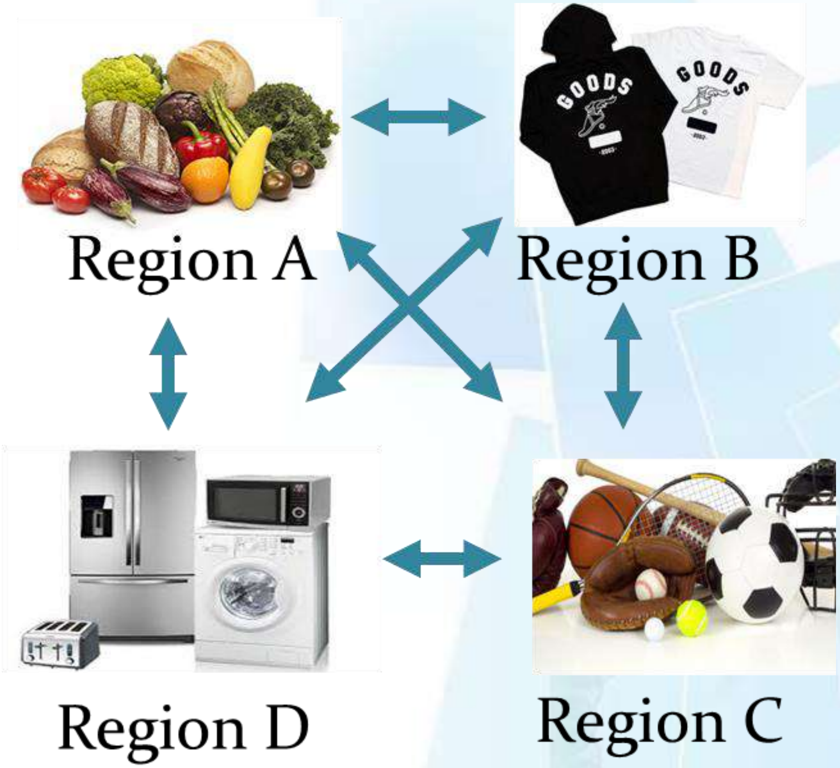
# Economic Significance of Transportation

- A geographical area specializes in the mass production of particular goods and/or services.

# Economic Significance of Transportation

- Transportation bridges the supply and demand gap inherent in the mass production oriented approach.
- Transportation lowers “landed cost” to production factors.

# Economic Significance of Transportation



Region A

Region B

Region D

Region C

# Economic Significance of Transportation

- Workforce mobility
- Growth of suburban areas
- Increased land and property values
- Tourism

# Economics of Transportation

- Aggregate demand for transportation is inelastic. Freight rate reductions will not dramatically increase the demand for freight transportation.

# Economics of Transportation

- Demand for specific modes of transportation or specific carriers is generally elastic or price sensitive. Reductions in rates charged by a particular mode usually result in increases in the volume of freight by that mode.

# Economics of Transportation

Mode

Carrier

# Economics of Transportation

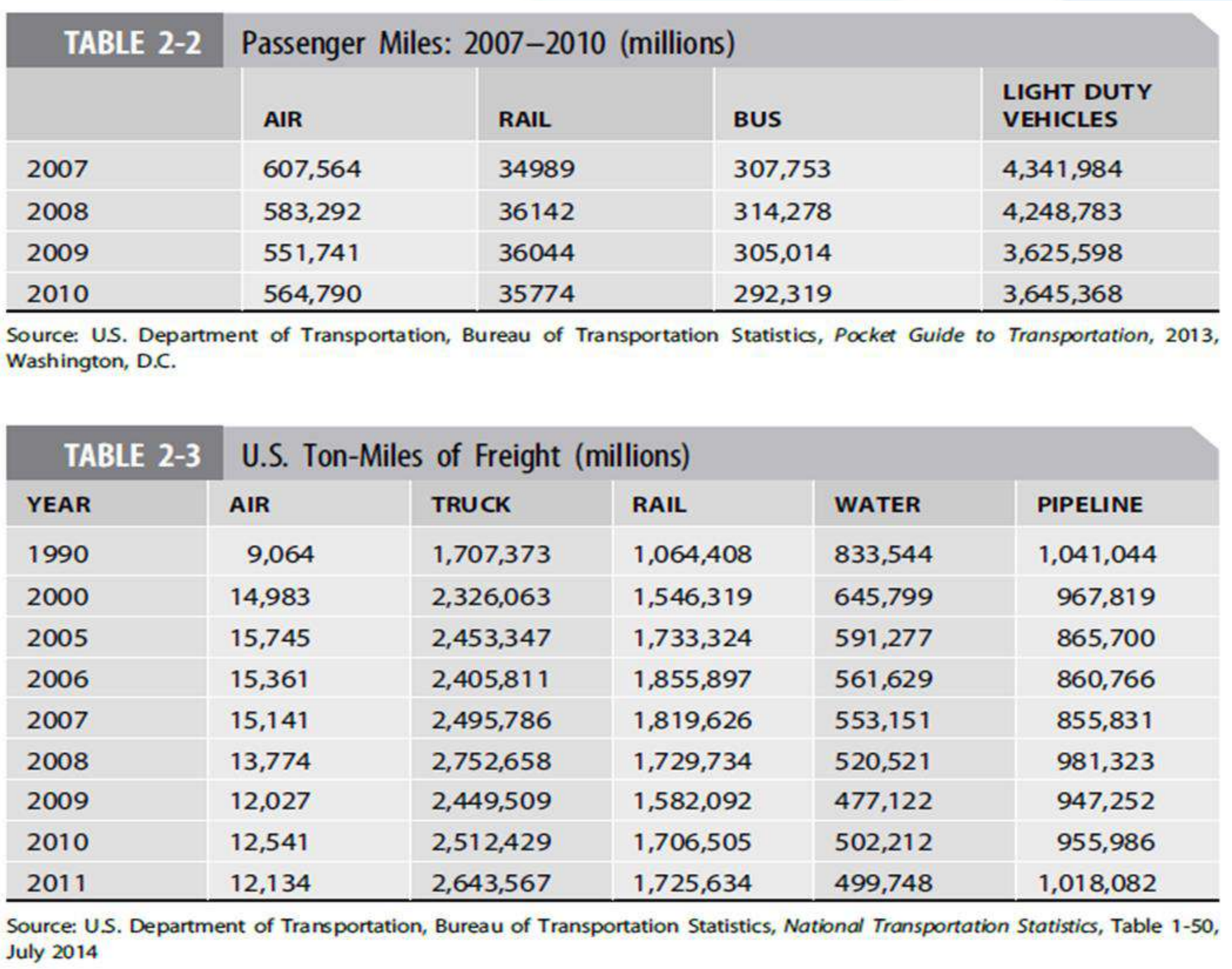


**TABLE 2-2** Passenger Miles: 2007–2010 (millions)

| | AIR | RAIL | BUS | LIGHT DUTY VEHICLES |
|---|---|---|---|---|
| 2007 | 607,564 | 34989 | 307,753 | 4,341,984 |
| 2008 | 583,292 | 36142 | 314,278 | 4,248,783 |
| 2009 | 551,741 | 36044 | 305,014 | 3,625,598 |
| 2010 | 564,790 | 35774 | 292,319 | 3,645,368 |

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, *Pocket Guide to Transportation*, 2013, Washington, D.C.

**TABLE 2-3** U.S. Ton-Miles of Freight (millions)

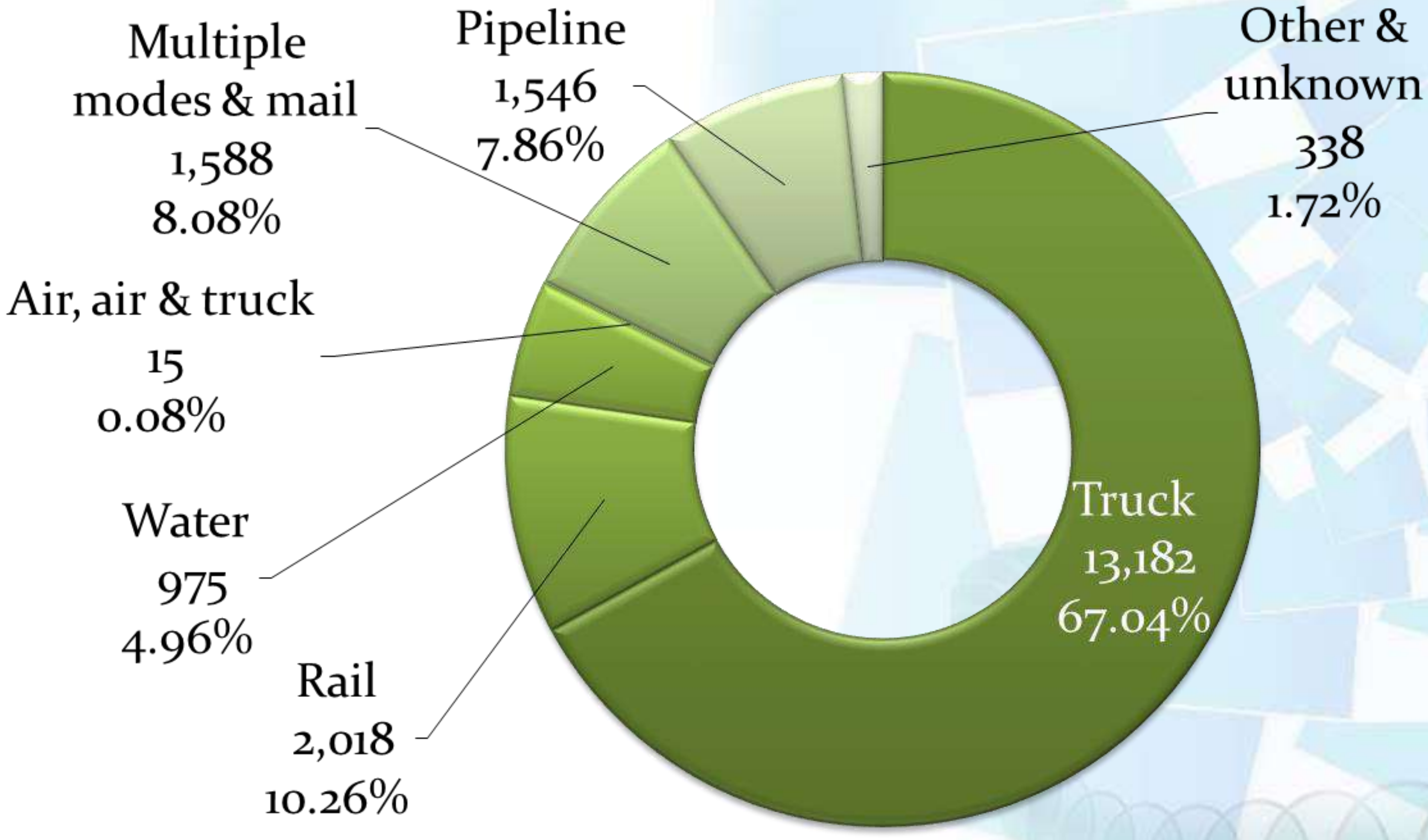
| YEAR | AIR | TRUCK | RAIL | WATER | PIPELINE |
|---|---|---|---|---|---|
| 1990 | 9,064 | 1,707,373 | 1,064,408 | 833,544 | 1,041,044 |
| 2000 | 14,983 | 2,326,063 | 1,546,319 | 645,799 | 967,819 |
| 2005 | 15,745 | 2,453,347 | 1,733,324 | 591,277 | 865,700 |
| 2006 | 15,361 | 2,405,811 | 1,855,897 | 561,629 | 860,766 |
| 2007 | 15,141 | 2,495,786 | 1,819,626 | 553,151 | 855,831 |
| 2008 | 13,774 | 2,752,658 | 1,729,734 | 520,521 | 981,323 |
| 2009 | 12,027 | 2,449,509 | 1,582,092 | 477,122 | 947,252 |
| 2010 | 12,541 | 2,512,429 | 1,706,505 | 502,212 | 955,986 |
| 2011 | 12,134 | 2,643,567 | 1,725,634 | 499,748 | 1,018,082 |

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 1-50, July 2014

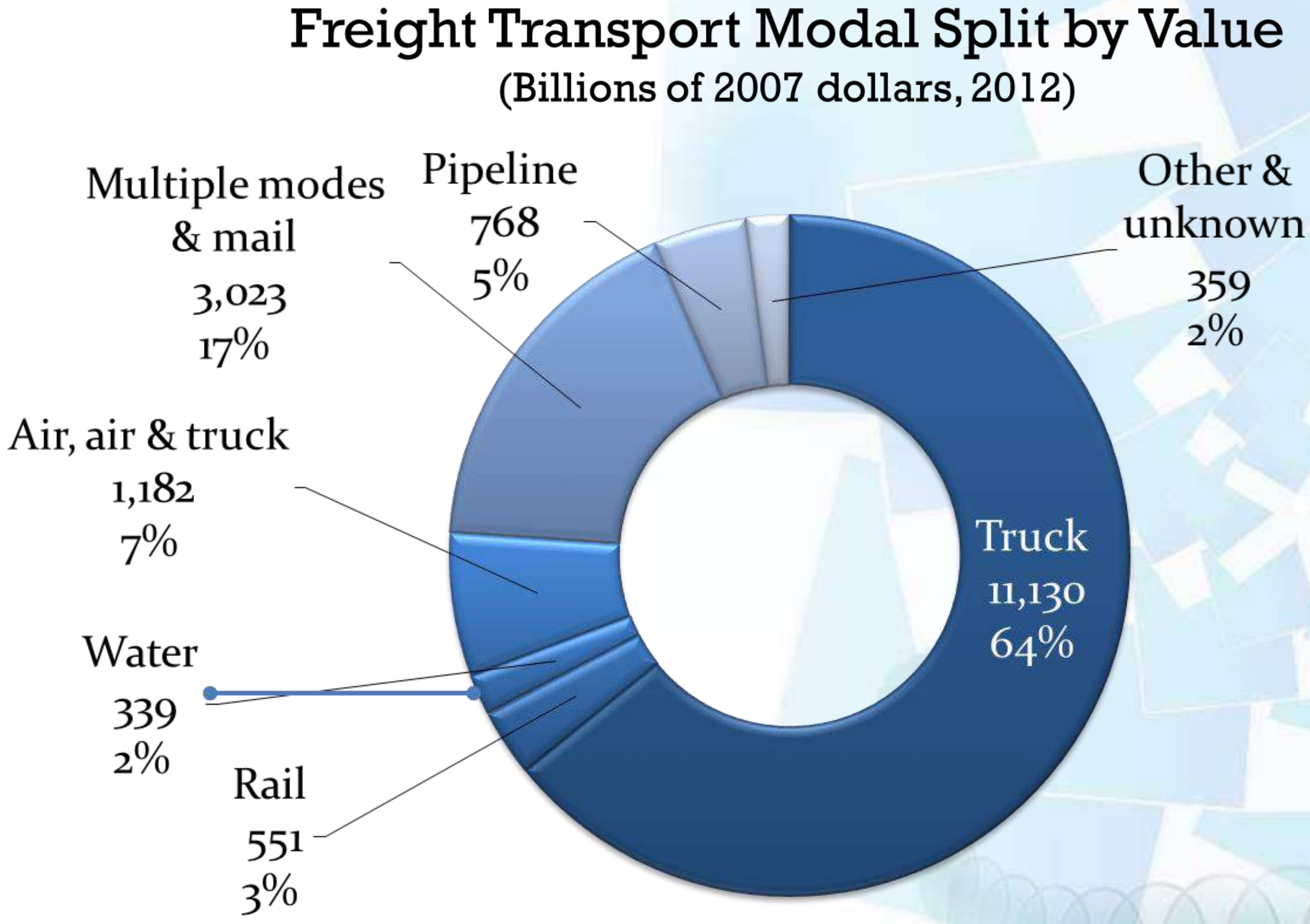
# Economics of Transportation

## Freight Transport Modal Split by Weight

(Millions of Tons, 2012)



# Economics of Transportation



# Economics of Transportation

- Derived Demand !

# Value of Transportation Service

- The impact of transportation costs and service on the demand for the product.

# Value of Transportation Service

## Landed Cost Example

① Production cost of overseas supplier
\+ ② Overseas warehouse & transport costs
\+ ③ Export tariffs
\+ ④ International freight transportation costs
\+ ⑤ Import duties
\+ ⑥ Buyer warehouse & transport costs
= ⑦ Landed costs at buyer facility

# Value of Transportation Service

## Service Components of Freight Demand

1 Transit time

2 Reliability

3 Accessibility

4 Security

# Value of Transportation Service

## Utilities of Transportation

- Place utility
- Time utility
- Quantity utility
- Cost utility of large-scale production

# Value of Transportation Service

- Transportation contributes to the value of goods by providing time and place utility that enhance the possibility of scale economies and increased market areas.

# Public Transportation Promotion

- Promotion connotes encouragement or provision of aid or assistance so transportation can grow or survive.

# Public Transportation Promotion

- **Two major concepts:**
- Created and assessed to pay for some or all of the services used by the carrier or mode. ( User Charges)

# Public Transportation Promotion

- Represents an extreme form of public assistance or provision of transportation.
- (Nationalization)

# Public Transportation Promotion

- Existence Charge:

A charge made against the person or tangible item unit regardless of the extent of use made of the services (e.g. driver’s license and auto registration fees)

# Public Transportation Promotion

- Unit Charge:

Fee assessed for use of a facility or resource, variable according to use, but does not distinguish between passengers or freight within each unit (e.g. tolls and fuel mileage taxes)

# Nationalization

- **Advantages of nationalization of transportation**
- Services can be provided that would not exist under private ownership.
- Capital can be attracted at favorable rates.

# Nationalization

- Criticisms of nationalized transport organizations
  - Slow to innovate
  - Unresponsive to the general public

# Nationalization

- – Dependent on large management staffs
- – Subject to political influence

# Nationalization

- Transport policy is vital as a direction for national resource allocation and the quality of services.

# Nationalization

- User charges play an important role in public transportation promotion.
- Movement toward privatization (vs. nationalization)

# Rates vs. Prices of Transportation Services

- All interstate rail freight traffic and much motor freight traffic was moved on published (tariff) rates.…

# Rates vs. Prices of Transportation Services

- A lawful charge that a carrier can impose on a given commodity movement.
- Determined primarily by considering a carrier's costs

# Rates vs. Prices of Transportation Services

- A lawful charge that a carrier can impose on a given commodity movement.
- Determined primarily by considering a carrier’s costs.

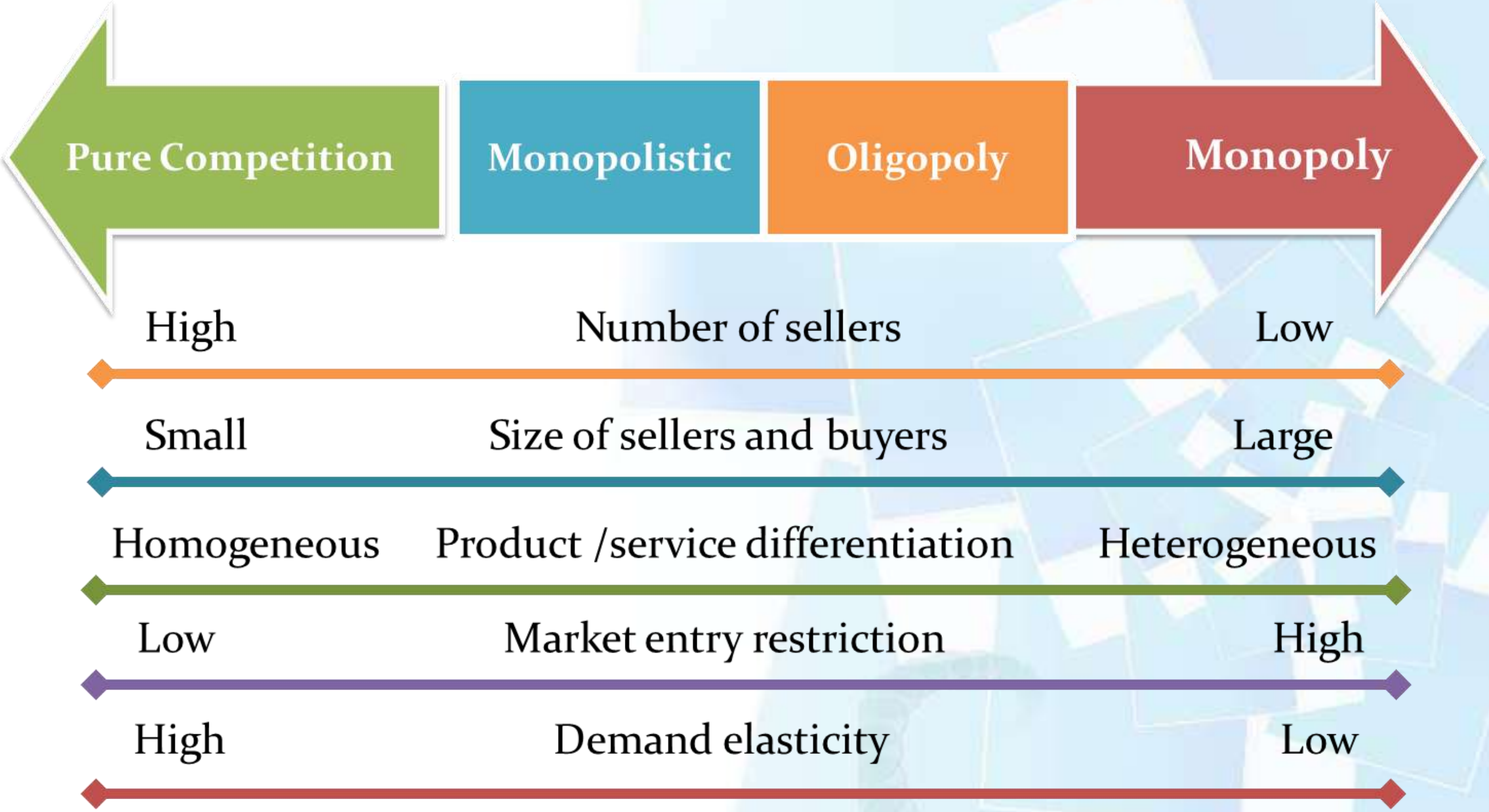
# Rates vs. Prices of Transportation Services

- Under freedom from economic regulation, the use of rates set in confidential contracts between carriers and shippers has become prominent.

# Rates vs. Prices of Transportation Services

- Carriers are free to charge whatever rates & operate wherever they choose geographically.
- Market-driven pricing.

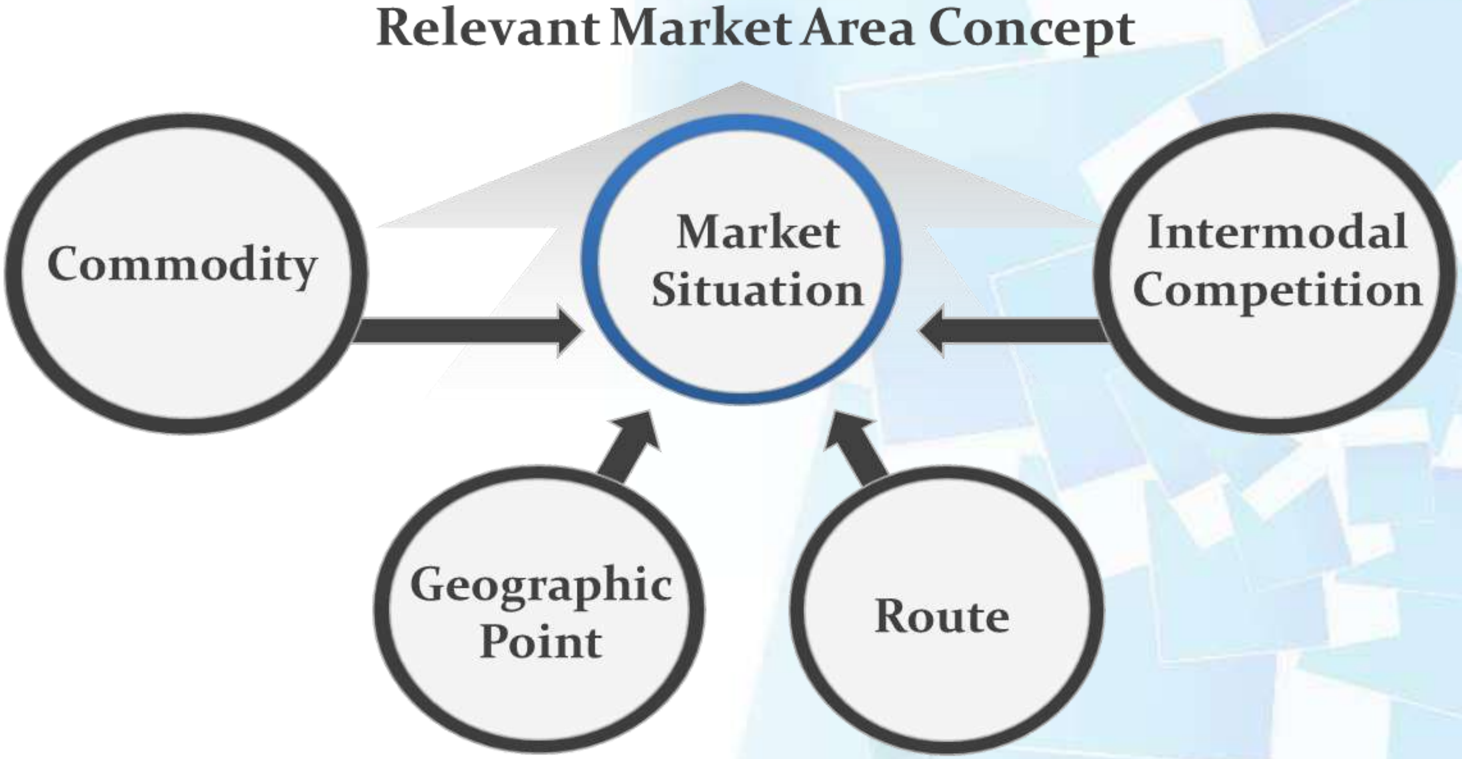
# Rates vs. Prices of Transportation Services



Pure Competition | Monopolistic | Oligopoly | Monopoly

| | | |
|---|---|---|
| High | Number of sellers | Low |
| Small | Size of sellers and buyers | Large |
| Homogeneous | Product /service differentiation | Heterogeneous |
| Low | Market entry restriction | High |
| High | Demand elasticity | Low |

# Rates vs. Prices of Transportation Services



# Rates vs. Prices of Transportation Services

- All four types of markets can be found in transportation industries, depending on particular market situations.

# Cost-of-service Pricing

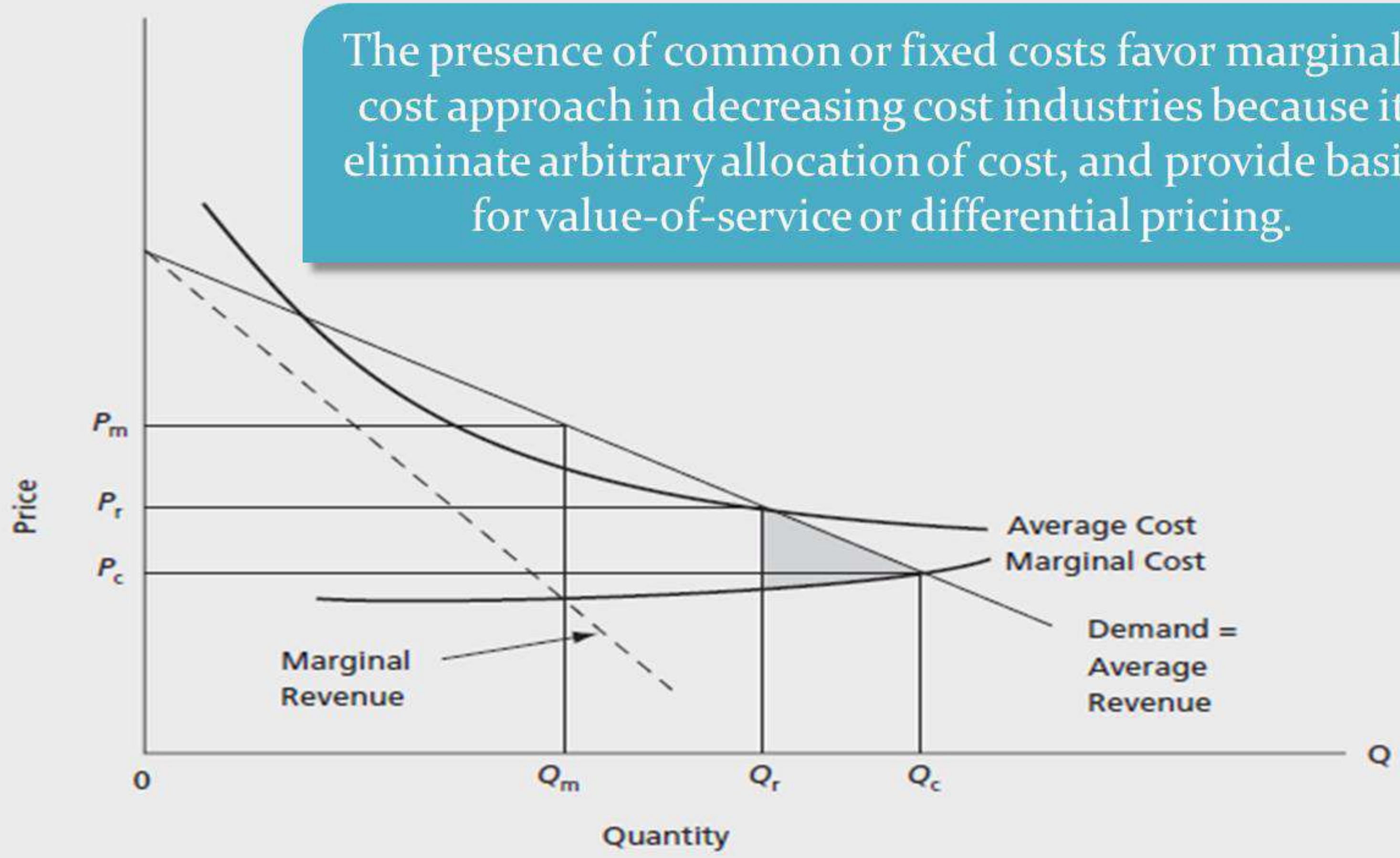
- Two alternative concepts:
- Average-cost approach
- Rates are based on average or fully allocated costs.

# Cost-of-service Pricing

- Marginal-cost / Variable-cost approach
- Rates are based on the cost of producing one more unit of an output.

# Cost-of-service Pricing

**FIGURE 4-2** Decreasing Cost Situation



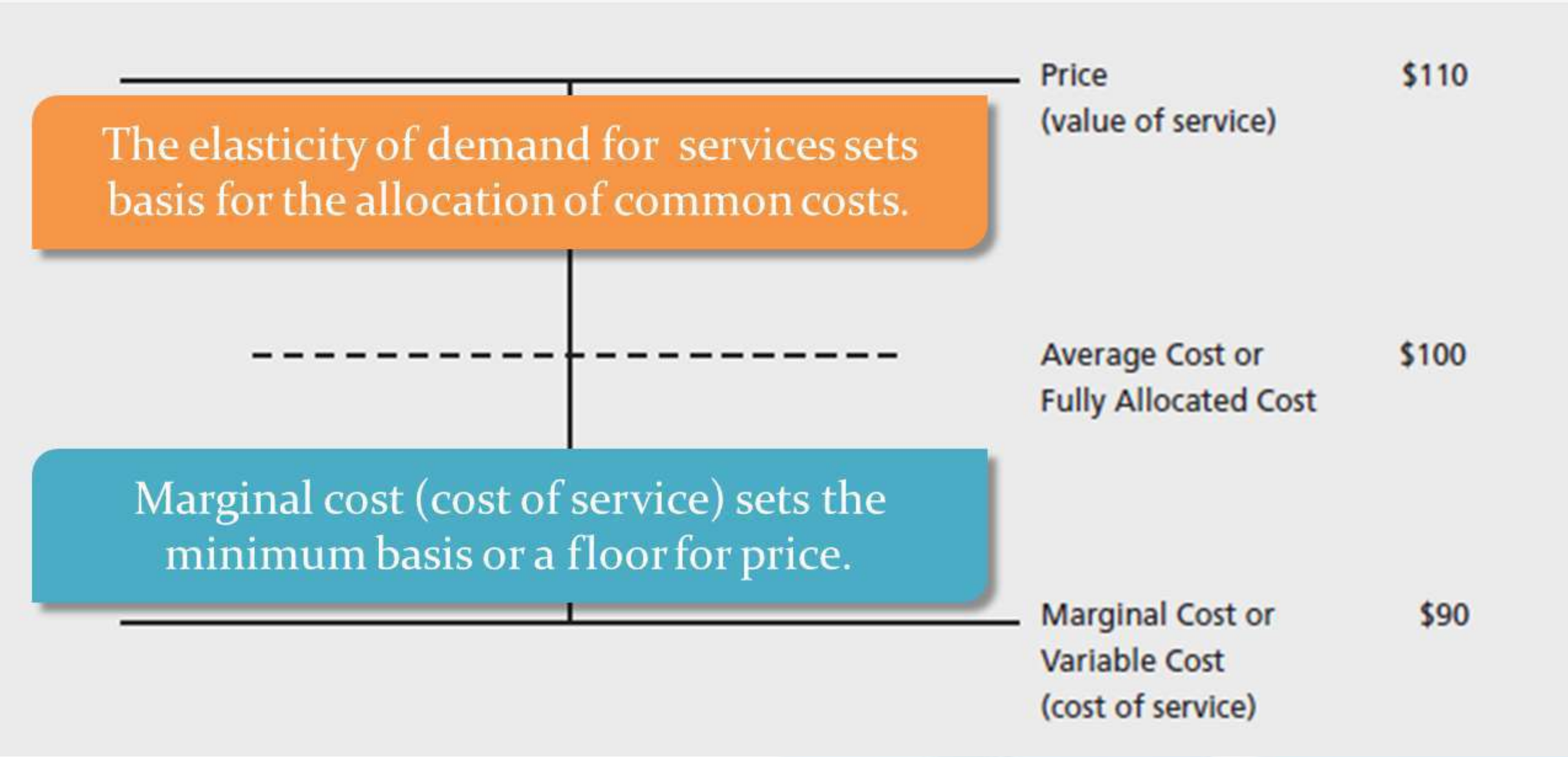
The presence of common or fixed costs favor marginal-cost approach in decreasing cost industries because it eliminate arbitrary allocation of cost, and provide basis for value-of-service or differential pricing.

# Value-of-service Pricing

- Charging what the traffic will bear.

# Value-of-service Pricing

**FIGURE 4-3** Cost of Service As Price Floor–Generic Example



The elasticity of demand for services sets basis for the allocation of common costs.

Marginal cost (cost of service) sets the minimum basis or a floor for price.

# Value-of-service Pricing

**High prices for the movement of high-valued products, and low prices for low-valued commodities.**

**Influence on cost**

**Value of Products**

**Influence on demand elasticity**

- More risk involved in moving high-valued commodities
- More expensive equipment necessary

- High-valued commodities can bear higher prices as transportation cost is a small percentage of the final selling.

# Value-of-service Pricing

- Pricing according to the value of the product.

# Price discrimination and Differential Pricing

- Third-degree Price Discrimination !

# Price discrimination and Differential Pricing

## Third-degree Price Discrimination

A situation in which a seller sets two or more different market prices for two or more separate groups of buyers of essentially the same commodity or service.

**Three necessary conditions**

1. The seller must be able to separate buyers into groups or submarkets according to their different elasticity of demand.
2. The seller must be able to prevent the transfer of sales between the submarkets.
3. The seller must possess some degree of monopoly power.

# Price discrimination and Differential Pricing

- By time
- By place
- By individual person
- By commodity

***Differential pricing*** can be done based on several methods of segregating the buyers into distinct groups.

# Price discrimination and Differential Pricing

- Examples!!

# Application of Service Pricing

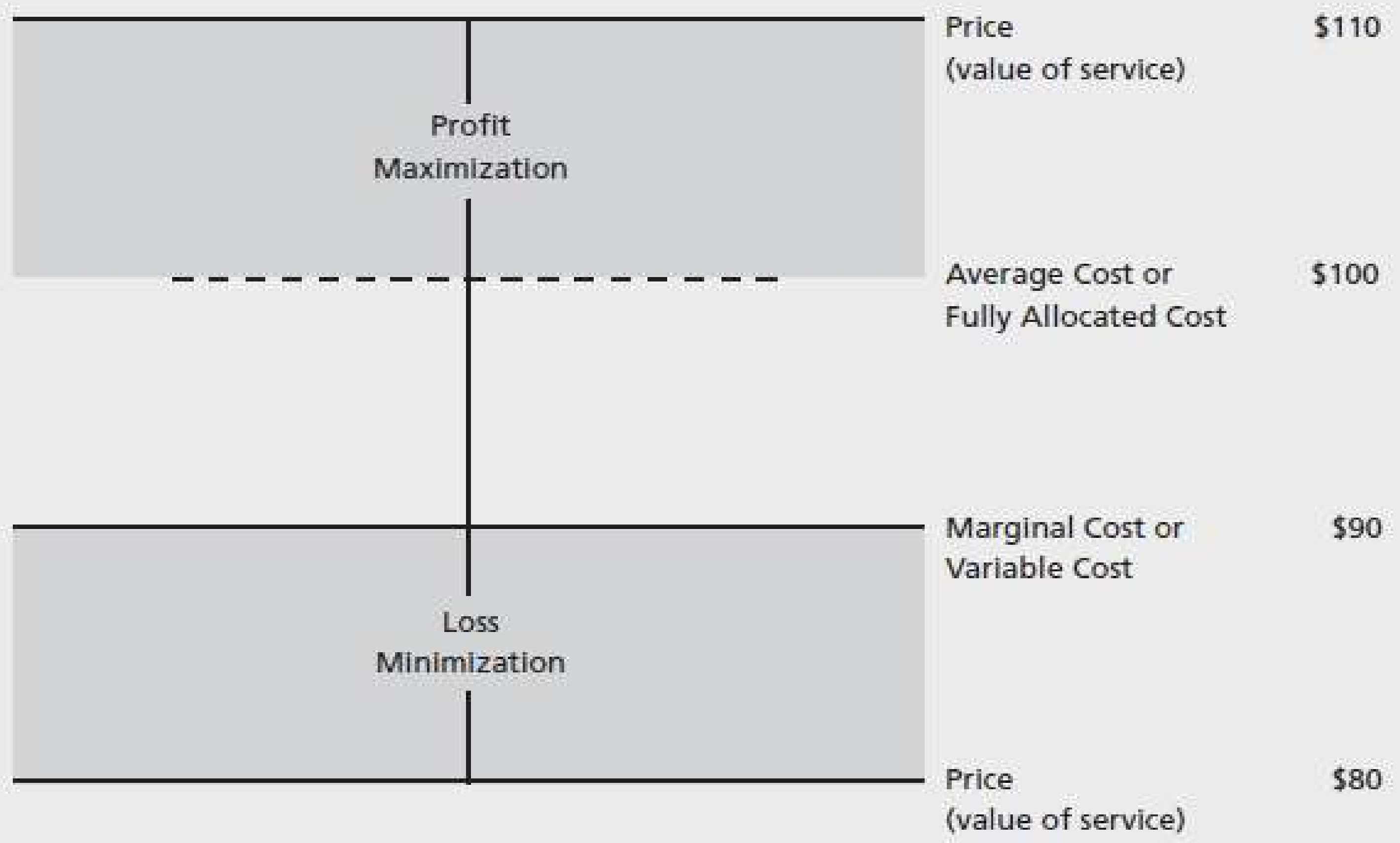
- **Accounting Perspective:**
- Value of service as price floor and price ceiling
- Marginal cost defined as the variable cost of providing the service.

# Application of Service Pricing

- **Economic Perspective:**
- Cost of service as price floor & value of service as price ceiling
- Marginal cost defined as costs that would be avoided if the service is not provided.

# Application of Service Pricing

**FIGURE 4-6** Value of Service as Price Floor and Price Ceiling

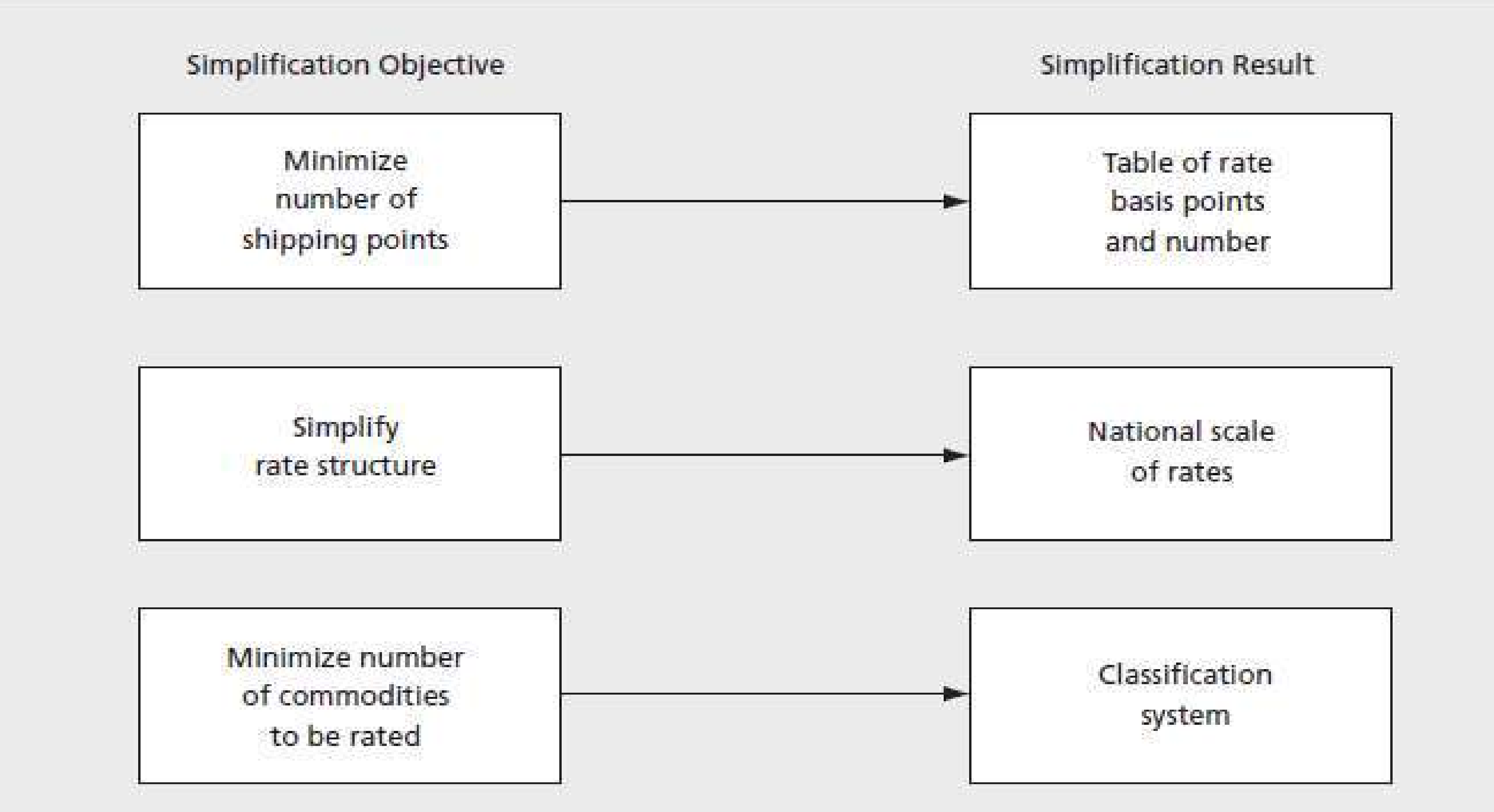


# Rate Structure Systems

- Class Rates
- Exception Rates
- Commodity Rates
- Special Rates

# Rate Structure Systems

**FIGURE 4-8** Class Rate Simplification



Simplification Objective

Simplification Result

Minimize number of shipping points → Table of rate basis points and number

Simplify rate structure → National scale of rates

Minimize number of commodities to be rated → Classification system

# Rate Structure Systems

Simplification Result

Table of rate basis points and number

National scale of rates

Classification system

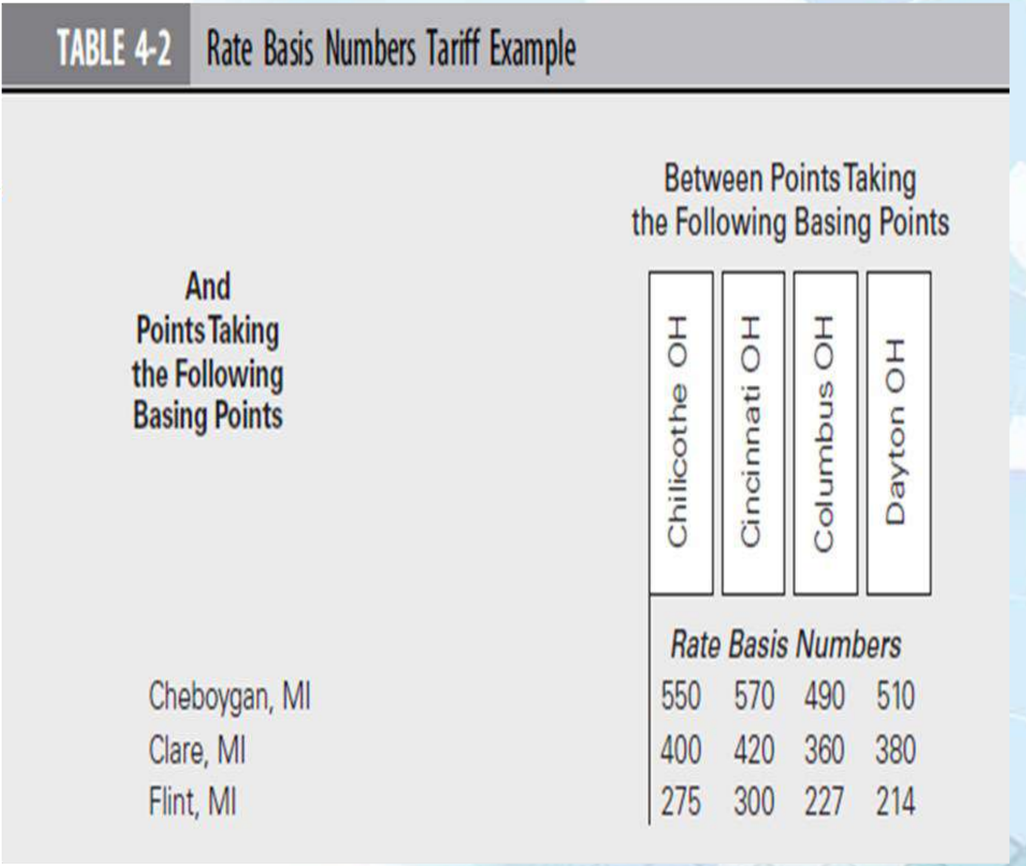
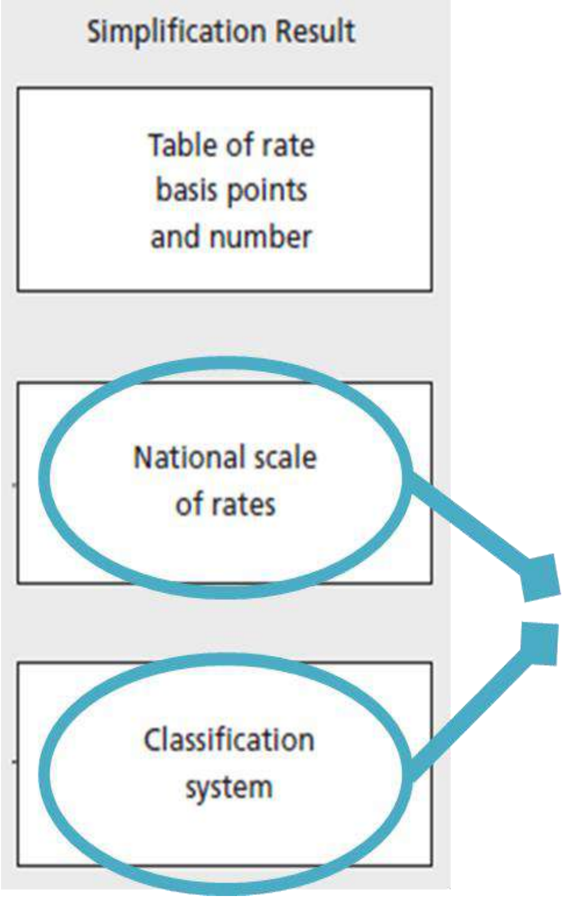


**TABLE 4-2** Rate Basis Numbers Tariff Example

| And Points Taking the Following Basing Points | Between Points Taking the Following Basing Points | | | |
|---|---|---|---|---|
| | Chilicothe OH | Cincinnati OH | Columbus OH | Dayton OH |
| | *Rate Basis Numbers* | | | |
| Cheboygan, MI | 550 | 570 | 490 | 510 |
| Clare, MI | 400 | 420 | 360 | 380 |
| Flint, MI | 275 | 300 | 227 | 214 |

# Rate Structure Systems



Simplification Result

Table of rate basis points and number

National scale of rates

Classification system

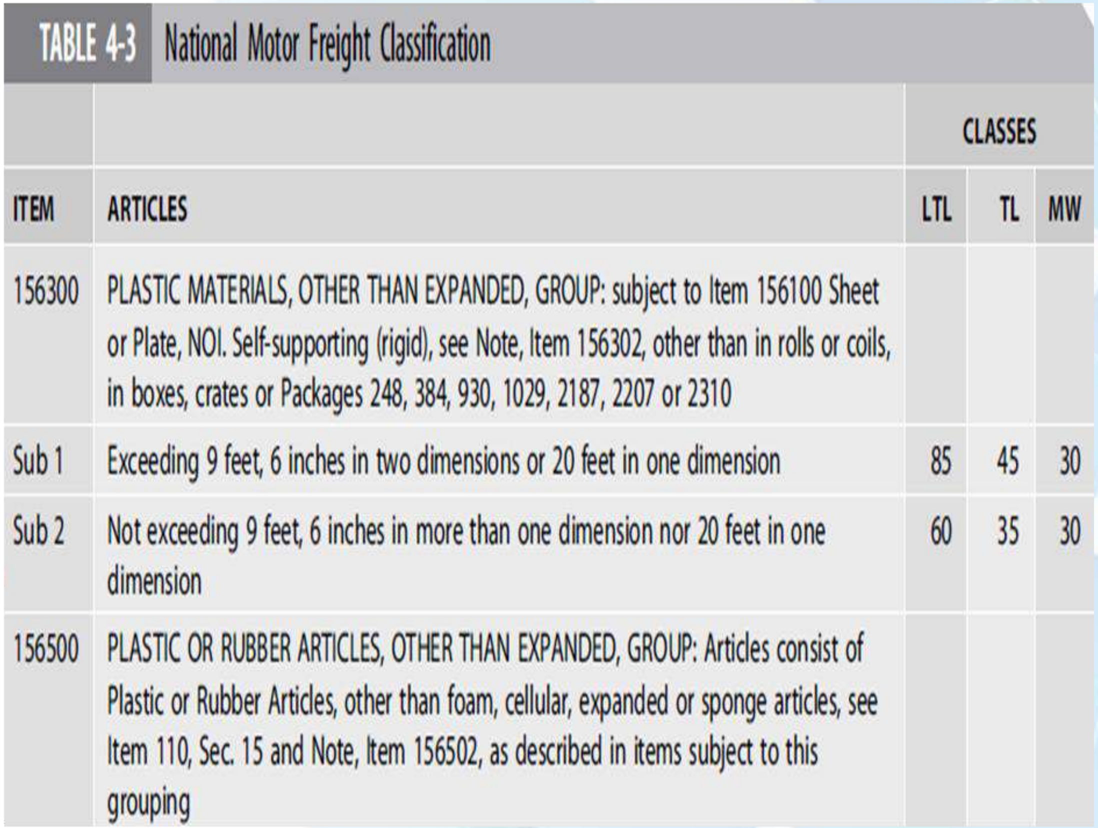


**TABLE 4-3** National Motor Freight Classification

| | | CLASSES | | |
|---|---|---|---|---|
| **ITEM** | **ARTICLES** | **LTL** | **TL** | **MW** |
| 156300 | PLASTIC MATERIALS, OTHER THAN EXPANDED, GROUP: subject to Item 156100 Sheet or Plate, NOI. Self-supporting (rigid), see Note, Item 156302, other than in rolls or coils, in boxes, crates or Packages 248, 384, 930, 1029, 2187, 2207 or 2310 | | | |
| Sub 1 | Exceeding 9 feet, 6 inches in two dimensions or 20 feet in one dimension | 85 | 45 | 30 |
| Sub 2 | Not exceeding 9 feet, 6 inches in more than one dimension nor 20 feet in one dimension | 60 | 35 | 30 |
| 156500 | PLASTIC OR RUBBER ARTICLES, OTHER THAN EXPANDED, GROUP: Articles consist of Plastic or Rubber Articles, other than foam, cellular, expanded or sponge articles, see Item 110, Sec. 15 and Note, Item 156502, as described in items subject to this grouping | | | |

# Rate Structure Systems

**Product density**

- Directly impacts the use of the carrier's vehicle and the cost per hundredweight.

**Stowability and handling**

- Reflect the cost the carrier will incur in securing and handling the product in the vehicle.

**Liability**

- Considers the value of the product and susceptibility to damage.

# Rate Structure Systems

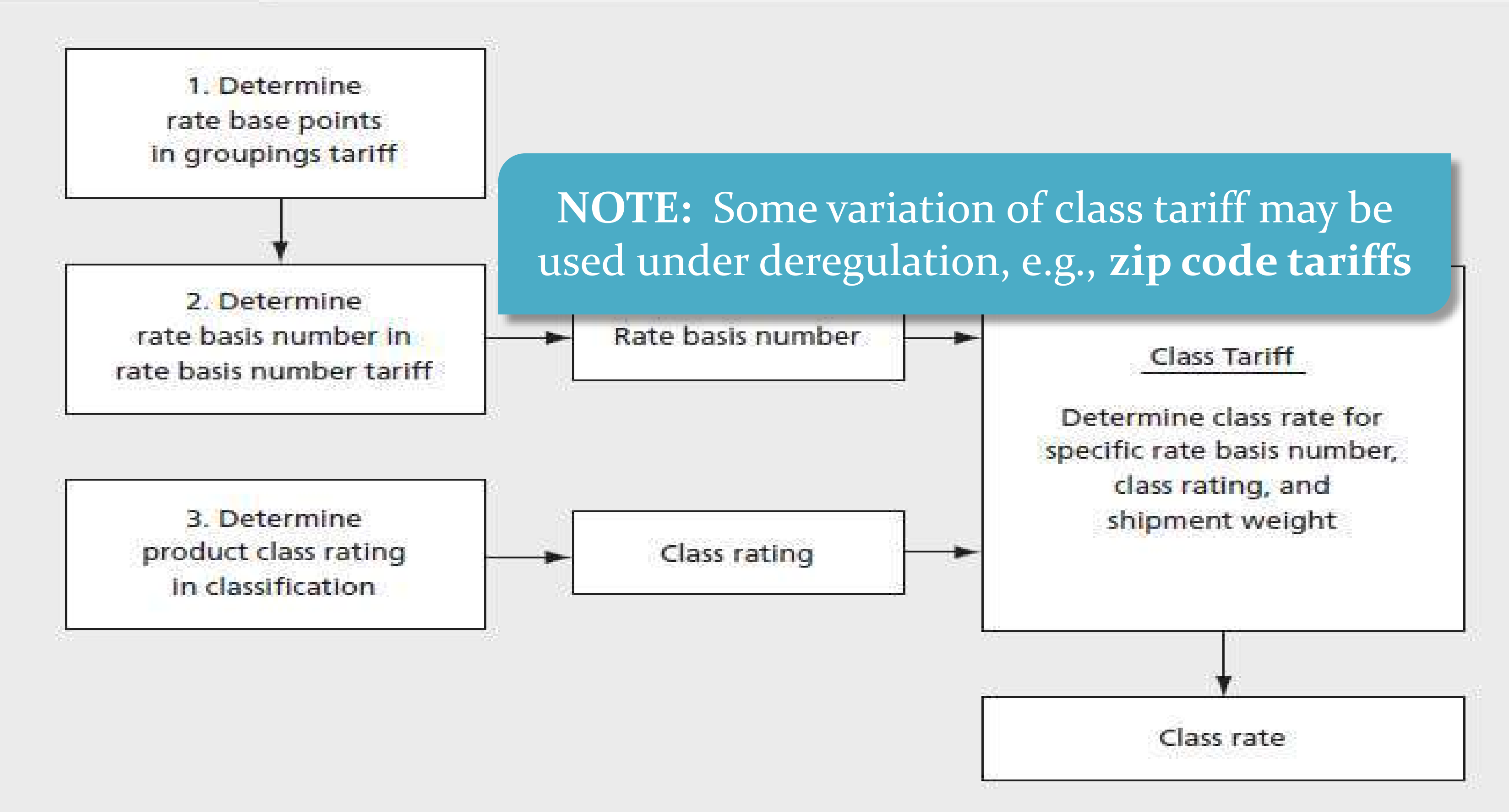


**FIGURE 4-9** Procedure for Determining a Class Rate

**NOTE:** Some variation of class tariff may be used under deregulation, e.g., **zip code tariffs**

# Exception Rates

- An exception rate is a modification to the national classification instituted by an individual carrier.

# Exception Rates

- Modifications may be made to rating, minimum weight, density group, etc.
- There does not have to be an exception rate for every class rate.

# Commodity Rates

- A specific rate published on a specific commodity or group of related commodities between specific points and generally via specific routes in specific directions.

# Commodity Rates

- Offered for those commodities that are moved regularly in large quantities.
- When published, the commodity rate takes precedence over the class rate or exception rate on the same article between the specific points.

# Commodity Rates

- Variations under deregulation – Mileage rate

# Commodity Rates

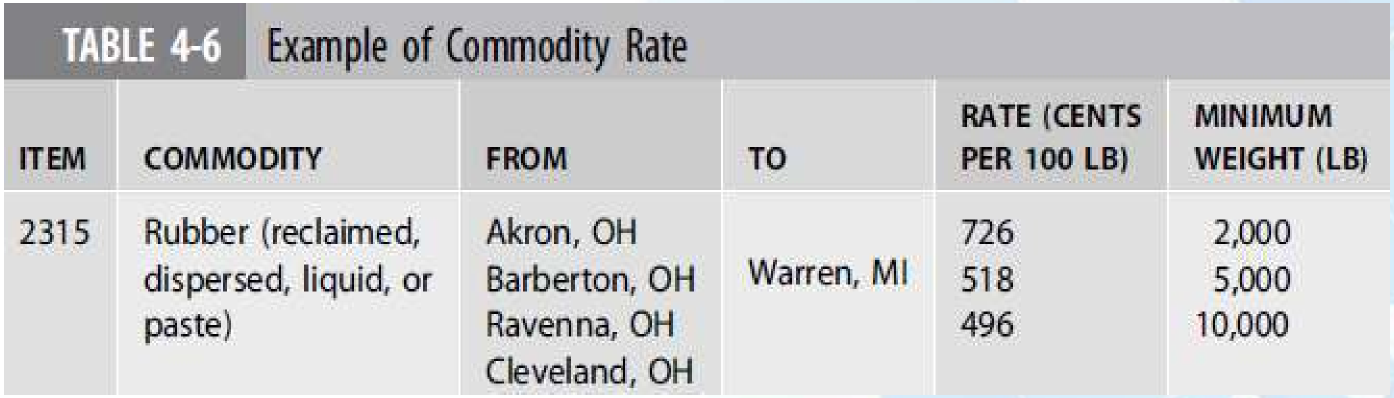


TABLE 4-6 Example of Commodity Rate

| ITEM | COMMODITY | FROM | TO | RATE (CENTS PER 100 LB) | MINIMUM WEIGHT (LB) |
|---|---|---|---|---|---|
| 2315 | Rubber (reclaimed, dispersed, liquid, or paste) | Akron, OH<br>Barberton, OH<br>Ravenna, OH<br>Cleveland, OH | Warren, MI | 726<br>518<br>496 | 2,000<br>5,000<br>10,000 |

# Special Rates

- **Shipment Rates**
- LTL/TL Rates (motor carriers)
- Multiple-Car Rates (rail carriers)
- Incentive Rates (usually apply only to weight or units loaded over and above the normally shipped quantities)

# Special Rates

- Unit-Train Rates (often used by rail carriers for trailer on flatcar [TOFC] or container on flatcar [COFC] movements)
- Per-Car and Per-Truckload Rates

# Special Rates

- Any-Quantity Rates (usually found with large, bulky commodities)
- Density Rates (common in air container shipments)

# Special Rates

- **Area, Location, or Route Rates**
- Local Rates
- Joint Rates (applied in through-movement arrangement)

# Special Rates

Proportional Rates (applied in through-movement arrangement)

- Differential Rates (generally applied by a carrier that faces a service time disadvantage compared to a faster carrier or mode)

# Special Rates

- Per-Mile Rates (commonly used in bulk chemical truck moves, air charter movements, and special train movements)
- Terminal-to-Terminal Rates / Ramp-to-Ramp Rates

# Special Rates

- **Contract Rates**
- Contract services are governed by contracts negotiated between the shipper and carrier, not by generally published tariffs.

# Special Rates

- Examples of contract service features
- A reduced rate in exchange for a guarantee of a certain minimum tonnage to be shipped over a specified period

# Special Rates

- Special-equipment movement, or exclusive-equipment movements
- Storage service in addition to movement

# Special Rates

- Released Value
- Empty-Haul Rates
- Two-Way or Three-Way Rates
- Spot-Market Rates
- Menu Pricing

# Strategic Transportation Pricing

- Strategic pricing decisions can be grouped into three categories.
- Set prices on a new service
- Modify prices over time

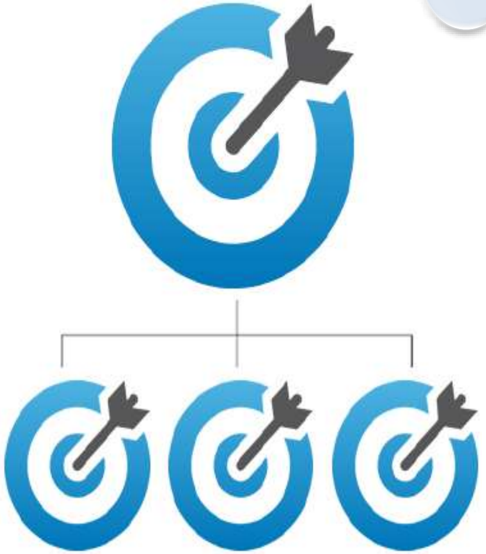
# Strategic Transportation Pricing

- Initiate and respond to price changes – Concept of price leader

# Strategic Transportation Pricing

- **Key considerations**
- Corporate objectives
- Competitive strategies
- Stage of product or service life cycle
- Markets (carriers with multiple markets)

# Strategic Transportation Pricing



- Survival-based pricing
- Unit volume pricing
- Profit maximization – Skimming prices
- Sales-based pricing
- Market share pricing
- Social responsibility pricing

# Setting Price Levels

- **Rule of Thumb**
- Must be the result of a reduction in carrier costs because of an action by the customer.
- May not exceed the cost savings to the carrier.

# Setting Price Levels

- **Discounts and Allowances**
- As rewards to a buyer for doing something that is beneficial for the supplier.
- Examples: quantity discounts, cash discounts

# Setting Price Levels

- **Geographic Adjustments**
- Used by shippers and receivers (not carriers) for transportation costs in the final price to their customer.

# Setting Price Levels

- Examples: FOB origin and FOB destination pricing (e.g. uniform-delivered pricing, zone pricing)

# Setting Price Levels

- Over reliance on cost-based pricing
- Fail to react to or capitalize on market changes
- Price set independently of marketing mix

# Setting Price Levels

- “One price for all” mentality
- Price managed independently of overall strategic plan

# Motor Carriers

- Started around World War I, when converted automobiles were used for pickup and delivery in local areas.

# Motor Carriers

- The interstate system of highways developed from the 1950s to 1991.
- Motor carriers steadily replaced railroads as the mode of choice for freight transportation.

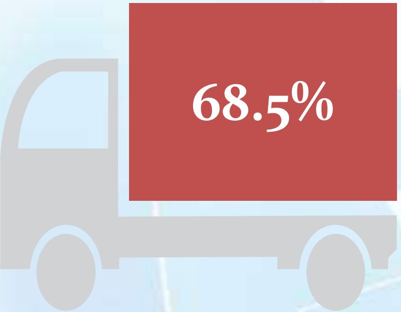
# Motor Carriers

- Dominant mode of freight transportation today.

# Motor Carriers

**9.4 billion tons**

Transported by motor carriers in 2012



**68.5%**

Of the total domestic movements by motor carriers in 2012

**6.9 million people**

Employed in the motor carrier industry in 2011

**397.8 billion miles**

Travelled by motor carriers for business purposes in 2010

# Motor Carriers

- Types !

# Types of Motor Carriers

- **For-hire vs. Private Carriers**
- For- hire
- Provide services to the public.
- Charge a fee for the service.

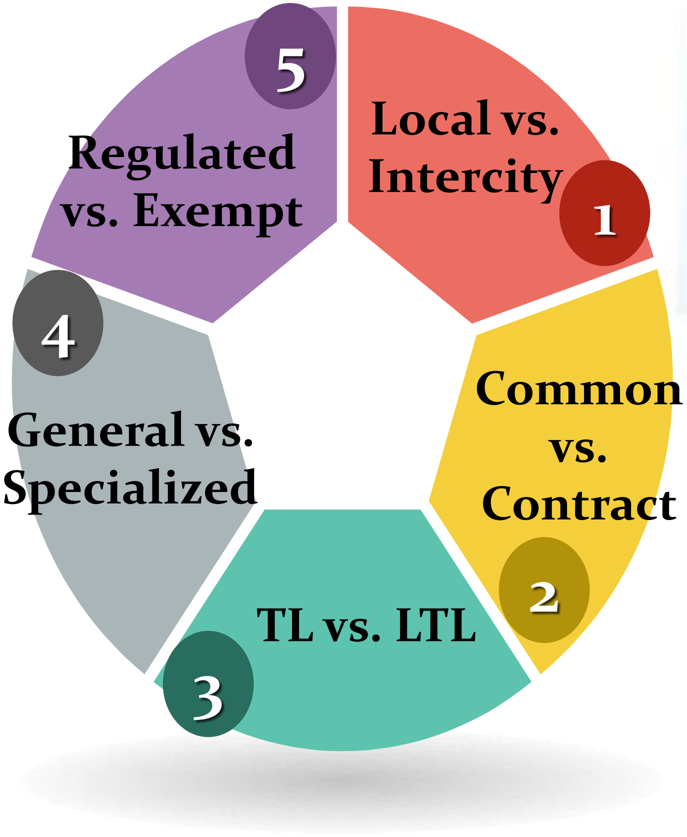
# Types of Motor Carriers

- Private Carriers
- Provide a service to the industry or company that owns or leases the vehicles.

# Types of Motor Carriers

- Do not charge a fee, but incur cost.
- Transport commodities for hire as exempt for-hire carriers.

# Types of Motor Carriers



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- Local carriers pick up and deliver freight within the commercial zone of a city.
- Intercity carriers operate between specifically defined commercial zones.
- Local carriers and intercity carriers often work in conjunction.

# Types of Motor Carriers

- **Common carriers** are required to serve the general public upon demand, at reasonable rates, and without discrimination.

# Types of Motor Carriers

- Further classified by the type of commodity authorized to haul
- **Contract carriers** serve specific shippers with whom the carriers have a continuing contract.

# Types of Motor Carriers

- Dedicated carriage over “dedicated” regular routes
- **TL carriers** provide service to shippers who tender sufficient volume to meet the minimum weights required for a truckload shipment.

# Types of Motor Carriers

- **LTL carriers** provide service to shippers who tender shipments lower than the minimum truckload quantities
- “Heavy LTL” motor carriers (upper end of LTL shipments

# Types of Motor Carriers

- **Specialized motor** carriers haul a special commodity such as:
- Odd-sized and/or heavy freight
- Liquids products
- Freight requiring controlled temperature

# Types of Motor Carriers

- Hazardous materials
- Specialized motor carriers haul a special commodity such as:

- Odd-sized and/or heavy freight

# Types of Motor Carriers

**An exempt for-hire** motor carrier transports exempt (unregulated) commodities owned by others for compensation.

# Types of Motor Carriers

The exempt commodities usually include unprocessed or unmanufactured goods, fruits and vegetables, and other items of little or no value..

# Structure of Motor Carrier Industry

- **Monopolistic**
- A large number of relatively small firms with relative freedom of entry and exit due to limited capital requirement.

# Structure of Motor Carrier Industry

- TL sector with strong competition with private carriers.

# Structure of Motor Carrier Industry

- **Oligopolistic**
- A small number of relatively large firms with some degree of capital constraint for entry.

# Structure of Motor Carrier Industry

- LTL. Significant investment in a network of terminals
- Special equipment carriers. Larger investments in equipment and terminals than general freight

# Structure of Motor Carrier Industry

- Large, national TL carriers.  Significant capital investment for scale and geographic scope of operations..

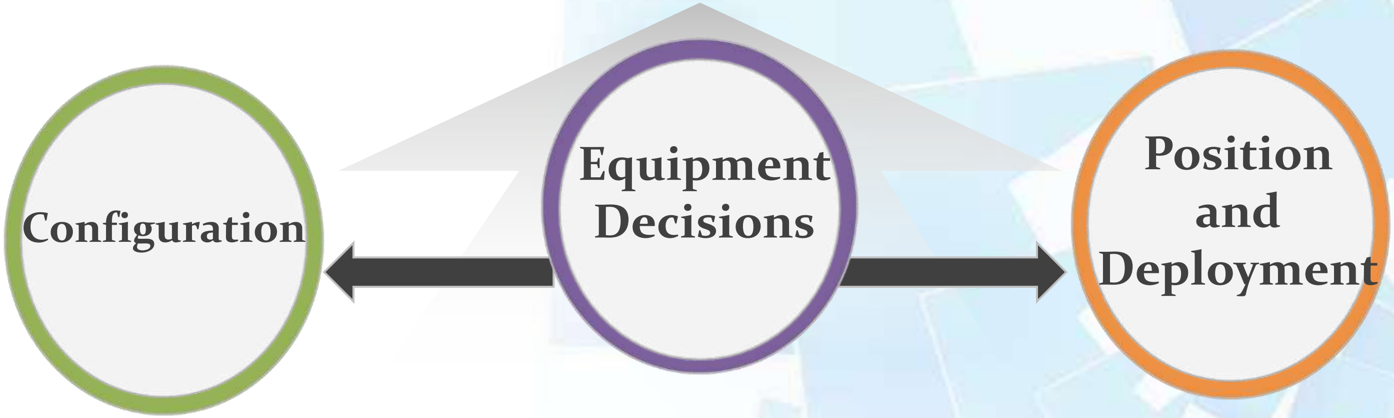
# Operating and Service Characteristics

- Accessibility (Door-to-door services)
- Speed (Transit time)
- Universal Modal Connector
- Carrying Capacity (Inventory levels and service frequency)

# Operating and Service Characteristics

- Loss and Damage (Relatively damage free)
- In most cases, equipment represents the largest operating asset that a carrier maintains.

# Operating and Service Characteristics



Equipment Decisions

Configuration

Position and Deployment

- **Tractor .** Axle (e.g. single, twin), engine, and drive train combinations.
- **Trailer .** Length (e.g. 28 feet, 45 feet, 48 feet, 53 feet) and type (e.g. dry van, refrigerated, ragtop, container, flatbed).

- More important in an LTL operation than in a TL operation.

# Operating and Service Characteristics

- Loss and Damage (Relatively damage free)
- In most cases, equipment represents the largest operating asset that a carrier maintains.

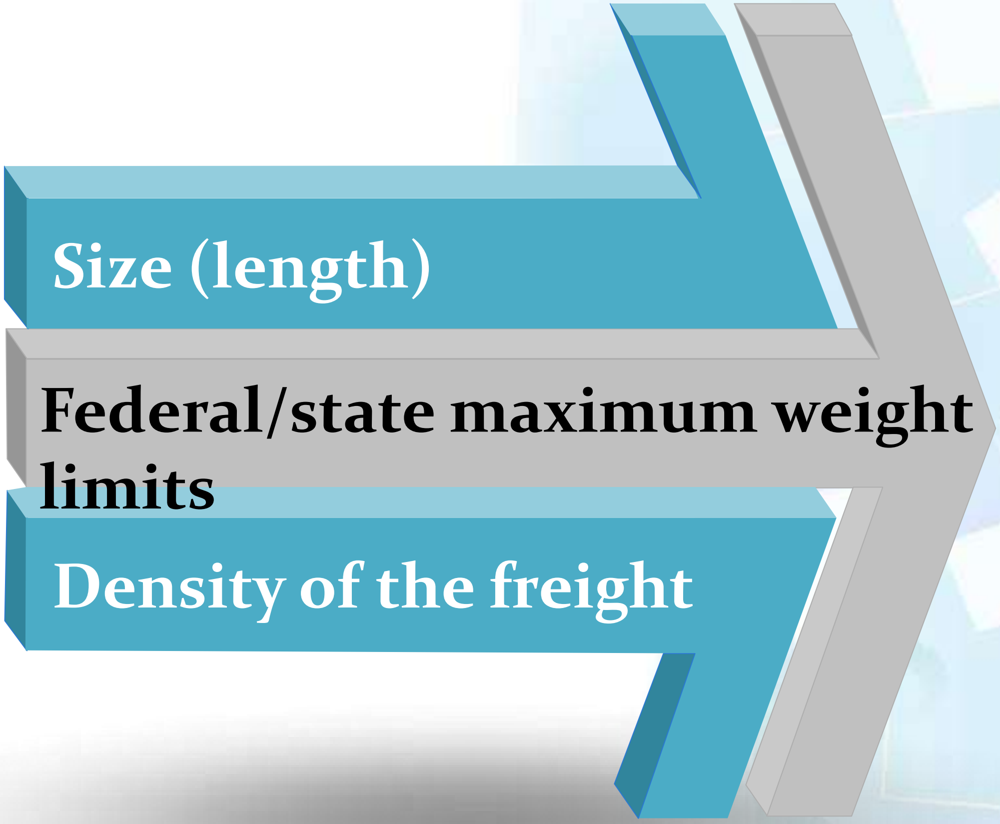
# Vehicles

- **Line-haul** vehicles are used to haul freight long distances between cities.
- Usually a tractor–trailer combination of three or more axles.

# Vehicles

- **City straight** trucks are used within a city to provide pickup and delivery service.
- Normally smaller than line-haul vehicles and are single units.

# Vehicles



Size (length)

Federal/state maximum weight limits

Density of the freight

Cargo-carrying Capacity of Line-haul Vehicles

# Vehicles

- The city truck has the cargo and power unit combined in one vehicle.
- The typical city truck is approximately 20 to 25 feet long with a cargo unit 15 to 20 feet long.

# Vehicles

- “Loaded to ride” – Use of small trailers (28 feet) for pick up/deliver in the city and for line-haul..

# Vehicles

**Dry van:** Standard trailer or straight truck with all sides enclosed.

**Open top:** Trailer top is open to permit loading through the top.

**Flatbed:** Trailer has no top or sides, used extensively to haul steel.

**Tank trailer:** Used to haul liquids like petroleum products.

**Refrigerated vehicles:** Cargo unit has controlled temperature.

**High cube:** Cargo unit is higher than normal to increase cubic capacity.

# Terminals

- **Pickup and Delivery Terminals (PUD),** also called satellite or end-of-the-line (EOL) terminals, most commonly found in the LTL hub-and-spoke system .

# Terminals

- **Break-bulk Terminals,** commonly found in the LTL hub-and-spoke system .

# Terminals

- **Relay Terminals** necessitated by the maximum hours of service regulation that is imposed on drivers.

# Terminals

- **PUD** Provide the pickup and/or delivery services for freight on peddle runs.
- Two elements of a peddle run
  - Stem time
  - Peddle time

# Terminals

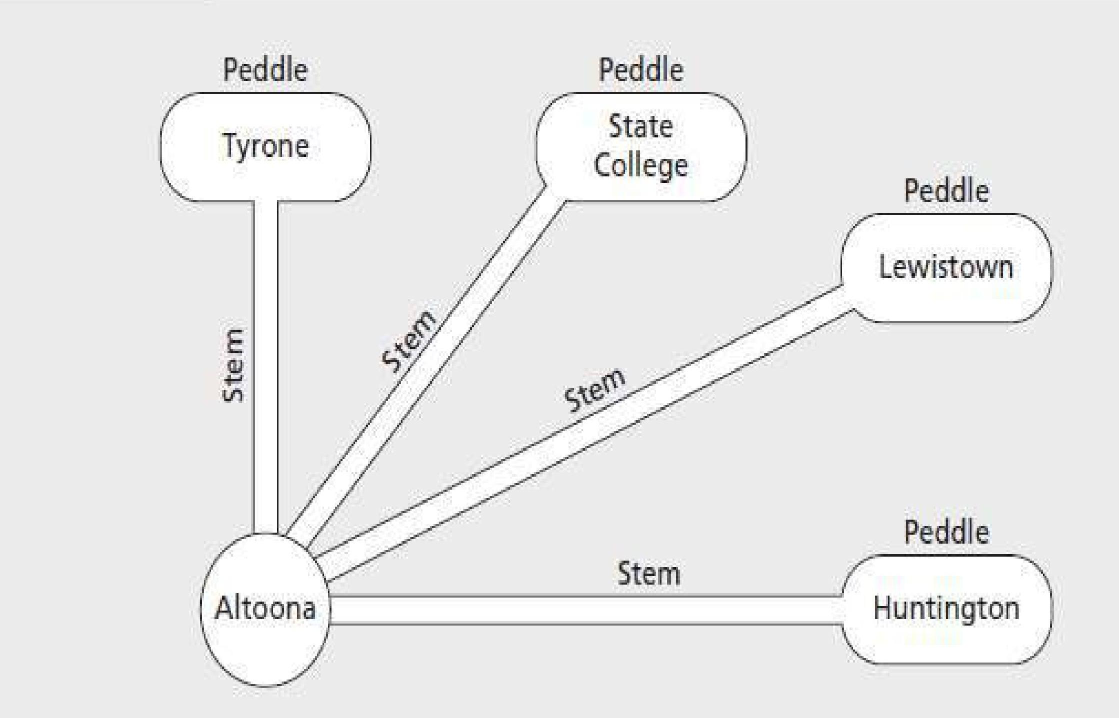
- Services performed
  - Shipment consolidation and distribution operations.
  - Vehicle dispatch operations

# Terminals

- Other services e.g. tracing, rating and billing, sales, and claims.

# Terminals

**FIGURE 5-6** Terminal Peddle Run



# Break-bulk Terminals

- Provide an intermediate point where freight with common destinations from the PUD terminals is combined to facilitate higher utilization of vehicle capacity.

# Break-bulk Terminals

- Services performed
- Shipment consolidation and dispersion (or break-bulk) operations
- Long-haul driver domiciles

# Break-bulk Terminals

- Services performed
- Shipment consolidation and dispersion (or break-bulk) operations
- Long-haul driver domiciles

# Break-bulk Terminals

- Relay terminals are different from the PUD and break-bulk terminals in that freight is never touched.

# Break-bulk Terminals

- Services performed.  At the relay terminal, one driver substitutes for another who has accumulated the maximum hours of service (11 hours after 10 consecutive hours off duty).

# Break-bulk Terminals

- “Slip seat” and sleeper team – An alternative to the use relay terminal…

# Terminal Management Decisions

- **Number of Terminals**
  - The degree of market penetration and customer service desired
  - Terminal size vs. peddle run distance tradeoffs

# Terminal Management Decisions

- **Location of Terminals**
  - Hours-of-service regulation
  - Consideration of backhauls between terminals

# Terminal Management Decisions

- Market penetration and customer service desired.

# Terminal Management Decisions

1. The LTL carrier collects the shipments at the shipper's dock with a PUD vehicle.
2. PUD vehicle returns to a PUD or break-bulk terminals.
3. At the terminals, the packages are sorted by their final destination.
4. The shipments are loaded into 28-foot, 48-foot, or 53-foot trailers for line haul.
5. The trailers are unloaded at another break-bulk terminal, then sorted & reloaded into a PUD vehicle for delivery.

# Cost structure for Motor Carriers

- High levels of variable costs and relatively low fixed costs, with higher fixed cost in LTL operation due to terminal systems

# Cost structure for Motor Carriers

- The public investment in the highway system
- Ability to increase /decrease number of vehicles in short periods of time and in small increments of capacity

# Cost structure for Motor Carriers

- Labor
- Fuel
- Maintenance
- Highway user fees (e.g. fuel tax and vehicle registration

# Cost structure for Motor Carriers

- Small-scale operations are viable and competitive.
- Long-run economies of scale
- Not significant in TL motor carrier segment

# Cost structure for Motor Carriers

- Some degree of EOS in the LTL segment through greater use of indivisible inputs such as terminals, management specialists, and information systems.

# Cost structure for Motor Carriers

- Operating ratio is a measure of operating efficiency and a benchmark of financial viability
- The operating ratio measures the percent of operating expenses to operating revenue.

# Cost structure for Motor Carriers

- (Operating expenses /Operating revenue) x 100
- LTL motor carriers – between 93 and 96
- TL motor carriers – low to mid 80s..

# Current Issues

- **Importance of Safety Issues**
- Rules for motor carrier safety fitness inspections
- Safety impact on profitability

# Current Issues

- **Key issues**
- Labor safety
- Alcohol and drug abuse
- Drivers’ hours of service and fatigue
- Vehicle size and weight

# Current Issues

- **Importance of Technological Issues**
- Enhance management control
- Enable timely communications
- Enhance environmental safety in movement

# Current Issues

- **Key technology**
- Satellite technology and GPS systems
- Electronic on-board recorders (EOBRs)..

# Further Issues

- **Importance of LTL Rate issue**
- Shippers must exercise caution because federal oversight and enforcement is greatly diminished.

# Further Issues

**Key issues**

- Limited anti-trust immunity
- No tariff filing requirements

# Further Issues

**Importance of Financial stability issue**

Carrier financial stability is now an important aspect of carrier selection.

# Further Issues

**Key issues**

High operating ratios (exceeding 95%) are indications of financial plight and low competitive rates.

Recurring problem of overcapacity..

# Rail Roads

- Dominant mode from 1850s to World War II, playing a pivotal role in US economic development

# Rail Roads

- Domination begins to wane after 1920 due to:

- Public funding for roads, inland waterways, and air transport

# Rail Roads

- Changes in economy and shipper service-related needs
- Financial plight and economic regulation

# Rail Roads

- Improved price and service competitiveness after economic deregulation (The Staggers Rail Act), continuing to be a vital part of US economy today…

# Rail Mergers

- A total of 28 mergers and 50 unifications overall have taken place during the past 30 years.  As a result, small number of carriers own majority of track and carry majority of rail freight.

# Rail Mergers

- **Capacity Expansion**
- Early rail mergers made to expand capacity to achieve large-volume traffic efficiencies and economies.

# Rail Mergers

- **Side by Side Mergers**
- Later, side-by-side mergers made to strengthen financial position and reduce duplication.

# Rail Mergers

- **End to End Mergers**
- More recently, end-to-end mergers made to improve competitive position against other railroads, and against other modes…

# Intramodal and Intermodal Competition

- **Differentiated Oligopoly**
- There are a small number of very large railroads.
- Few market areas are served by multiple railroads.

# Intramodal and Intermodal Competition

- **Intermodal Competition**
- The major source of competition in the industry, particularly from the motor carrier industry for non-bulk traffic.

# Intramodal and Intermodal Competition

- **Intramodal Competition**
- Reduced intramodal competition due to mergers, with selective competition between railroads serving the same geographic region…

# Constraints and Strengths

- Large carrying capacity (few size or weight constraints).
- Capable of handling almost any type of cargo.
- Railroads assume liability for loss & damage.

# Constraints and Strengths

- Fixed rights-of-way impedes door-to-door service.
- Through service prone to delays in delivery.
- Relatively high percentage of goods damaged in transit..

# Equipment – Types of Rail Car

- **Boxcar:** Standardized roofed freight car with sliding doors on the side used for general commodities (plain);

# Equipment – Types of Rail Car

- It can be specially modified (equipped) for specialized merchandise, such as automobile parts.

# Equipment – Types of Rail Car

- **Hopper car:** A freight car with the floor sloping to one or more hinged doors used for discharging bulk materials.

# Equipment – Types of Rail Car

- **Covered hopper:** A hopper car with a roof designed to transport bulk commodities that need protection from the elements.

# Equipment – Types of Rail Car

- **Flatcar:** A freight car with no top or sides used primarily for TOFC service, and movements of machinery and building materials.

# Equipment – Types of Rail Car

- **Refrigerated car**: A freight car with refrigeration equipment for temperature control.

# Equipment – Types of Rail Car

- **Gondola:** A freight car with a flat bottom, fixed sides, and no top used primarily for hauling bulk commodities.

# Equipment – Types of Rail Car

- **Tank car:**
  Specialized car used for the transport of liquids and gases..

# Intermodal Services

- Designed to increase service levels to intermodal customers.

# Intermodal Services

- Largely segregated from regular freight, with dedicated intermodal trains running on regularly scheduled departures and priority operating schedules.

# Intermodal Services

- Directed to non-bulk, manufactured products.
- Competes directly with truckload (TL) service, but some TL carriers are also major customers.

# Intermodal Services

**Trailer on Flatcar**

- Transports highway trailers on railroad flatcars.
- Combines line-haul efficiencies of rail with the flexibility of motor transport.

# Intermodal Services

- On-time deliveries, regularly scheduled departures, and fuel efficiency major reasons for growth.

# Intermodal Services

**Container on Flatcar**

- Transports shipping containers on railroad flatcars.
- Land-bridge operations key component of international trade.

# Intermodal Services

- Double-stack container trains greatly improves rail equipment and train productivity…

# Unit Train Services

- Specialized, one commodity trains used frequently for coal and grain shipments.
- Run on priority service schedules from origin to destination, with no stops in-transit.

# Unit Train Services

- Shippers often own rail cars.
- Advantage: Improved overall car utilization
- Disadvantage: Empty backhauls

# Unit Train Services

- Improved suspension system
- End-of-car cushioning devices
- In-car force instrumentation packages
- Quality certification program

# Unit Train Services

- Terminal improvements
- Equipment redesign
- Right-of-way improvements
- Microprocessors for communications and signaling

# Unit Train Services

- Elaborate information and communication systems for car ordering , billing, and car tracking…

# Cost structures: Rail Industry

- **Fixed Cost:**
- High proportion of fixed costs
- Right of way ownerships
- Terminal facilities (e.g. freight yards, terminal areas and sidings)

# Cost structures: Rail Industry

- Equipment (especially locomotives) and various types of rolling stock

# Cost structures: Rail Industry

- **Semi- Variable Cost:**
- Include maintenance of rights-of-way, structures & equipment

# Cost structures: Rail Industry

- Include maintenance of rights-of-way, structures & equipment
- Necessitated by exposure to weather rather than use.
- Often deferred during financial difficulties.

# Cost structures: Rail Industry

- **Variable Cost:**
- Vary substantially with traffic volume
- Labor cost
- Largest element
- Multiple labor unions

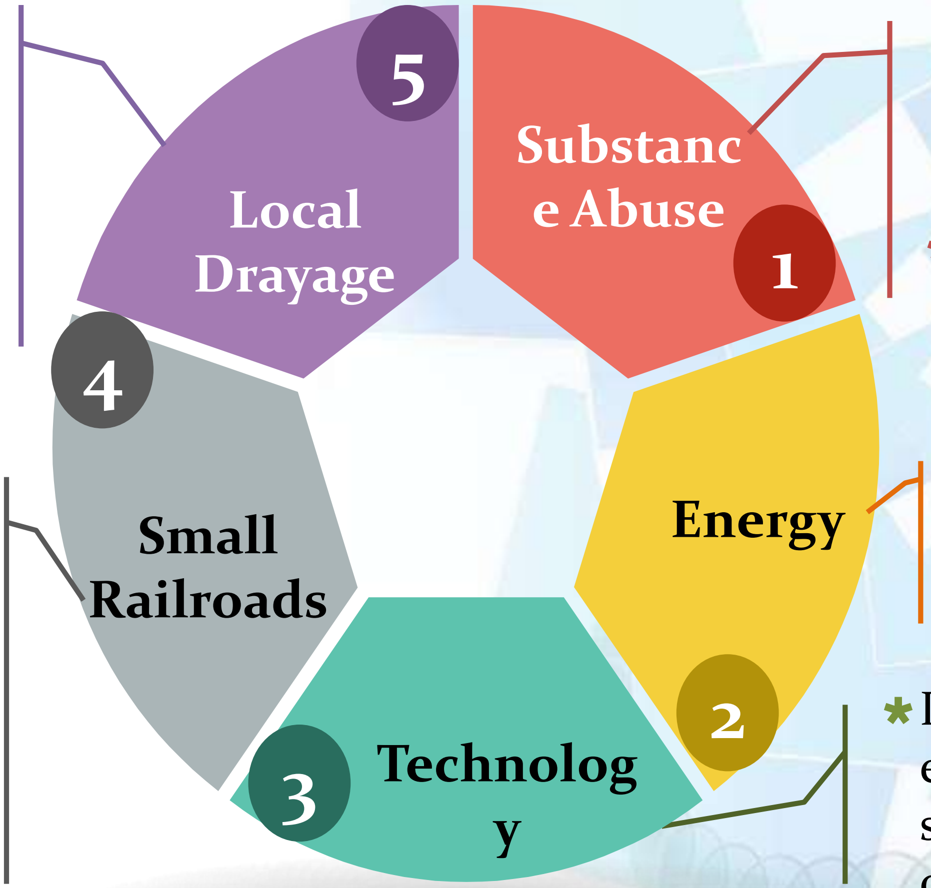
# Cost structures: Rail Industry

- Outdated work rules
- Fuel and power costs
- Second largest
- More productive & fuel efficient locomotive…

# Current Issues

- Given the high fixed costs, railroads operate under conditions of increasing returns until capacity is reached. Per-unit costs decline as fixed costs are spread out over an increased number of units.

# Current Issues



- Scarce availability
- High rates of services
- Additional transit time

- Cost disadvantage
- Usually not unionized
- Financial assistance from local and state governments

- Nature of railroad work (long hours, away from home & low supervision)
- Employee assistance programs (EAPs)

- Large element of variable costs

- Important enablers of services and operations

# Current Issues

- Substance abuse, energy, technology, small railroads, and local drayage…

# Development of Airline Industry

- Today, airline travel is a common form of transportation for long-distance passenger and
- freight travel, especially when time is of the essence.

# Development of Airline Industry

- 93.1 billion revenue ton-miles transported by air carriers between June 2013 and May 2014.
- 589,151 people employed in the air carrier industry in June 2014.

# Development of Airline Industry

- 99.2 percent of total operating revenue miles came from passenger transportation during August 2013 to July 2014.
- $199.7 billion of operating revenues generated by for-hire air carriers in 2013…

# Market Structure of Airline Industry

- A relatively large number of airline companies exist, but a small number (10) account for more than 90 % of the total revenue.

# Market Structure of Airline Industry

- **Intermodal Competition**
- Limited competition from other modes for long distance (800+ miles) trips in both passengers and freight markets.

# Market Structure of Airline Industry

- **Intramodal Competition**
- Intense competition among air carriers in terms of rates and service as driven by:

# Market Structure of Airline Industry

- New entrants in selected routes (markets)
- Market coverage expansion
- Excess capacity..

# Service and Cargo Competition

- **Service Competition**
- The frequency and timing of flights on a route primary service competition.

# Service and Cargo Competition

- Advertising used to differentiate services (e.g. amenities, frequent flyer programs).
- No-frills service

# Service and Cargo Competition

- **Cargo Competition**
- Low transit time emphasis
- Door-to-door service through contracts with motor carriers, or through own fleets of delivery vehicles.
- .

# Service and Cargo Competition

- Increased competition from surface carriers entering air cargo business.
- Reduced passenger travel creates excess capacity and increased competition in cargo business…

# Constraints and Strengths

- High terminal-to-terminal speed
- Reliability (low transit time variation)
- Low rates of damages

# Constraints and Strengths

- Limited accessibility.
- Reduced frequency of flights.
- High service rates.
- Added access and terminal time and cost significant for short distances (under 800 miles)…

# Utility of Air carriers

- There are several different sizes of airplanes in use, from small commuter planes to huge, wide-body, four-engine planes used by the nationals.
- Example: Delta Airlines Fleet

# Utility of Air carriers

- Government (state and local) invest and operate airports and airways.
- Certain airports in the carriers’ scope of operation become hubs, similar to the motor carrier’s break-bulk terminal.

# Utility of Air carriers

- Air carriers pay for the use of the airport through:
- Landing fees
- Rent and lease payments for space
- Taxes on fuel and airline tickets
- Aircraft registration taxes

# Utility of Air carriers

- Airport terminals provide services to passengers, such as restaurants, banking centers, souvenir and gift shops, and snack bars.
- Users pay a tax on airline tickets and air freight charges.

# Cost Structure for Airline Industry

- Airport and airways usage fees are variable in nature.
- Fuel costs (34%) and labor costs (25%) are major elements of operating costs.
- Operating costs vary by different types of aircraft used.

# Cost Structure for Airline Industry

- Low fixed-cost structure is attributable to publicly provided airways and terminals.

# Cost Structure for Airline Industry

**Short-run economies of plane size and utilization are significant in the air carrier industry.**

- Economies of scale for aircrafts and integrated communication network.
- The inability to inventory unused seats indicates existence of economies of scale for aircraft.
- Sufficient demand must exist.

- Achieved from having significant volume between an origin–destination pair.

# Cost Structure for Airline Industry

- Revenue management !

# Rates for Airline Industry

- **Discount Pricing.** The price of seats on different flights and the price of the same seat on a particular flight can vary due to:

# Rates for Airline Industry

- Competition
- Time and day of departure/return
- Level of service (e.g. first class, coach)
- Advance ticket purchase

# Rates for Airline Industry

- **Cargo pricing** is dependent mainly on weight and/or cubic dimensions. Other factors affecting cargo rates:

# Rates for Airline Industry

- Over-dimensional charge for low-density cargo (< 8 cubic ft.)
- Special services (e.g. armed guards)

# Rates for Airline Industry

- Major and national airlines use a hub approach to their service, which contributes to operating efficiency.

# Rates for Airline Industry

- Important measures of operating efficiency
- Operating ratio = (Operating Expense /Operating Revenue) *100
- Load factor = (Number of passengers /Total number of seats) * 100..

# Current Issues for Airline Industry

- Accident rates
- Substance abuse
- Sophisticated equipment and programs facilitate high speed transport

# Current Issues for Airline Industry

- Automated information processing programs
- Air traffic control system

# Current Issues for Airline Industry

- Passenger & luggage screening, carry-on limitations, and screening of freight carried on passenger airlines..

# Water Carriers Industry

- The first principle form of long distance freight and people transport, played an important role in the early development of the United States and settlements.

# Water Carriers Industry

- Continued to be the most important and efficient form of transportation available until the railroads were developed in the mid-18th century.

# Water Carriers Industry

- Today, water transport remains viable for the movement of basic raw materials, and plays a primary role in global commerce transportation.

# Water Carriers Industry

- The relative importance of water carriers' in the US transportation system declined somewhat over the past decade due to shift from manufacturing- to a service-based economy, and a supply chain emphasis on speed..

# Water Carriers Industry

# Overview Water Carriers Industry

- **Great Lakes Carriers**
- Provide services between ports on Great Lakes.
- Lake ships tend to remain on lakes…

# Overview Water Carriers Industry

- Lake ships can access Atlantic and Gulf coast ports via St. Lawrence Seaway (classified as a coastal operation).

# Overview Water Carriers Industry

- **Coastal Carriers**
- Operate ocean-going ships and barges along Atlantic, Pacific, and Gulf of Mexico coasts…

# Overview Water Carriers Industry

- Move large quantities of crude oil from Alaska ports to refineries along the Pacific Coast.

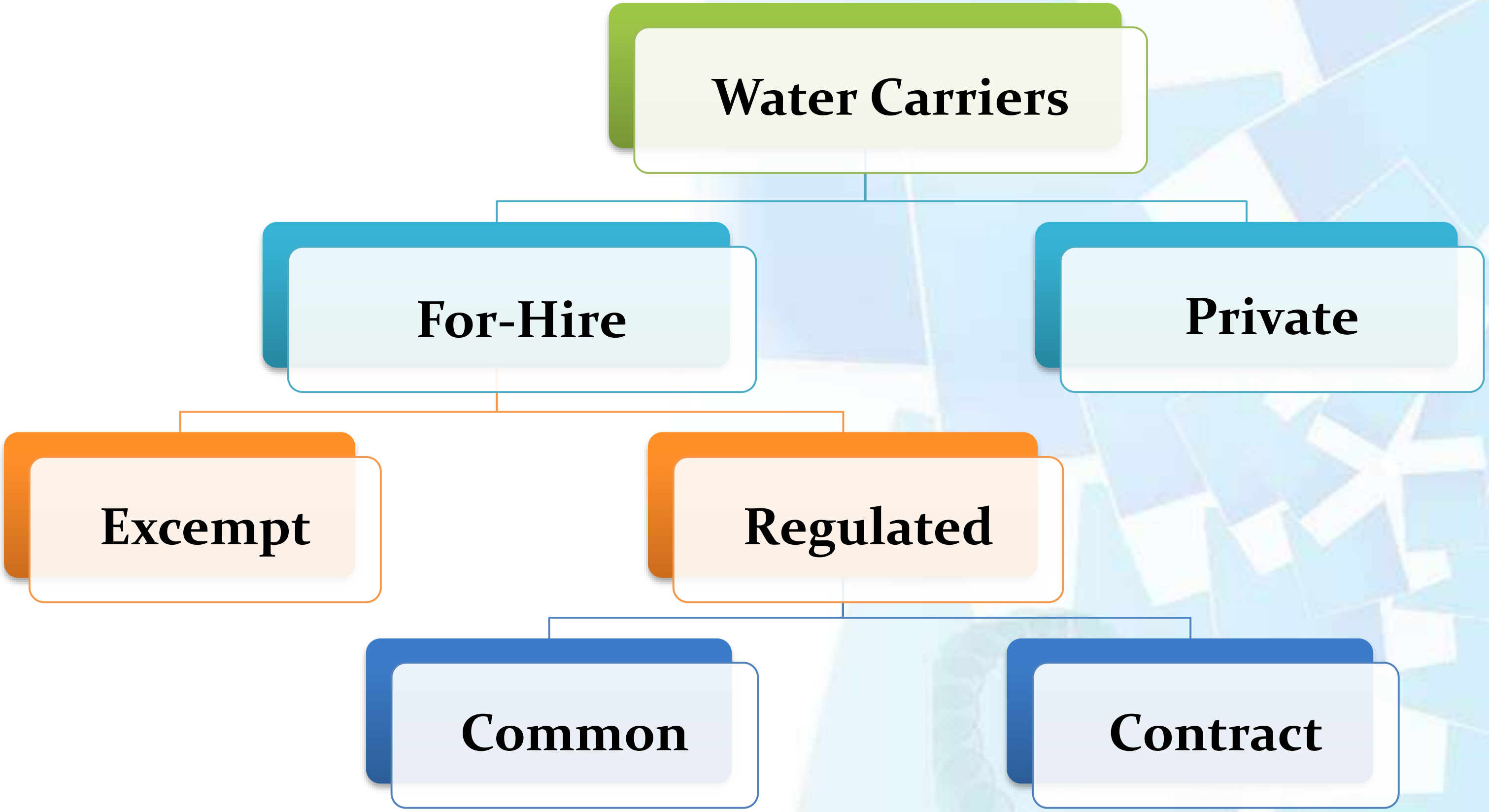
# Overview Water Carriers Industry

- **Inter-coastal Carriers**
- Operate ocean-going ships and barges between East Coast and West Coast ports via the Panama Canal…

# Overview Water Carriers Industry

- Move large quantities of petroleum, crude & refined between the Atlantic and Gulf of Mexico.

# Overview Water Carriers Industry



- Water Carriers
  - For-Hire
    - Exempt
    - Regulated
      - Common
      - Contract
  - Private

# Overview Water Carriers Industry

# Water Carriers Industry Market Structure

- The domestic for-hire water carrier industry consists of a limited number of relatively small firms.

# Water Carriers Industry Market Structure

## Rank by Operating Revenues for Hauling Domestic Freight

1. Inland (rivers and canals)
2. Coastal
3. Great Lakes

# Water Carriers Industry Market Structure

- **Intermodal Competition**
- Railroad
- Dry bulk commodities (grain, ores, coal)
- Focused around central US river system and the Great Lakes

# Water Carriers Industry Market Structure

- **Pipeline**
- Bulk liquids (petroleum, chemicals)
- Focused along the Gulf, Atlantic, and Pacific coasts.

# Water Carriers Industry Market Structure

- **Intra-modal Competition**
- Limited degree of competition between water carriers due to the relatively small number of carriers in the industry.

# Strength and Constraints

- **Strengths:**
- Low cost transport service for large volumes over medium to long distances
- Relatively large carrying capacity
- Fuel efficient

# Strength and Constraints

- **Constraints:**
- Speed of service (slowest mode for dry cargoes)
- Vulnerable to ice, flood, and drought conditions
- Accessibility limitations…

# Strength and Constraints

- Packaging requirements for high-value goods..

# Terminals for Water Carriers

- Ship terminals require significant capital investment.
- Most ports and terminals are publicly provided and operated.

# Terminals for Water Carriers

- Large bulk commodity shippers may own and operate private terminals.
- Recent improvements focus on the mechanization of materials-handling systems.

# Terminals for Water Carriers

## Functions

1. Facilitate ship loading and unloading.
2. Facilitate intermodal transfers.
3. Provide temporary storage in port area.

# Terminals for Water Carriers

- User charges (lock fees, dock fees, and fuel taxes) are variable in nature.
- Not labor-intensive.
- Major variable expenses are line-operating costs, operating rents, and maintenance.

# Terminals for Water Carriers

- Low fixed-cost structure can be attributed in part to public aid in construction & maintenance of waterways.
- Fixed costs include depreciation & amortization and general expenses..

# Transportation Planning and Strategy

- In most organizations, responsibility for transportation decisions falls to one or more of the following departments: logistics, procurement, and marketing.

# Transportation Planning and Strategy

- Inbound transportation typically controlled by the purchasing department
- Outbound transportation typically controlled by marketing or logistics

# Transportation Planning and Strategy

- Often, this decision-making structure leads to missed opportunities to generate transportation efficiencies and service improvements.

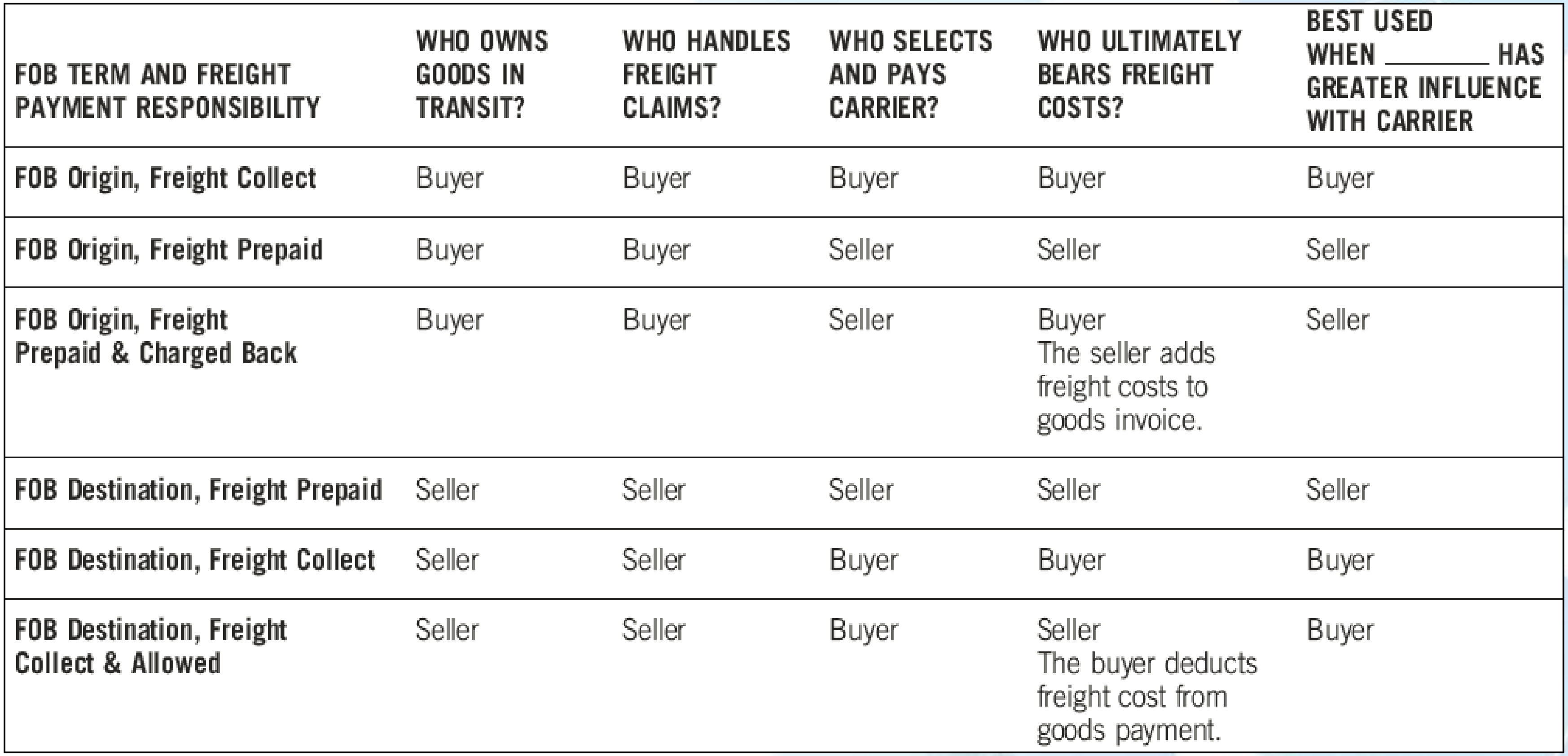
# Transportation Planning and Strategy

- Terms of sale clarify the delivery and payment terms agreed upon by a seller and buyer. Wise selection of these terms is…

# Transportation Planning and Strategy

- critical as the decision determines where the buyer’s responsibilities begin and where the seller’s responsibilities end.

# Transportation Planning and Strategy



| FOB TERM AND FREIGHT PAYMENT RESPONSIBILITY | WHO OWNS GOODS IN TRANSIT? | WHO HANDLES FREIGHT CLAIMS? | WHO SELECTS AND PAYS CARRIER? | WHO ULTIMATELY BEARS FREIGHT COSTS? | BEST USED WHEN ________ HAS GREATER INFLUENCE WITH CARRIER |
|---|---|---|---|---|---|
| **FOB Origin, Freight Collect** | Buyer | Buyer | Buyer | Buyer | Buyer |
| **FOB Origin, Freight Prepaid** | Buyer | Buyer | Seller | Seller | Seller |
| **FOB Origin, Freight Prepaid & Charged Back** | Buyer | Buyer | Seller | Buyer<br>The seller adds freight costs to goods invoice. | Seller |
| **FOB Destination, Freight Prepaid** | Seller | Seller | Seller | Seller | Seller |
| **FOB Destination, Freight Collect** | Seller | Seller | Buyer | Buyer | Buyer |
| **FOB Destination, Freight Collect & Allowed** | Seller | Seller | Buyer | Seller<br>The buyer deducts freight cost from goods payment. | Buyer |

# Transportation Planning and Strategy

# Decision to Outsource Transportation

- The organization with FOB freight control and procurement responsibility must analyze and choose between using a…

# Decision to Outsource Transportation

- private fleet (the "make" option) and using external service providers to move freight (the "buy" option).

# Decision to Outsource Transportation

- **Private fleet**
- A well-run private fleet can operate at costs competitive with for-hire carriers while providing greater scheduling flexibility and control over transit time.

# Decision to Outsource Transportation

- Intangible benefits: Promotional impact and prestige of having highly visible company trucks on the road

# Decision to Outsource Transportation

- **For-hire carriers.** Using for-hire carriers avoids large capital cost of starting a private fleet, time needed to build transportation expertise, and challenges inherent in operating a private fleet.

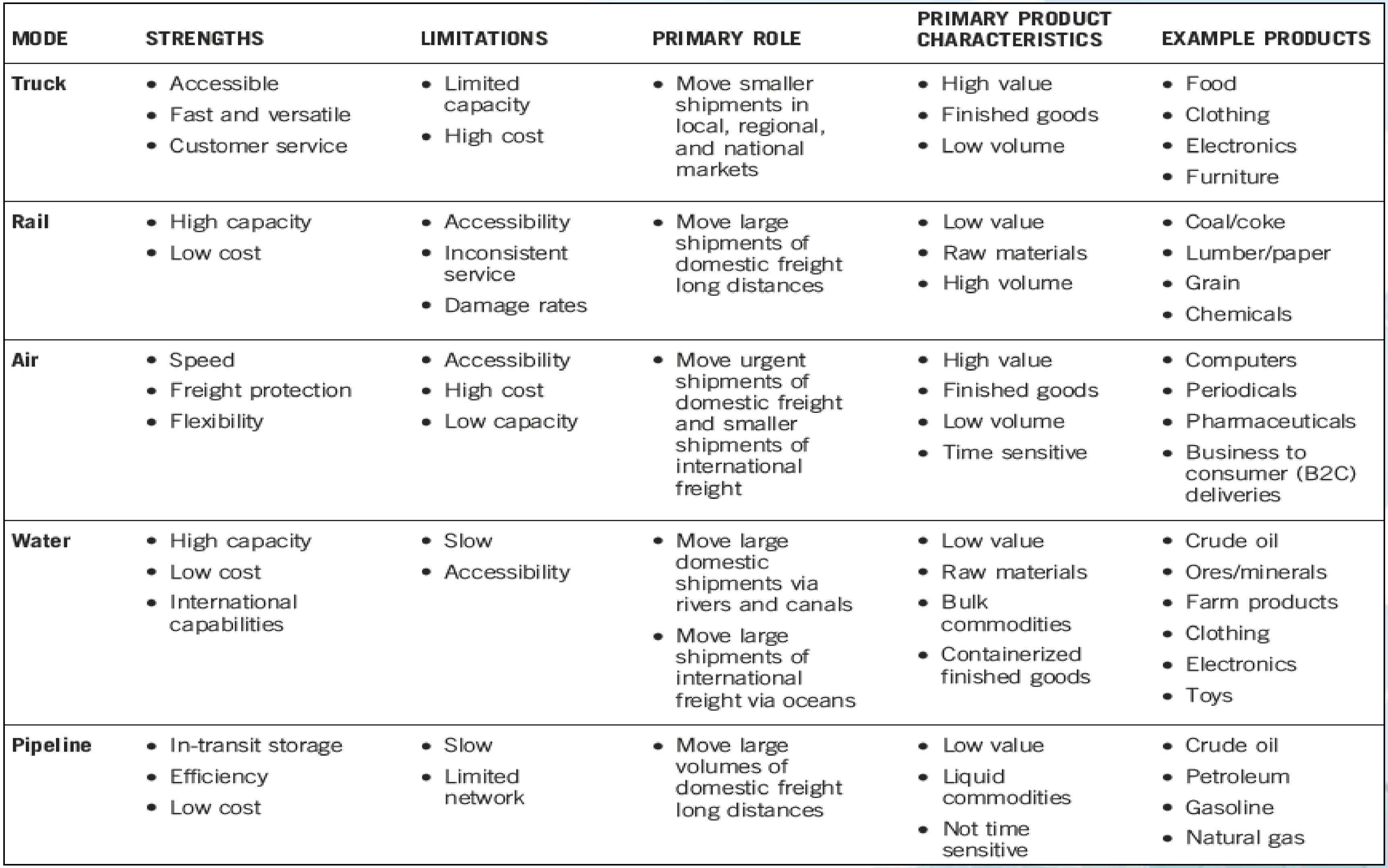
# Decision to Outsource Transportation

- 3PLs. Provide a wide array of transportation services: (1) dedicated contract carriage, (2) traffic management…

# Decision to Outsource Transportation

- (3) specialized international freight 3PLs, notably International Freight Forwarders (IFF), Non Vessel-owning Common Carriers (NVOCC), and Customs Brokers

# Decision to Outsource Transportation



| MODE | STRENGTHS | LIMITATIONS | PRIMARY ROLE | PRIMARY PRODUCT CHARACTERISTICS | EXAMPLE PRODUCTS |
|---|---|---|---|---|---|
| **Truck** | • Accessible<br>• Fast and versatile<br>• Customer service | • Limited capacity<br>• High cost | • Move smaller shipments in local, regional, and national markets | • High value<br>• Finished goods<br>• Low volume | • Food<br>• Clothing<br>• Electronics<br>• Furniture |
| **Rail** | • High capacity<br>• Low cost | • Accessibility<br>• Inconsistent service<br>• Damage rates | • Move large shipments of domestic freight long distances | • Low value<br>• Raw materials<br>• High volume | • Coal/coke<br>• Lumber/paper<br>• Grain<br>• Chemicals |
| **Air** | • Speed<br>• Freight protection<br>• Flexibility | • Accessibility<br>• High cost<br>• Low capacity | • Move urgent shipments of domestic freight and smaller shipments of international freight | • High value<br>• Finished goods<br>• Low volume<br>• Time sensitive | • Computers<br>• Periodicals<br>• Pharmaceuticals<br>• Business to consumer (B2C) deliveries |
| **Water** | • High capacity<br>• Low cost<br>• International capabilities | • Slow<br>• Accessibility | • Move large domestic shipments via rivers and canals<br>• Move large shipments of international freight via oceans | • Low value<br>• Raw materials<br>• Bulk commodities<br>• Containerized finished goods | • Crude oil<br>• Ores/minerals<br>• Farm products<br>• Clothing<br>• Electronics<br>• Toys |
| **Pipeline** | • In-transit storage<br>• Efficiency<br>• Low cost | • Slow<br>• Limited network | • Move large volumes of domestic freight long distances | • Low value<br>• Liquid commodities<br>• Not time sensitive | • Crude oil<br>• Petroleum<br>• Gasoline<br>• Natural gas |

# Decision to Outsource Transportation

# Modal and Carrier Selection

- Carrier Selection Factors:
- Geographic coverage
- Transit time average and reliability…

# Modal and Carrier Selection

- Freight rates
- Equipment availability and capacity
- Product protection

# Modal and Carrier Selection

| | Mode of Transportation | | | | |
|---|---|---|---|---|---|
| | Truck | Air | Rail | Water | Pipeline |
| Accessibility* | 1 | 3 | 2 | 4 | 5 |
| Transit time* | 2 | 1 | 3 | 4 | 5 |
| Reliability* | 2 | 3 | 4 | 5 | 1 |
| Security* | 3 | 2 | 4 | 5 | 1 |
| Cost** | 4 | 5 | 3 | 2 | 1 |

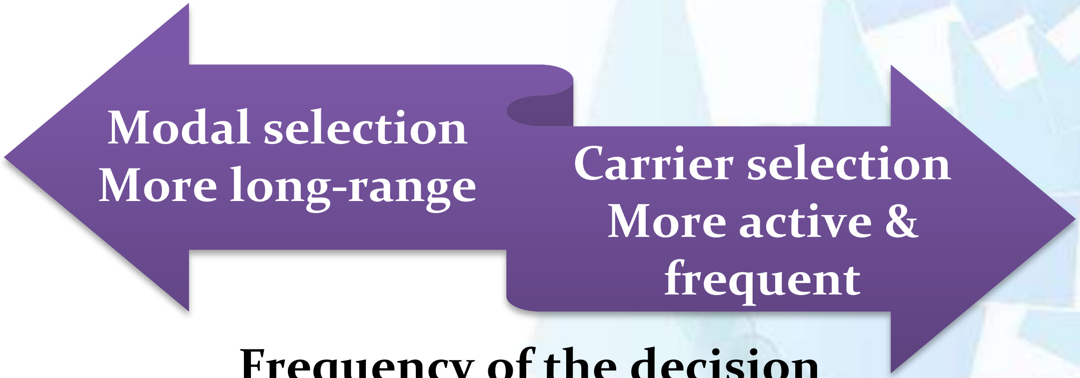
# Modal and Carrier Selection

## Modal Selection vs. Carrier Selection

Modal selection
More options

Carrier selection
Fewer options

Number of options available



Modal selection
More long-range

Carrier selection
More active & frequent

Frequency of the decision

# Modal and Carrier Selection

- **Core carrier strategy.**
- Carrier selection strategy commonly focuses on concentrating the transportation buy with a limited …

# Modal and Carrier Selection

- number of quality carriers, while striving to be carrier-friendly shippers.

# Modal and Carrier Selection

- **Advantages**
- Helps the organization leverage its purchasing dollars for lower overall rates.
- Allows the company to focus its attention on other supply chain issues.

# Modal and Carrier Selection

- Promotes strong relationships with the carriers that produce mutual understanding of requirements, coordination of processes, and service improvement…

# Modal and Carrier Selection

- Give a company priority access to the carriers' limited capacity..

# Transportation Control

- **Adversarial Approach**
- Seeks to minimize transportation cost regardless of the impact on carrier financial performance or long-term viability

# Transportation Control

- **Collaborative Approach**
- Focuses on developing contracts with carriers for a tailored set of transportation services at rates that fairly compensate the carriers.

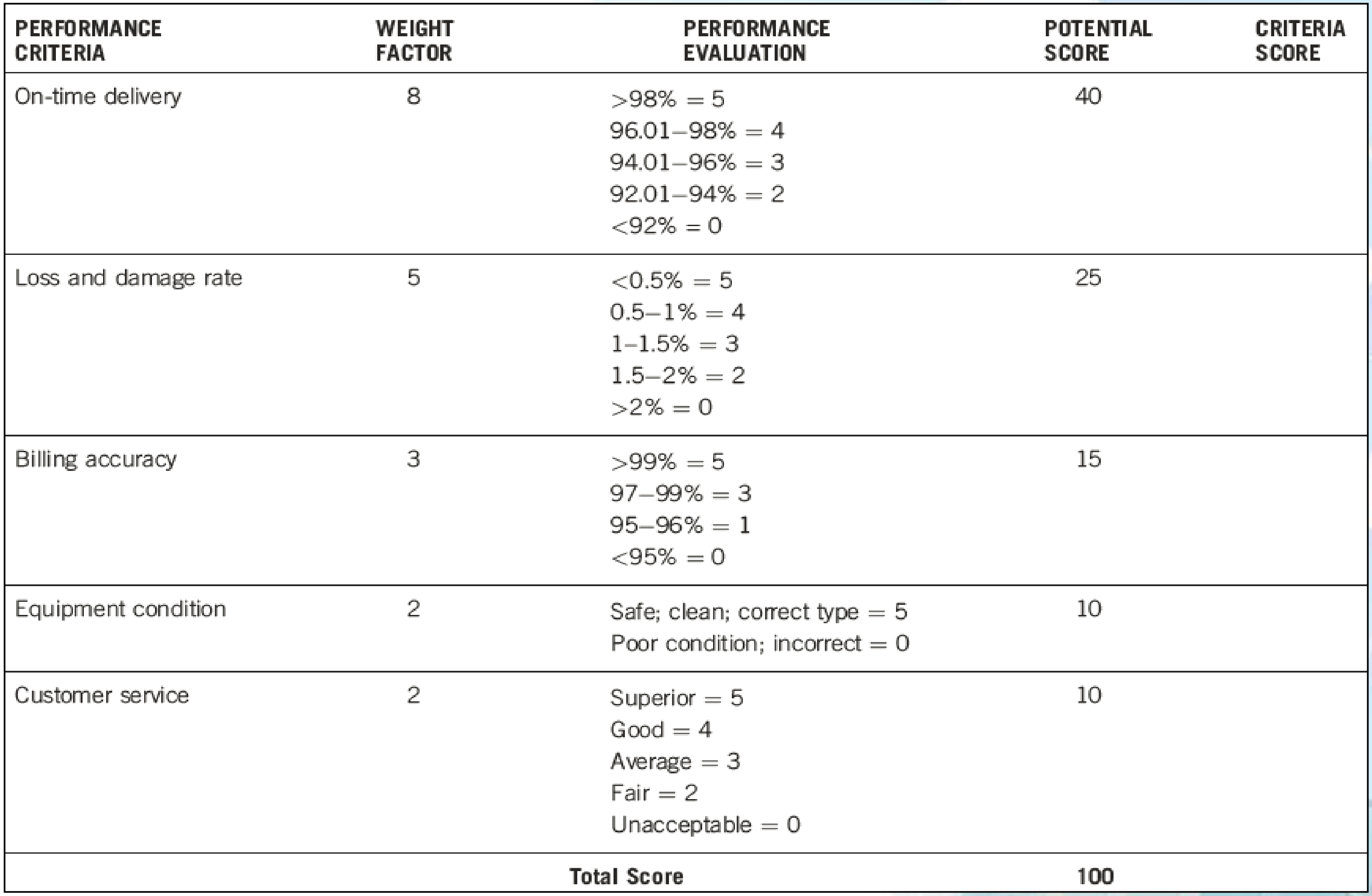
# Transportation Control

- Shipment Preparation
- Freight Documentation
- Maintain In-Transit Visibility
- Transportation Metrics
- Monitor Service Quality

# Transportation Control

| Metric | Formula | Typical Target |
|---|---|---|
| On-time Delivery | Total on-time deliveries / Total deliveries | > 95% |
| Transit Time Average | Sum of transit times / Total deliveries | Low variation around goal |
| Damage Rate | Total units damaged / Total units shipped | < 1% |
| Shortage Rate | Total units lost or stolen / Total units shipped | < 1% |
| Billing accuracy | Total accurate freight bills / Total freight bills | > 99% |
| Perfect Delivery Index | On-Time % × Damage-Free % × Billing Accuracy % | > 95% |

# Transportation Control



| PERFORMANCE CRITERIA | WEIGHT FACTOR | PERFORMANCE EVALUATION | POTENTIAL SCORE | CRITERIA SCORE |
|---|---|---|---|---|
| On-time delivery | 8 | >98% = 5<br>96.01–98% = 4<br>94.01–96% = 3<br>92.01–94% = 2<br><92% = 0 | 40 | |
| Loss and damage rate | 5 | <0.5% = 5<br>0.5–1% = 4<br>1–1.5% = 3<br>1.5–2% = 2<br>>2% = 0 | 25 | |
| Billing accuracy | 3 | >99% = 5<br>97–99% = 3<br>95–96% = 1<br><95% = 0 | 15 | |
| Equipment condition | 2 | Safe; clean; correct type = 5<br>Poor condition; incorrect = 0 | 10 | |
| Customer service | 2 | Superior = 5<br>Good = 4<br>Average = 3<br>Fair = 2<br>Unacceptable = 0 | 10 | |
| | | **Total Score** | **100** | |

# Transportation Control

- **Key negotiation issues:** Volume commitments, shipment frequencies, origin–destination combinations, freight characteristics, and related cost issues..

# Transportation Management System

- Transportation buyers and managers leverage a variety of tools and technologies to support supply chain success. The carrier community relies on technology to coordinate the flow of customer freight.

# Transportation Management System

- Individual applications e.g. load planning optimization, freight rating, and load tendering…

# Transportation Management System

- Integrated supply chain tools e.g. global trade management software, and transportation management systems (TMS)

# Transportation Management System

- Routing and load planning tools promoting optimization of pickup, linehaul, and delivery…

# Transportation Management System

- Dispatching software facilitating management of drivers, in-transit visibility, & regulatory compliance…

# Transportation Management System

- Brokerage solutions helping to match loads with available capacity and transaction financial manage…

# Transportation Management System

- Tracking and communication technology supporting visibility and control of freight
- Others e.g. pricing strategy, documentation..

# Shipment Preparation

- **Last-minute, cost-saving decisions**
- consolidate freight
- coordinate shipment deliveries
- take full advantage of container capacity
- an accurate freight count should be taken

# Shipment Preparation

- **Bill of lading**
- originates the shipment
- provides all the information the carrier needs
- stipulates the contract terms, including carrier’s liability for loss and damage

# Shipment Preparation

- acts as a receipt for the goods the shipper tenders to the carrier
- in some cases, shows certificate of title to the goods

# Shipment Preparation

- **Freight bill**
- carrier's invoice for carrier charges listing:
- shipment
- origin and destination
- consignee
- items
- total weight
- total charges

# Global Location Strategies

- Facility location affects the efficiency and effectiveness of managing supply chains & a firm’s overall competitive advantage.

# Global Location Strategies

- Companies can locate anywhere in the world due to increased globalization, technology, faster transportation, improved communication & open markets.

# Global Location Strategies

- Location still matters- industry clusters show that innovation & competition are geographically concentrated.

# Global Location Strategies

- Global location decisions involve location of the facility, defining its strategic role & identifying the markets it serves.

# Global Location Strategies

- Global location decisions should optimize the performance of the supply chain and be consistent with the firm’s competitive strategy.

# Global Location Strategies

- A firm competing on cost is likely to select a location that provides a cost advantage.
- A firm that competes on speed of delivery, such as the FedEx Corp., uses the hub and spoke approach to determine location.

# Global Location Strategies

- To get the most out of foreign-based facilities, managers must treat these plants as having a strategic role to perform..

# Typical Location Strategies

- Dr. Kasra Ferdows suggests 6 location types:
- Offshore factory - low cost investment & labor costs.

# Typical Location Strategies

- **Source factory** - plant management involved in supplier selection & production planning.

# Typical Location Strategies

- **Server factory** - firm uses government incentives & low exchange risk & tariff barriers to reduce taxes & logistics costs.

# Typical Location Strategies

- **Contributor factory** - firm involved in product development, production planning, procurement decisions, & developing suppliers.

# Typical Location Strategies

- **Outpost factory** - embedded network of suppliers, competitors, research facilities for materials, components, technology & products.

# Typical Location Strategies

- **Lead factory** - firm is source of innovation & competitive advantage of the organization..

# Critical Location Factors

- Regional Trade Agreements (RTA) & WTO
- World Trade Organization (WTO) successor to the General Agreement on Tariffs/Trade (GATT)…

# Critical Location Factors

- Only global international organization which deals with the rules of trade between nations…

# Critical Location Factors

- Goal is to help producers of goods and services, exporters, and importers conduct their business
- Has 159 members..

# Critical Location Factors

- World Trade Organization functions include:
- Administering agreements
- Forum for trade negotiations
- Trade disputes…

# Critical Location Factors

- Monitor trade policies
- Aid for developing countries
- Cooperating with other International organizations.

# Critical Location Factors

**Table 11.2** International Competitiveness Ranking

| RANKING | 2013–14 GLOBAL COMPETITIVENESS REPORT | 2013 WORLD COMPETITIVENESS YEARBOOK |
|---|---|---|
| 1. | Switzerland | United States |
| 2. | Singapore | Switzerland |
| 3. | Finland | Hong Kong |
| 4. | Germany | Sweden |
| 5. | United States | Singapore |
| 6. | Sweden | Norway |
| 7. | Hong Kong SAR | Canada |
| 8. | Netherlands | United Arab Emirates |
| 9. | Japan | Germany |
| 10. | United Kingdom | Qatar |

# Critical Location Factors

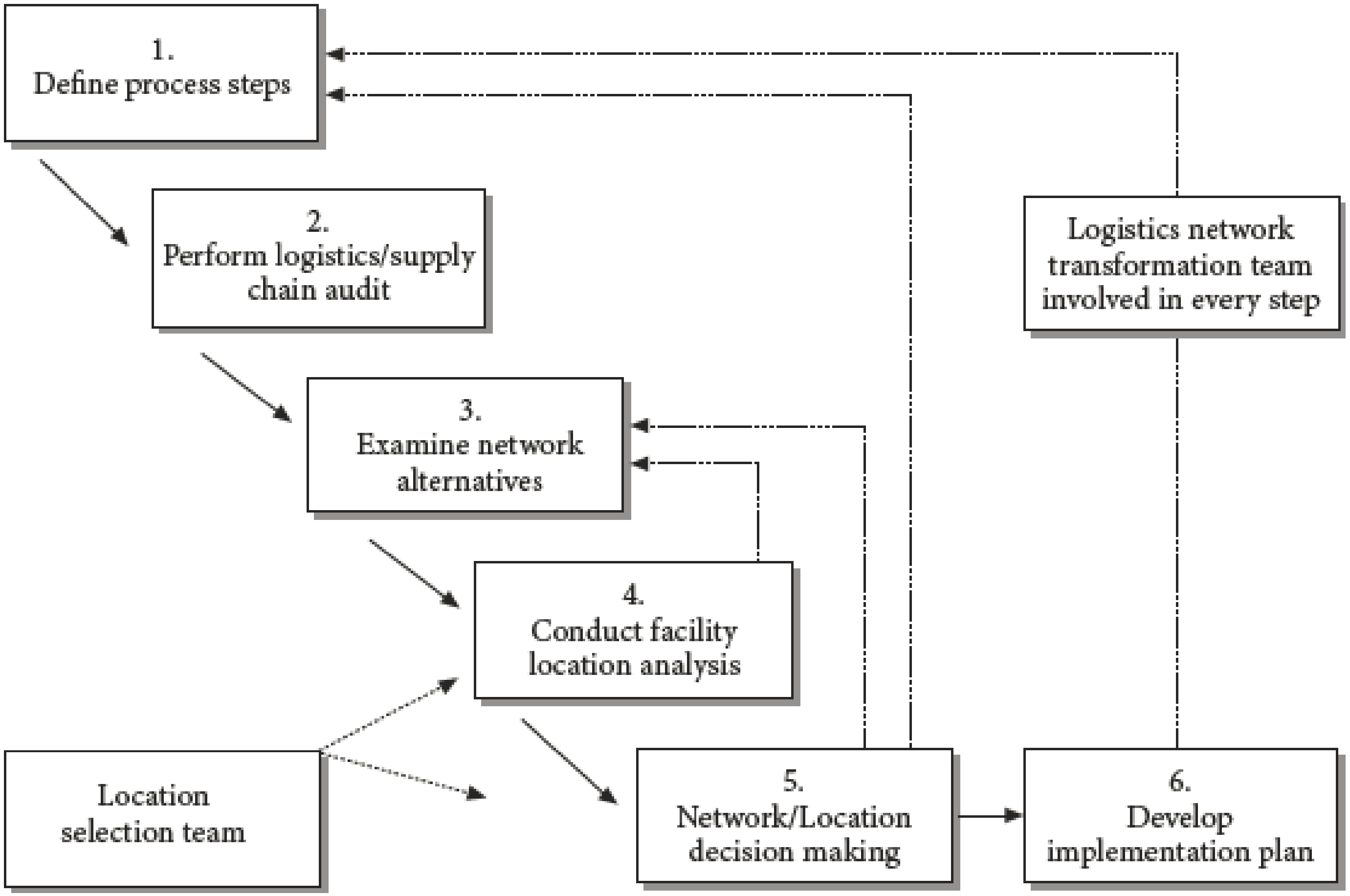
# Strategic Network Design

- In the short run, a firm's logistics/supply chain network and the locations of its key facilities are fixed…

# Strategic Network Design

- Site availability, leases, contracts, and investments make changing facility locations impractical in the short run.  In the long run, however, the design of the overall network must be thought of as variable

# Strategic Network Design



1.
Define process steps

2.
Perform logistics/supply chain audit

3.
Examine network alternatives

4.
Conduct facility location analysis

5.
Network/Location decision making

6.
Develop implementation plan

Logistics network transformation team involved in every step

Location selection team

# Strategic Network Design

- Step 1: Define the logistics / supply chain design process.
- Step 2: Perform a logistics / supply chain audit.
- Step 3: Examine the logistics / supply chain network alternatives.

# Strategic Network Design

- Step 4: Conduct a facility location analysis.
- Step 5: Make decisions regarding network and facility location.
- Step 6: Develop an implementation plan.

# Pillars of Competitiveness

- Institutions
- Infrastructure
- Macroeconomic stability
- Health & primary education
- Higher education & training
- Goods market efficiency

# Pillars of Competitiveness

- Labor market efficiency
- Financial market sophistication
- Technological readiness
- Market size
- Business sophistication
- Innovation

# Pillars of Competitiveness

- Government Taxes & Incentives
- Several levels of government must be considered when evaluating potential locations.
- Countries with high tariffs discourage importing goods into the country.

# Pillars of Competitiveness

- High tariffs encourage multinational corporations to produce locally.
- Many countries have foreign trade zones (FTZs) where materials are imported duty-free as inputs to production.

# Pillars of Competitiveness

- **Currency Stability**
- Impacts business costs & consequently location decisions

# Pillars of Competitiveness

- **Environmental Issues**
- Environmental cooperation with
- Global warming, air pollution, acid rain, carbon footprint, & cradle-to-grave analysis of how products and services affect the environment.

# Pillars of Competitiveness

- **Access & Proximity to Markets**
- Relocation to China not just for cheap labor but for access to the market
- In the service industry, proximity to customers is even more critical…

# Pillars of Competitiveness

- Convenience is a factor in consumer choice
- **Labor Issues**
- Labor availability, productivity, & skill
- Unemployment & underemployment rates…

# Pillars of Competitiveness

- Wage rates; turnover rates; labor force competitors
- Employment trends.

# Pillars of Competitiveness

- **Access to Suppliers & Cost**
- Supplier proximity influences the delivery of materials & effectiveness of the supply chain.

# Pillars of Competitiveness

- **Utility Availability & Cost**
- Supply of electricity has not kept pace with the high speed of development.
- In heavy industries the availability & cost of energy are critical considerations..

# The Weighted-Factor Rating Model

- Compares the attractiveness of several locations along a number of quantitative & qualitative dimensions. Steps:
- Identify the factors

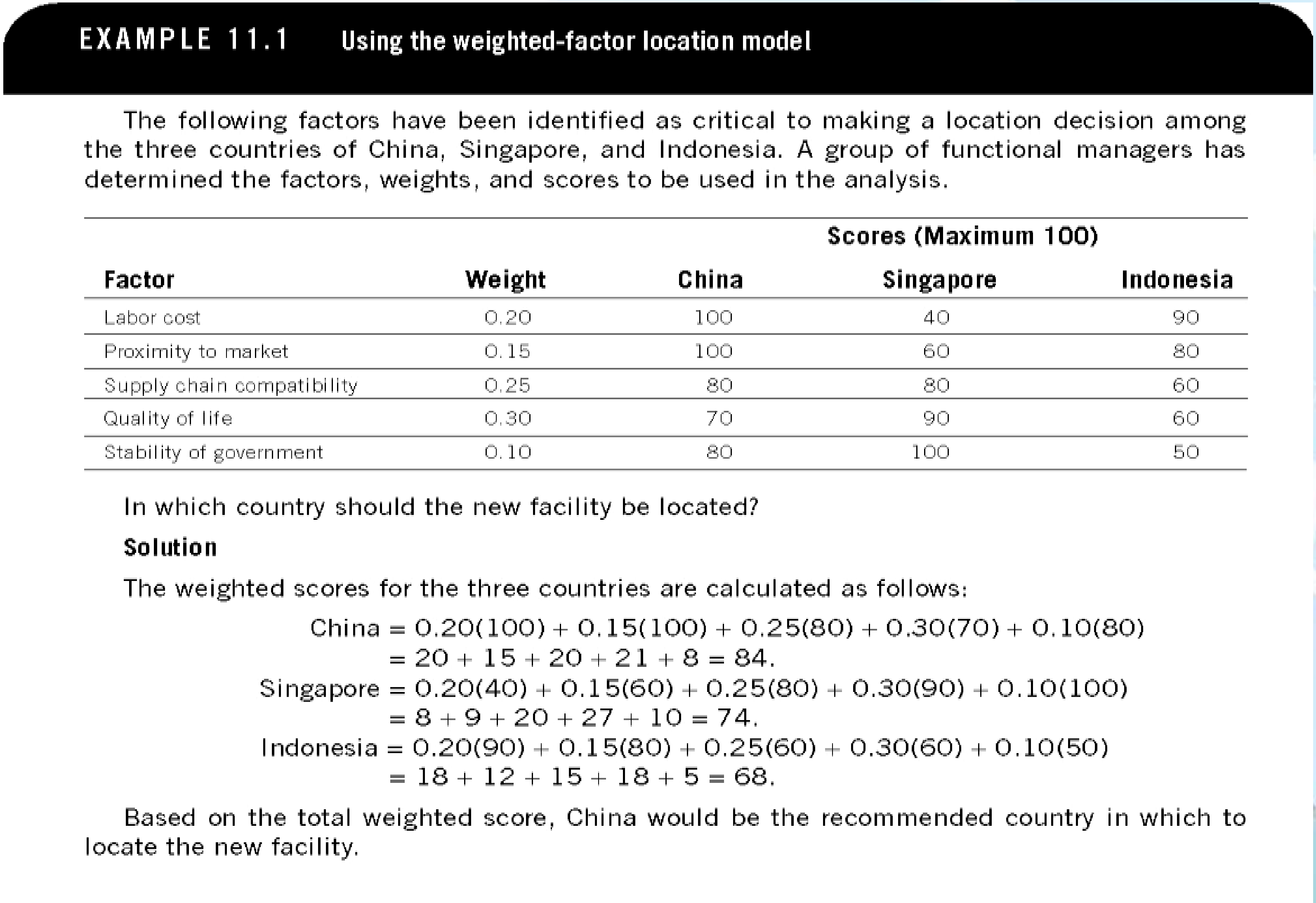
# The Weighted-Factor Rating Model

- Assign weights to each factor. The weights sum to 1.
- Determine a score for each factor.
- Multiply the factor score by the weight, then sum the weighted scores

# The Weighted-Factor Rating Model

- The location with the highest total weighted score is the recommended location.

# The Weighted-Factor Rating Model



**EXAMPLE 11.1** **Using the weighted-factor location model**

The following factors have been identified as critical to making a location decision among the three countries of China, Singapore, and Indonesia. A group of functional managers has determined the factors, weights, and scores to be used in the analysis.

| | | Scores (Maximum 100) | | |
|---|---|---|---|---|
| **Factor** | **Weight** | **China** | **Singapore** | **Indonesia** |
| Labor cost | 0.20 | 100 | 40 | 90 |
| Proximity to market | 0.15 | 100 | 60 | 80 |
| Supply chain compatibility | 0.25 | 80 | 80 | 60 |
| Quality of life | 0.30 | 70 | 90 | 60 |
| Stability of government | 0.10 | 80 | 100 | 50 |

In which country should the new facility be located?

**Solution**

The weighted scores for the three countries are calculated as follows:

$$\begin{aligned}
\text{China} &= 0.20(100) + 0.15(100) + 0.25(80) + 0.30(70) + 0.10(80) \\
&= 20 + 15 + 20 + 21 + 8 = 84. \\
\text{Singapore} &= 0.20(40) + 0.15(60) + 0.25(80) + 0.30(90) + 0.10(100) \\
&= 8 + 9 + 20 + 27 + 10 = 74. \\
\text{Indonesia} &= 0.20(90) + 0.15(80) + 0.25(60) + 0.30(60) + 0.10(50) \\
&= 18 + 12 + 15 + 18 + 5 = 68.
\end{aligned}$$

Based on the total weighted score, China would be the recommended country in which to locate the new facility.

# The Weighted-Factor Rating Model

# Break Even Model

- Useful location analysis technique when fixed & variable costs can be determined
- Identify the locations to be considered.

# Break Even Model

- Determine the fixed cost of land, property taxes, insurance, equipment, & buildings.
- Determine the unit variable cost, materials, utilities, & transportation costs.

# Break Even Model

- Construct the total cost lines.
- Determine the break-even points on the graph.
- Identify the range over which each location has the lower cost.

# Break Even Model

- Three locations have been identified as suitable candidates for building a new factory. The fixed and unit variable costs for each…

# Break Even Model

- of three potential locations have been estimated and are shown in the following table.

# Break Even Model

| Location | Annual Fixed Cost | Unit Variable Cost |
|---|---|---|
| A | $500,000 | $300 |
| B | $750,000 | $200 |
| C | $900,000 | $100 |

# Break Even Model

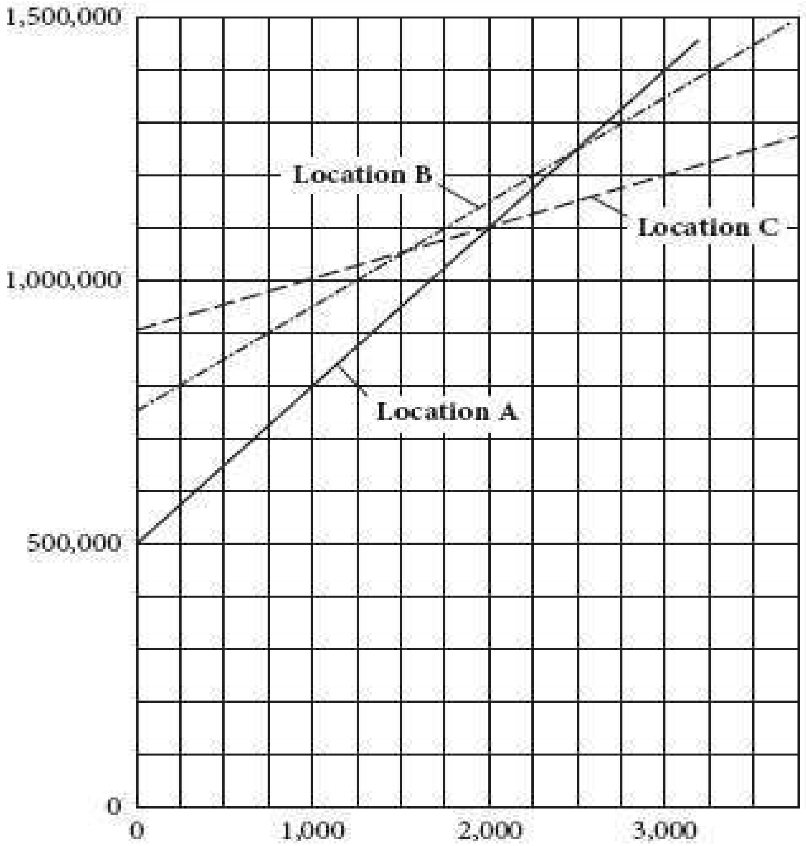
- Given a forecasted demand of 3,000 units per year, the best location can be found by first, plotting the three total cost curves, represented by

# Break Even Model

- TCA = 500,000 + 300Q
- TCB = 750,000 + 200Q
- TCC = 900,000 + 100Q

# Break Even Model

Figure 11.1 Break-even graph



# Break Even Model

- Next, the break-even point between Location A and Location B is determined:
- TCA = TCB
- 500,000 + 300Q = 750,000 + 200Q
- 100Q = 250,000 and then Q = 2,500 units

# Break Even Model

- This indicates that producing less than 2,500 units per year would be cheaper at Location A (when the lower fixed cost predominates)…

# Break Even Model

- while producing more than 2,500 units per year would be cheaper at Location B (when the lower variable cost predominates).

# Break Even Model

- Next, the break-even point between Location B and Location C is determined:
- TCB = TCC
- 750,000 + 200Q = 900,000 + 100Q
- 100Q = 150,000 and then Q = 1,500 units.

# Break Even Model

- This indicates that producing less than 1,500 units per year would be cheaper at Location B, while producing more than 1,500 units per year would be cheaper at Location C.

# Break Even Model

- Finally, the break-even point between Location A and Location C is determined:
- TCA = TCC
- 500,000 + 300Q = 900,000 + 100Q
- 200Q = 400,000 and then Q = 2,000 units.

# Break Even Model

- This indicates that producing less than 2,000 units per year would be cheaper at Location A, while producing more than 2,000 units per year would be cheaper at Location C.

# Break Even Model

- Based on the cost curves shown in Figure, Location C has the lowest total cost when producing the forecasted quantity of 3,000 units per year.

# Break Even Model

- If, however, the annual demand forecast was 1,000 units, then Location A would be preferred….

# Break Even Model

- Location B would never be the preferred location when comparing the costs of all three sites simultaneously..

# Business Clusters

- Geographic concentrations of interconnected companies & institutions in a particular field.
- Research parks & special economic/industrial zones serve as magnets for business clusters.

# Business Clusters

- **Reasons for success-**
- close cooperation, coordination, & trust among clustered companies
- fierce competition among rival companies…

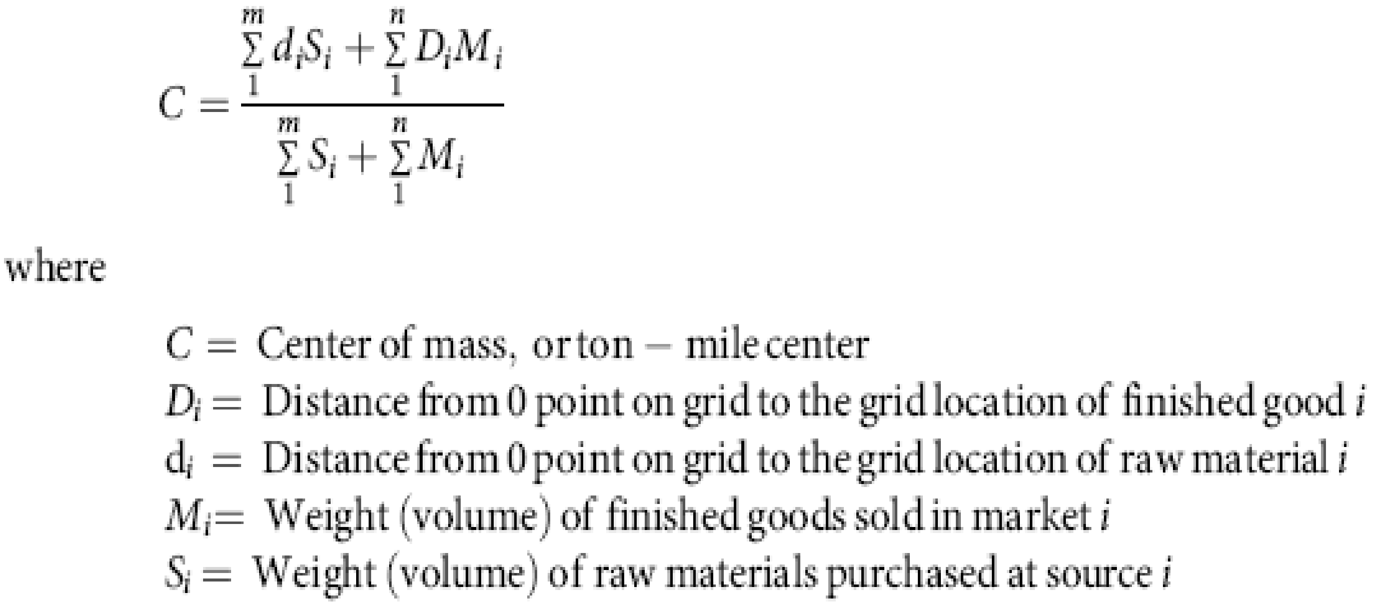
# Business Clusters

- companies recruit from local skilled workers
- competitive environment that promotes increasing innovation and profitability..

# Heuristic Approach: The Grid Technique

- Compute this concept mathematically, finding the ton-mile center, or center of mass, as follows:

# Heuristic Approach: The Grid Technique



$$C = \frac{\sum_{1}^{m} d_i S_i + \sum_{1}^{n} D_i M_i}{\sum_{1}^{m} S_i + \sum_{1}^{n} M_i}$$

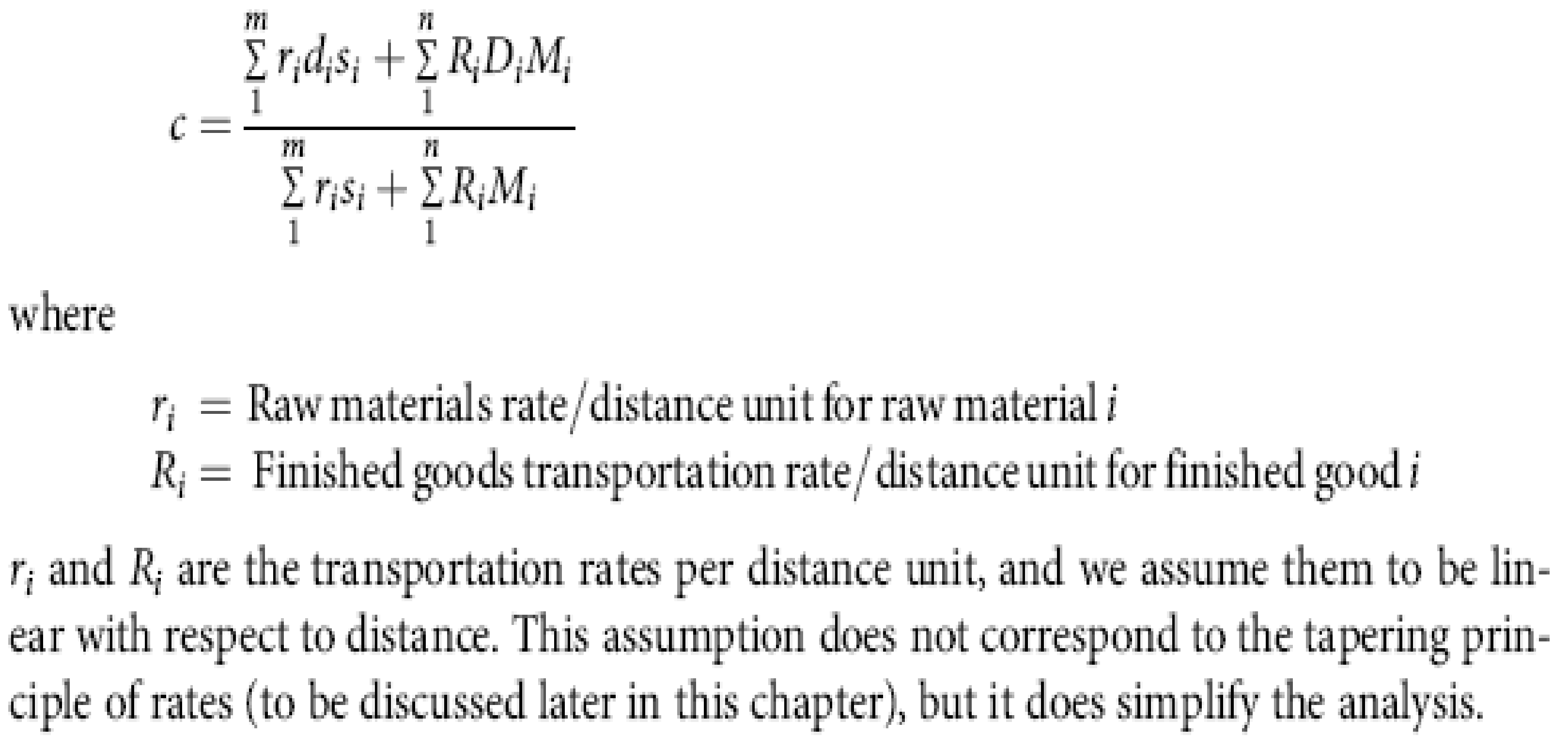
where

$C =$ Center of mass, or ton – mile center
$D_i =$ Distance from 0 point on grid to the grid location of finished good $i$
$d_i =$ Distance from 0 point on grid to the grid location of raw material $i$
$M_i =$ Weight (volume) of finished goods sold in market $i$
$S_i =$ Weight (volume) of raw materials purchased at source $i$

# Heuristic Approach: The Grid Technique

- Incorporate the transportation rates of different products, using this modification as follows:

# Heuristic Approach: The Grid Technique



$$c = \frac{\sum_{1}^{m} r_i d_i s_i + \sum_{1}^{n} R_i D_i M_i}{\sum_{1}^{m} r_i s_i + \sum_{1}^{n} R_i M_i}$$

where

$r_i$ = Raw materials rate/distance unit for raw material $i$
$R_i$ = Finished goods transportation rate/distance unit for finished good $i$

$r_i$ and $R_i$ are the transportation rates per distance unit, and we assume them to be linear with respect to distance. This assumption does not correspond to the tapering principle of rates (to be discussed later in this chapter), but it does simplify the analysis.

# Heuristic Approach: The Grid Technique

- Advantages
- The grid technique’s strengths are in its simplicity and its ability to provide a starting point for location analysis.

# Heuristic Approach: The Grid Technique

- The grid technique also provides a starting point for making a location decision.
- **Limitations**
- It is a static approach, and the solution is optimum for only one point in time.

# Heuristic Approach: The Grid Technique

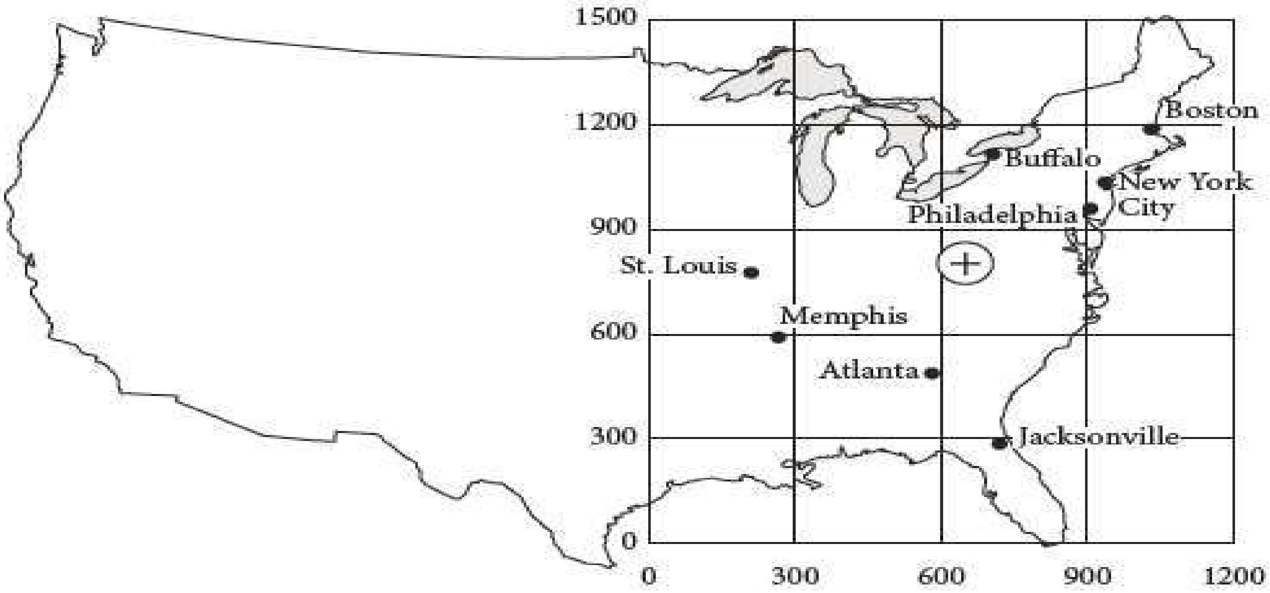
- The technique assumes linear transportation rates, whereas actual transportation rates increase with distance but less than proportionally…

# Heuristic Approach: The Grid Technique

- The technique does not consider the topographic conditions..

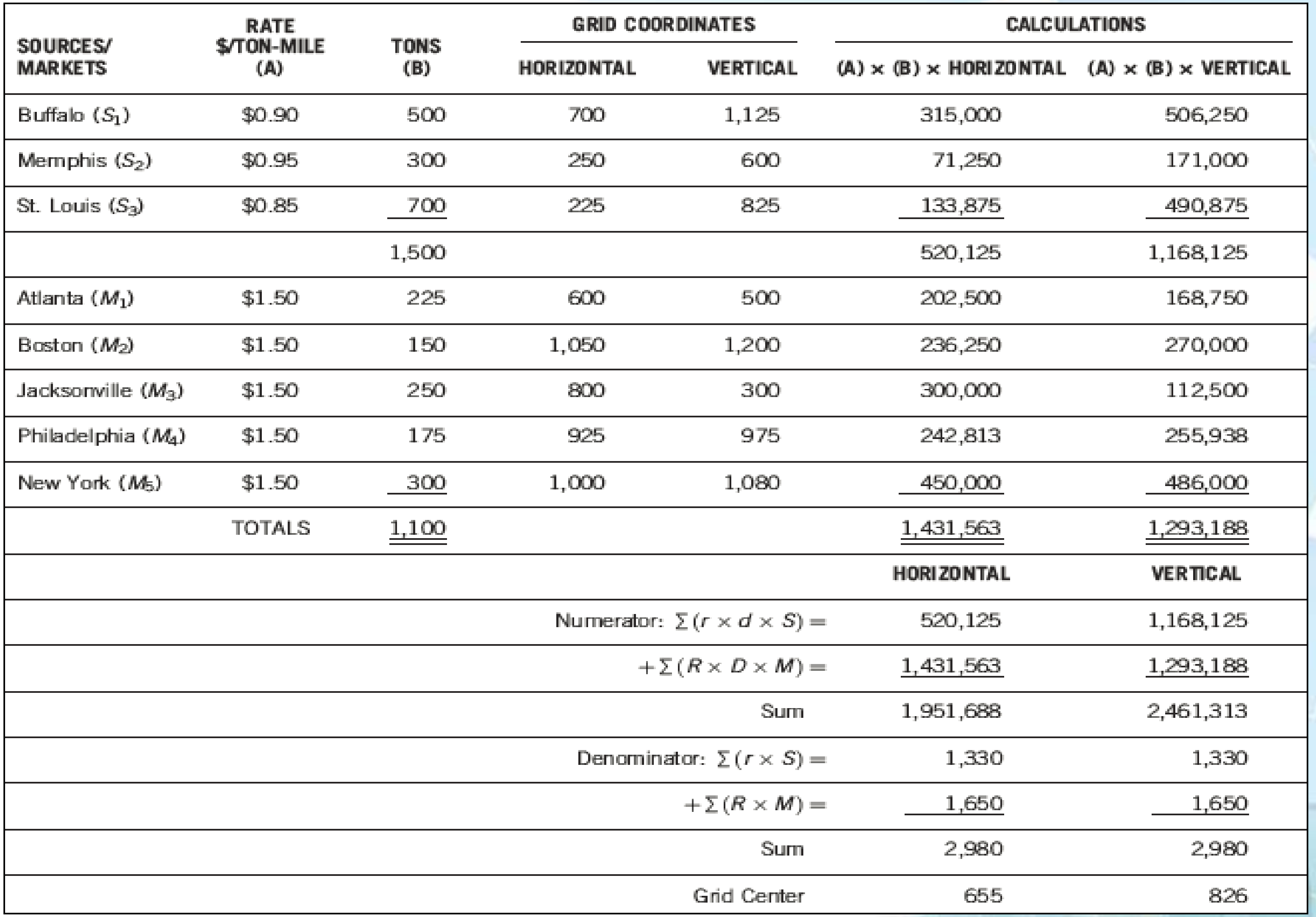
# The Grid Technique Example

# The Grid Technique Example



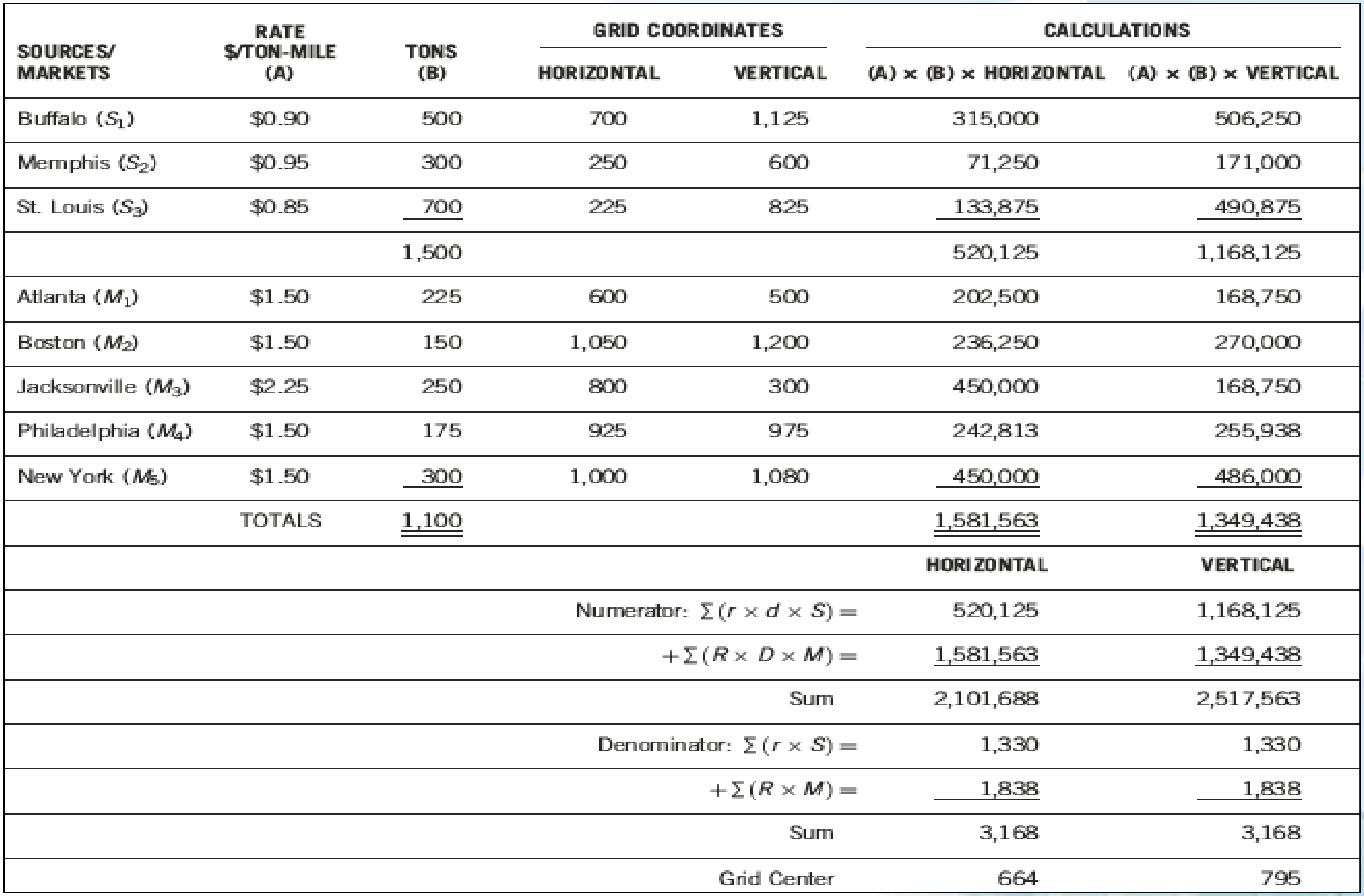
| | Grid Coordinates | |
|---|---|---|
| **Sources** | Horizontal | Vertical |
| Buffalo ($S_1$) | 700 | 1,125 |
| Memphis ($S_2$) | 250 | 600 |
| St. Louis ($S_3$) | 225 | 825 |
| **Markets** | | |
| Atlanta ($M_1$) | 600 | 500 |
| Boston ($M_2$) | 1,050 | 1,200 |
| Jacksonville ($M_3$) | 800 | 300 |
| Philadelphia ($M_4$) | 925 | 975 |
| New York ($M_5$) | 1,000 | 1,080 |

# The Grid Technique Example



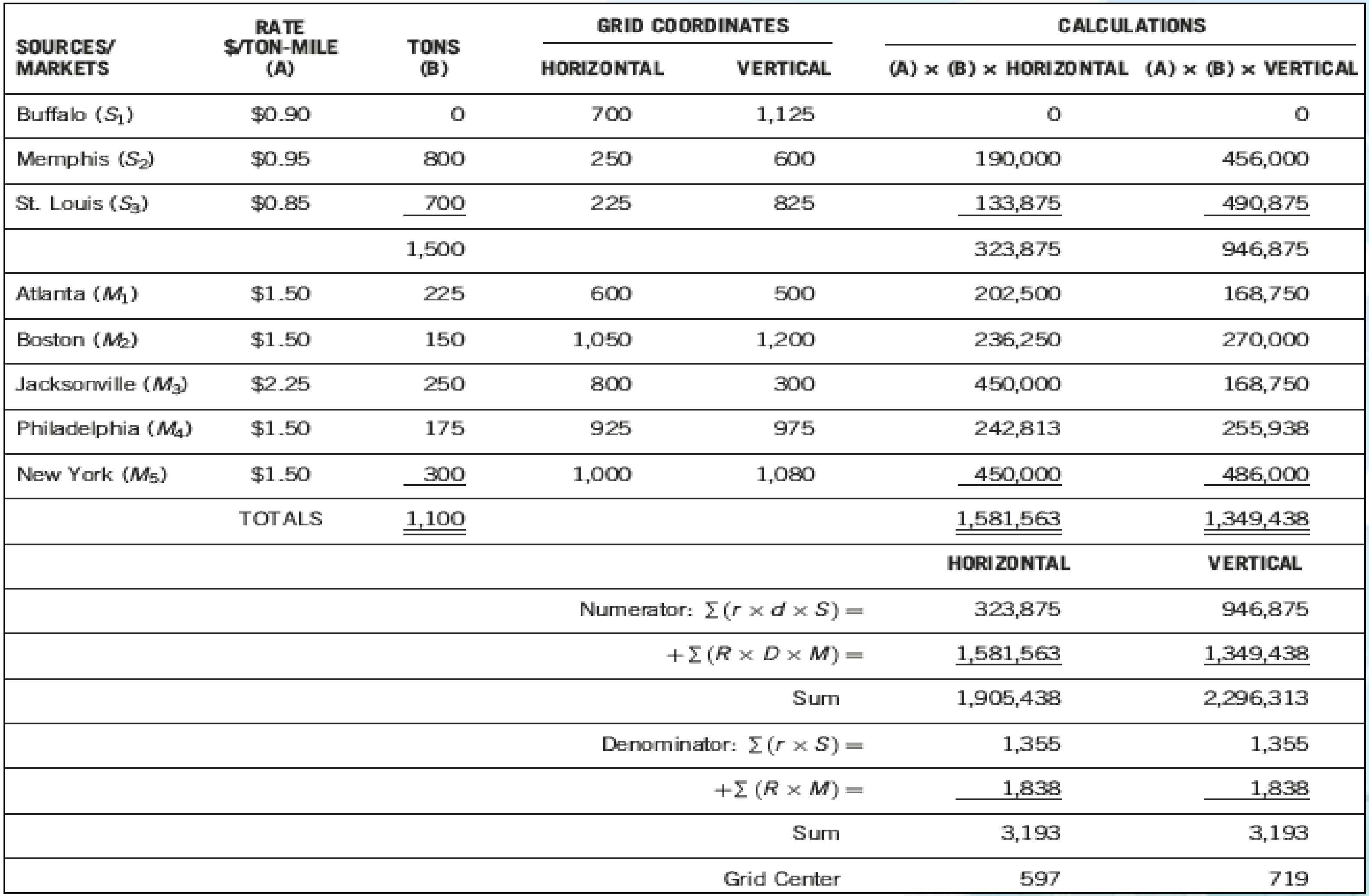
| SOURCES/ MARKETS | RATE $/TON-MILE (A) | TONS (B) | GRID COORDINATES | | CALCULATIONS | |
|---|---|---|---|---|---|---|
| | | | HORIZONTAL | VERTICAL | (A) × (B) × HORIZONTAL | (A) × (B) × VERTICAL |
| Buffalo ($S_1$) | $0.90 | 500 | 700 | 1,125 | 315,000 | 506,250 |
| Memphis ($S_2$) | $0.95 | 300 | 250 | 600 | 71,250 | 171,000 |
| St. Louis ($S_3$) | $0.85 | 700 | 225 | 825 | 133,875 | 490,875 |
| | | 1,500 | | | 520,125 | 1,168,125 |
| Atlanta ($M_1$) | $1.50 | 225 | 600 | 500 | 202,500 | 168,750 |
| Boston ($M_2$) | $1.50 | 150 | 1,050 | 1,200 | 236,250 | 270,000 |
| Jacksonville ($M_3$) | $1.50 | 250 | 800 | 300 | 300,000 | 112,500 |
| Philadelphia ($M_4$) | $1.50 | 175 | 925 | 975 | 242,813 | 255,938 |
| New York ($M_5$) | $1.50 | 300 | 1,000 | 1,080 | 450,000 | 486,000 |
| | TOTALS | 1,100 | | | 1,431,563 | 1,293,188 |
| | | | | | HORIZONTAL | VERTICAL |
| | | | | Numerator: $\Sigma(r \times d \times S) =$ | 520,125 | 1,168,125 |
| | | | | $+\Sigma(R \times D \times M) =$ | 1,431,563 | 1,293,188 |
| | | | | Sum | 1,951,688 | 2,461,313 |
| | | | | Denominator: $\Sigma(r \times S) =$ | 1,330 | 1,330 |
| | | | | $+\Sigma(R \times M) =$ | 1,650 | 1,650 |
| | | | | Sum | 2,980 | 2,980 |
| | | | | Grid Center | 655 | 826 |

# The Grid Technique Example



| SOURCES/ MARKETS | RATE $/TON-MILE (A) | TONS (B) | GRID COORDINATES | | CALCULATIONS | |
|---|---|---|---|---|---|---|
| | | | HORIZONTAL | VERTICAL | (A) × (B) × HORIZONTAL | (A) × (B) × VERTICAL |
| Buffalo ($S_1$) | $0.90 | 500 | 700 | 1,125 | 315,000 | 506,250 |
| Memphis ($S_2$) | $0.95 | 300 | 250 | 600 | 71,250 | 171,000 |
| St. Louis ($S_3$) | $0.85 | 700 | 225 | 825 | 133,875 | 490,875 |
| | | 1,500 | | | 520,125 | 1,168,125 |
| Atlanta ($M_1$) | $1.50 | 225 | 600 | 500 | 202,500 | 168,750 |
| Boston ($M_2$) | $1.50 | 150 | 1,050 | 1,200 | 236,250 | 270,000 |
| Jacksonville ($M_3$) | $2.25 | 250 | 800 | 300 | 450,000 | 168,750 |
| Philadelphia ($M_4$) | $1.50 | 175 | 925 | 975 | 242,813 | 255,938 |
| New York ($M_5$) | $1.50 | 300 | 1,000 | 1,080 | 450,000 | 486,000 |
| | TOTALS | 1,100 | | | 1,581,563 | 1,349,438 |
| | | | | | **HORIZONTAL** | **VERTICAL** |
| | | | | Numerator: $\Sigma(r \times d \times S) =$ | 520,125 | 1,168,125 |
| | | | | $+\Sigma(R \times D \times M) =$ | 1,581,563 | 1,349,438 |
| | | | | Sum | 2,101,688 | 2,517,563 |
| | | | | Denominator: $\Sigma(r \times S) =$ | 1,330 | 1,330 |
| | | | | $+\Sigma(R \times M) =$ | 1,838 | 1,838 |
| | | | | Sum | 3,168 | 3,168 |
| | | | | Grid Center | 664 | 795 |

# The Grid Technique Example



| SOURCES/ MARKETS | RATE $/TON-MILE (A) | TONS (B) | GRID COORDINATES | | CALCULATIONS | |
|---|---|---|---|---|---|---|
| | | | HORIZONTAL | VERTICAL | (A) × (B) × HORIZONTAL | (A) × (B) × VERTICAL |
| Buffalo ($S_1$) | $0.90 | 0 | 700 | 1,125 | 0 | 0 |
| Memphis ($S_2$) | $0.95 | 800 | 250 | 600 | 190,000 | 456,000 |
| St. Louis ($S_3$) | $0.85 | 700 | 225 | 825 | 133,875 | 490,875 |
| | | 1,500 | | | 323,875 | 946,875 |
| Atlanta ($M_1$) | $1.50 | 225 | 600 | 500 | 202,500 | 168,750 |
| Boston ($M_2$) | $1.50 | 150 | 1,050 | 1,200 | 236,250 | 270,000 |
| Jacksonville ($M_3$) | $2.25 | 250 | 800 | 300 | 450,000 | 168,750 |
| Philadelphia ($M_4$) | $1.50 | 175 | 925 | 975 | 242,813 | 255,938 |
| New York ($M_5$) | $1.50 | 300 | 1,000 | 1,080 | 450,000 | 486,000 |
| | TOTALS | 1,100 | | | 1,581,563 | 1,349,438 |
| | | | | | HORIZONTAL | VERTICAL |
| | | | | Numerator: $\Sigma(r \times d \times S) =$ | 323,875 | 946,875 |
| | | | | $+\Sigma(R \times D \times M) =$ | 1,581,563 | 1,349,438 |
| | | | | Sum | 1,905,438 | 2,296,313 |
| | | | | Denominator: $\Sigma(r \times S) =$ | 1,355 | 1,355 |
| | | | | $+\Sigma(R \times M) =$ | 1,838 | 1,838 |
| | | | | Sum | 3,193 | 3,193 |
| | | | | Grid Center | 597 | 719 |

# The Grid Technique Example

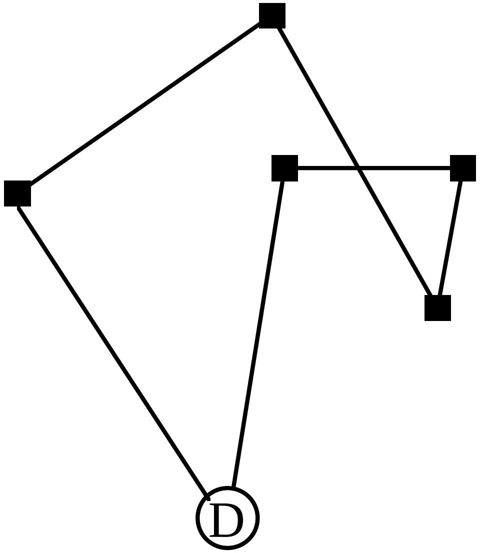
# Guidelines for Heuristic Approach

- Typical of many single truck routing problems from a single depot.
- Mathematically, a complex problem to solve efficiently.

# Guidelines for Heuristic Approach

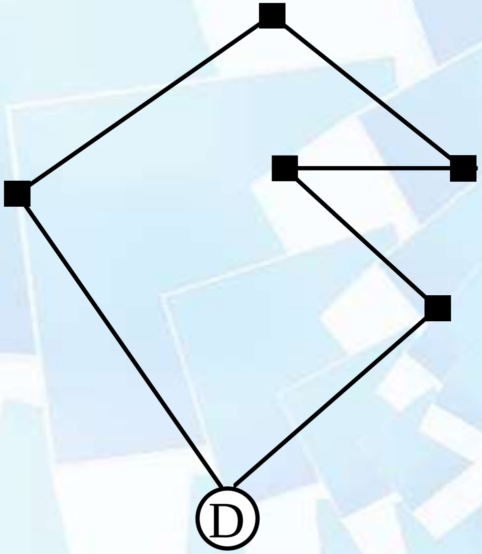
- However, good routes can be found by forming a route pattern where the paths do not cross - a "tear drop" pattern

# Guidelines for Heuristic Approach



Depot

(a) Poor routing--
paths cross

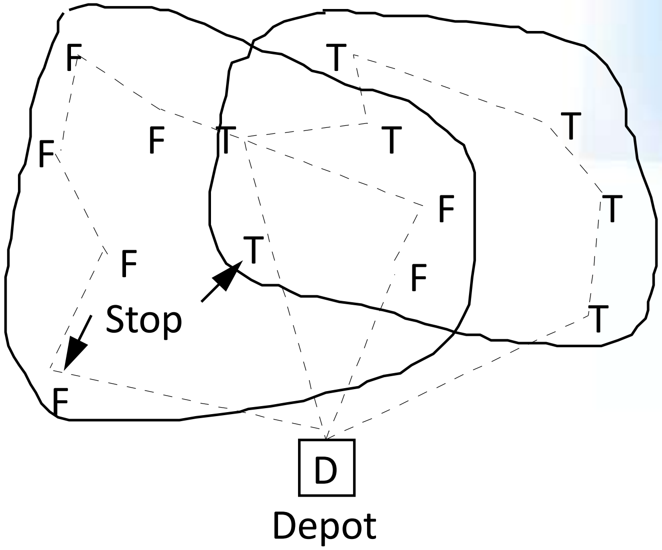


Depot

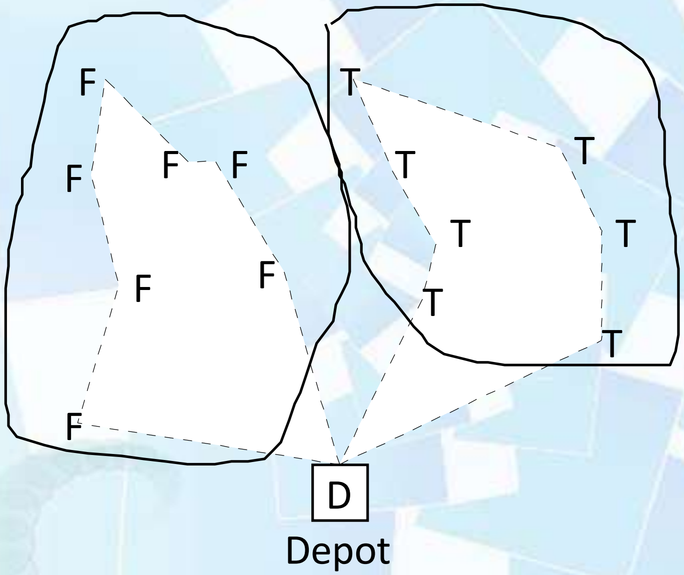
(b) Good routing--
no paths cross

# Guidelines for Heuristic Approach

2. *Stops on different days should be arranged to produce tight clusters*



(a) Weak clustering--routes cross



(b) Better clustering

# Guidelines for Heuristic Approach

- 3. Build routes beginning with the farthest stop from the depot
- 4. The stop sequence on a route should form a teardrop pattern (without time windows)

# Guidelines for Heuristic Approach

- 5. The most efficient routes are built using the largest vehicles available first
- 6. Pickups should be mixed into delivery routes rather than assigned to the end of the routes

# Guidelines for Heuristic Approach

- 7. A stop that is greatly removed from a route cluster is a good candidate for an alternate means of delivery
- 8. Narrow stop time window restrictions should be avoided (relaxed)

# Guidelines for Heuristic Approach

- A problem similar to the single-vehicle routing problem except that a number of restrictions are placed on the problem.  Chief among these are:

# Guidelines for Heuristic Approach

- A mixture of vehicles with different capacities
- Time windows on the stops
- Pickups combined with deliveries
- Total travel time for a vehicle

# Guidelines for Heuristic Approach

- Heuristic solution “Sweep” Method
- “Savings” Method

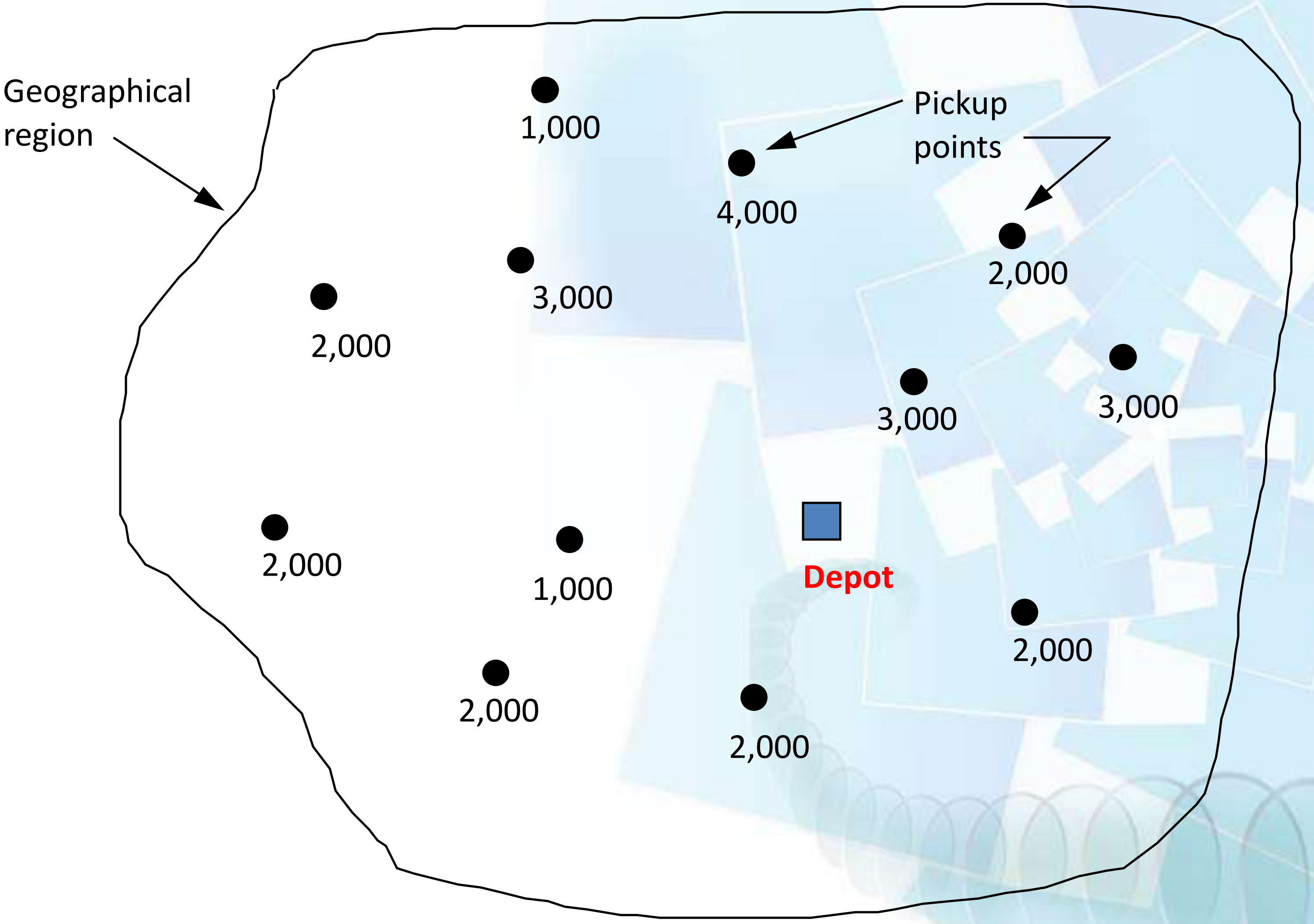
# “Sweep” Method for VRP

- Example A trucking company has 10,000-unit vans for merchandise pickup to be consolidated into larger loads for moving over long distances…

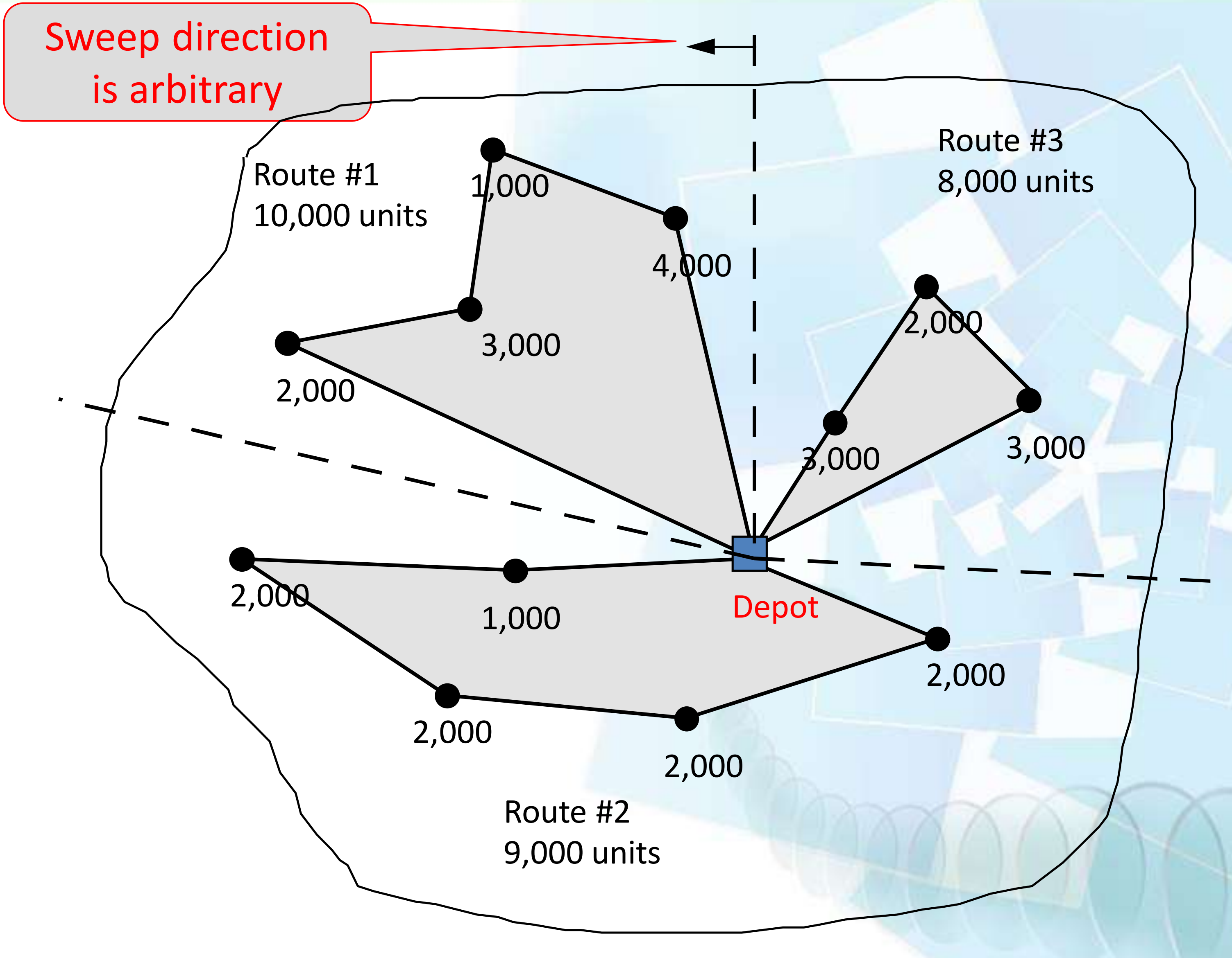
# “Sweep” Method for VRP

- A day’s pickups are shown in the figure. How should the routes be designed for minimal total travel distance?

# "Sweep" Method for VRP



# “Sweep” Method for VRP



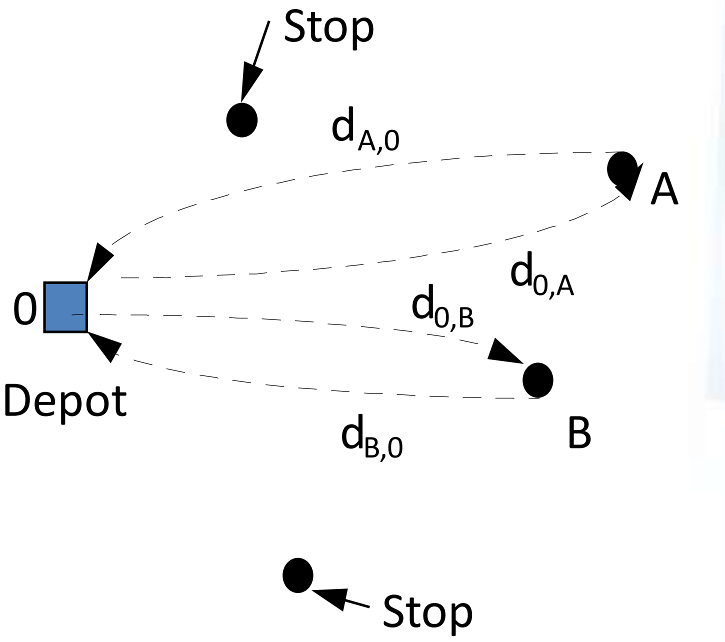
Sweep direction is arbitrary

# “Sweep” Method for VRP

# The “Savings” Method for VRP

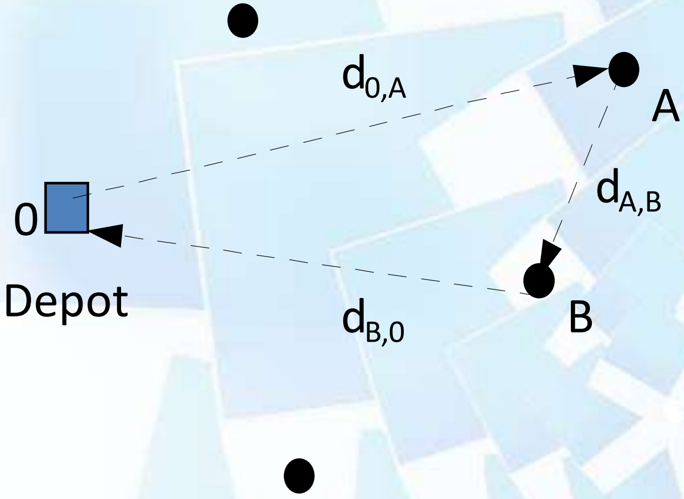
- The points that offer the greatest savings when combined on the same route are those that are farthest from the depot and that are closest to each other.

# The "Savings" Method for VRP



(a) Initial routing—

Route distance = $d_{0,A} + d_{A,0} + d_{0,B} + d_{B,0}$



(b) Combining two stops on a route—

Route distance = $d_{0,A} + d_{A,B} + d_{B,0}$

"Savings" is better than "Sweep" method—has lower average error

# The “Savings” Method for VRP

- This is a good principle
- for constructing multiple-stop Routes..

# Route Sequencing in VRP

- Combine small shipments into larger ones
- A problem of balancing cost savings against customer service reductions

# Route Sequencing in VRP

- An important area for cost reduction in many firms
- Based on the rate-shipment size relationship for for-hire carriers

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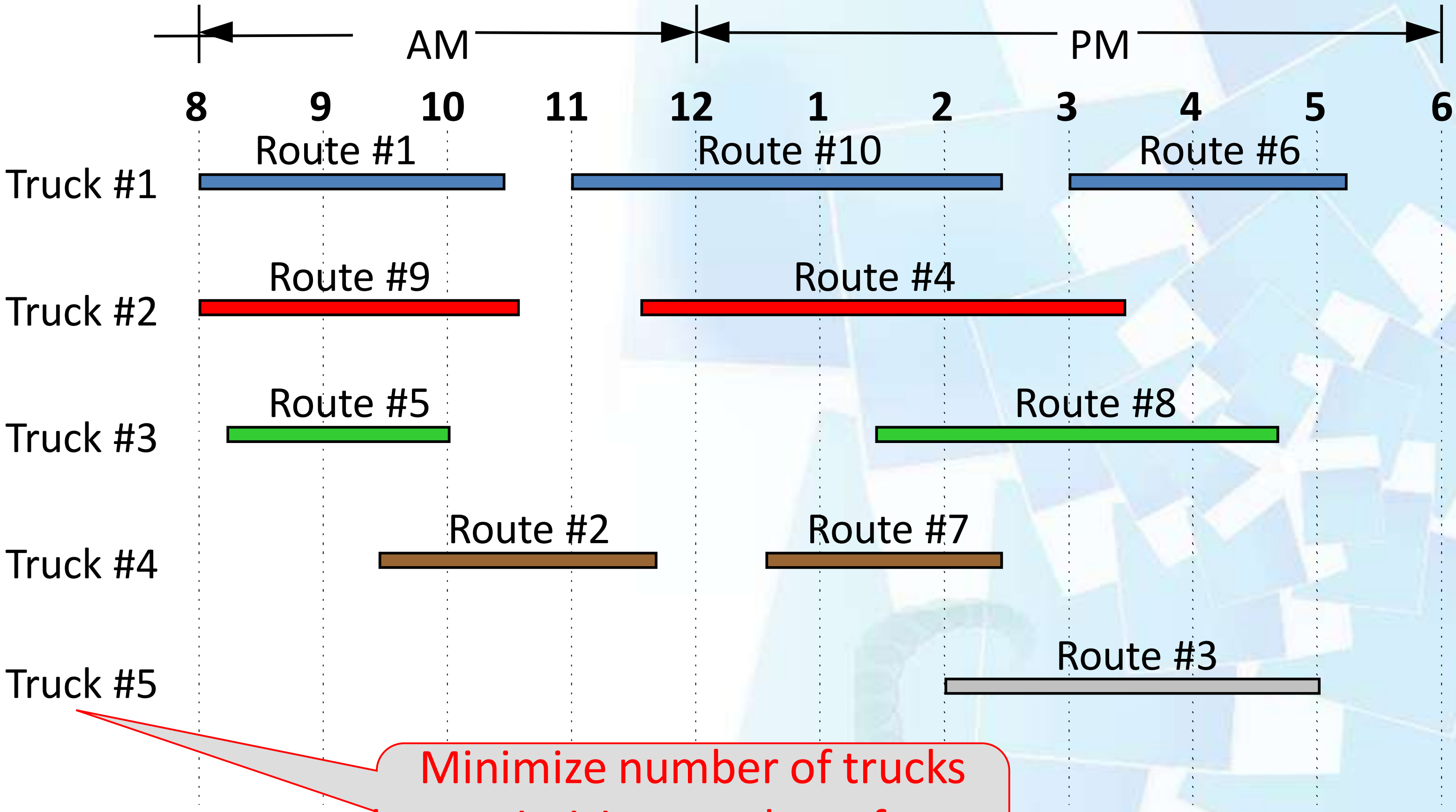
# Route Sequencing in VRP



Minimize number of trucks by maximizing number of routes handled by a single truck

# Route Sequencing in VRP

# Freight Consolidation Analysis

- Suppose we have the following orders for the next three days.
- Consider shipping these orders each day or consolidating them into one shipment. Suppose that we know the transport rates.

# Freight Consolidation Analysis

*From:*

| Ft Worth | *Day 1* | *Day 2* | *Day 3* |
|---|---|---|---|
| *To:* Topeka | 5,000 lb. | 25,000 lb. | 18,000 lb. |
| Kansas City | 7,000 | 12,000 | 21,000 |
| Wichita | 42,000 | 38,000 | 61,000 |

# Freight Consolidation Analysis

| | *Day 1*<br>Rate x volume = cost | *Day 2*<br>Rate x volume = cost |
|---|---|---|
| Topeka | 3.42 x 50 = $171.00 | 1.14 x 250 = $285.00 |
| Kansas City | 3.60 x 70 = 252.00 | 1.44 x 120 = 172.80 |
| Wichita | 0.68 x 420 = 285.60 | 0.68 x 400 [a] = 272.00 |
| | Total $708.60 | Total $729.80 |

---

[a] Ship 380 cwt., as if full truckload of 400 cwt.

| | *Day 3*<br>Rate x volume = cost | *Totals* |
|---|---|---|
| Topeka | 1.36 x 180 = $244.80 | $700.80 |
| Kansas City | 1.20 x 210 = 252.00 | 676.80 |
| Wichita | 0.68 x 610 = 414.80 | 972.40 |
| | Total $911.60 | **$2,350.00** |

# Freight Consolidation Analysis

***Consolidated shipment***

*Day 3*

Rate x volume = cost

Topeka 0.82 x 480[a] = $393.60
Kansas City 0.86 x 400 = 344.00
Wichita 0.68 x 1410 = 958.80

Total **$1,696.40**

Cheaper, but what about the service effects of holding early orders for a longer time to accumulate larger shipment sizes?

---

[a] 480 = 50 + 250 + 180

# Freight Consolidation Analysis

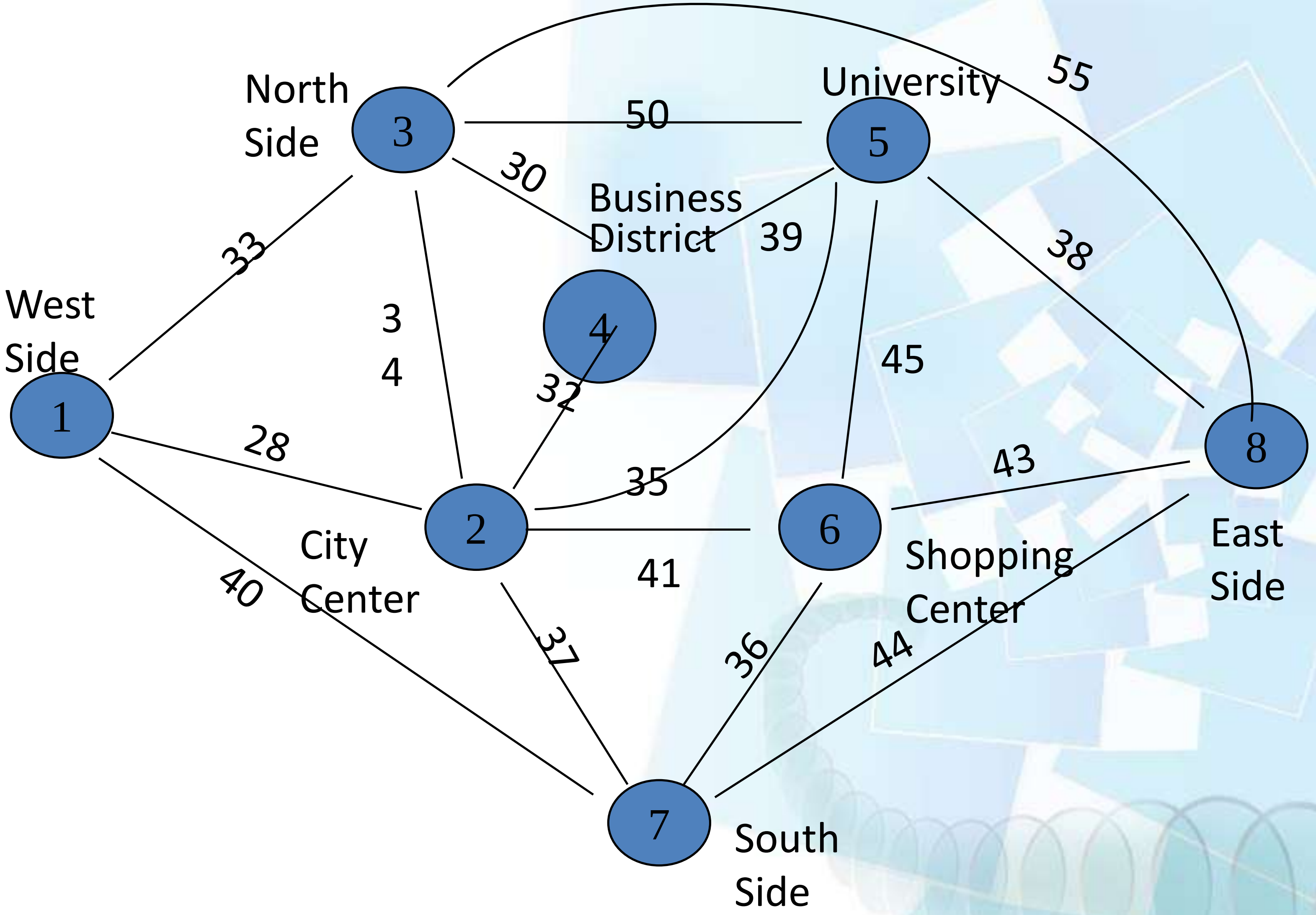
# Minimum Spanning Tree

- This problem arises when all the nodes of a given network must be connected to one another, without any loop.

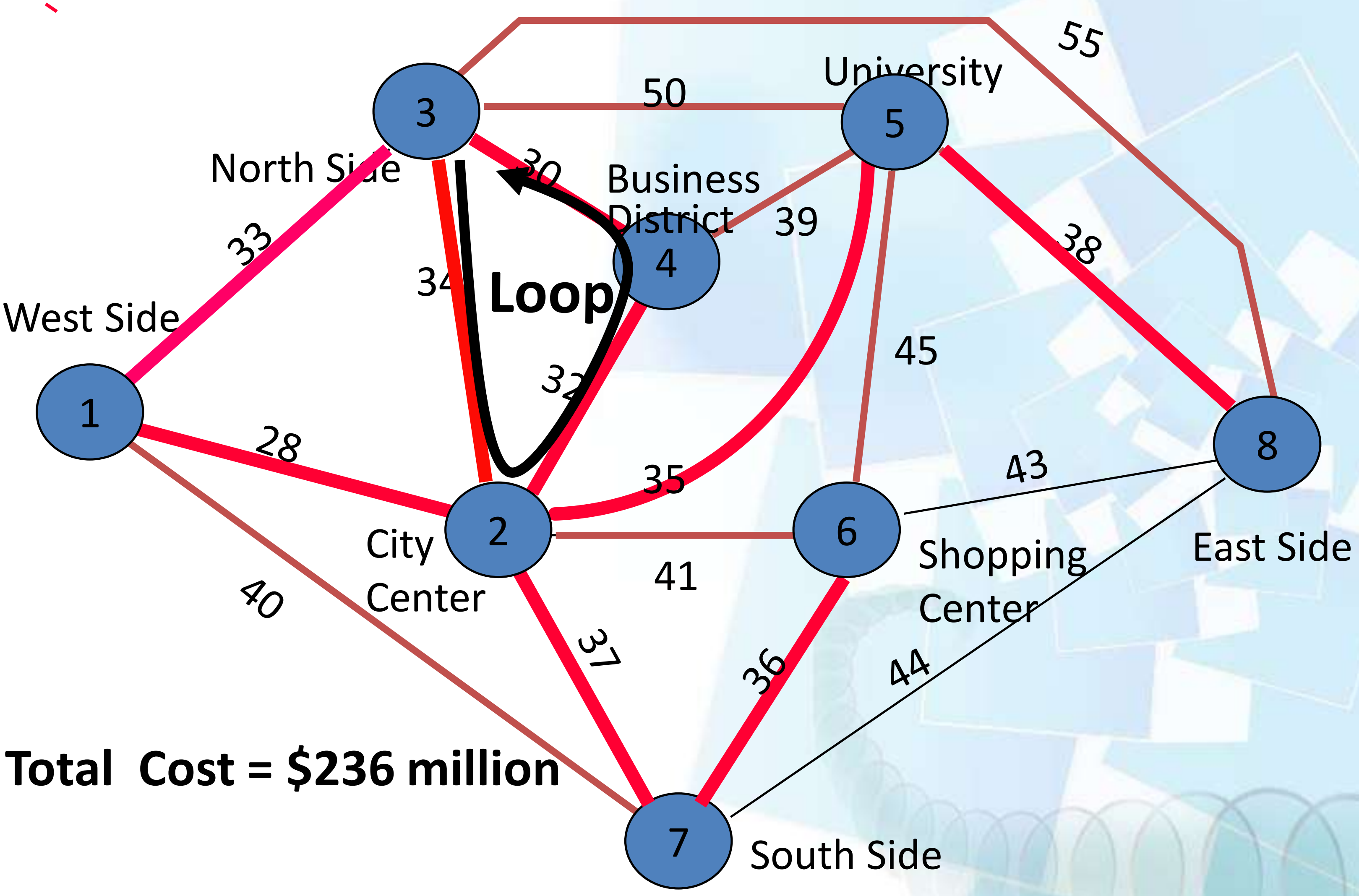
# Minimum Spanning Tree

- The minimal spanning tree approach is appropriate for problems for which redundancy is expensive, or the flow along the arcs is considered instantaneous.

# Minimum Spanning Tree



# Minimum Spanning Tree



**Total Cost = $236 million**

# Minimum Spanning Tree

# Distribution Functionality

- **Distribution Facility Functionality**
- Accumulation
- Sortation
- Allocation
- Assortment

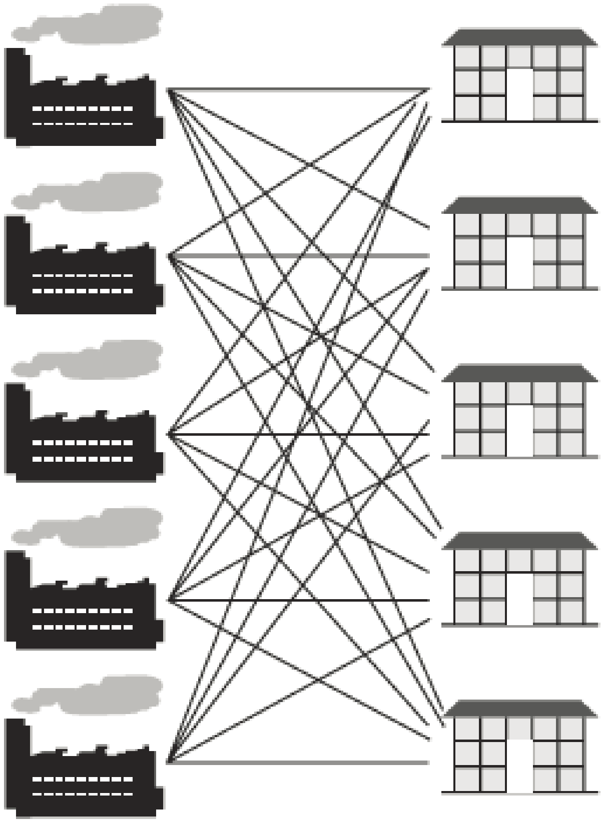
# Distribution Functionality

- **Distribution Tradeoffs**
- Cost of distribution centers and inventory vs. cost of transportation
- Cost of additional facilities vs. level of customer service
- Space vs. equipment

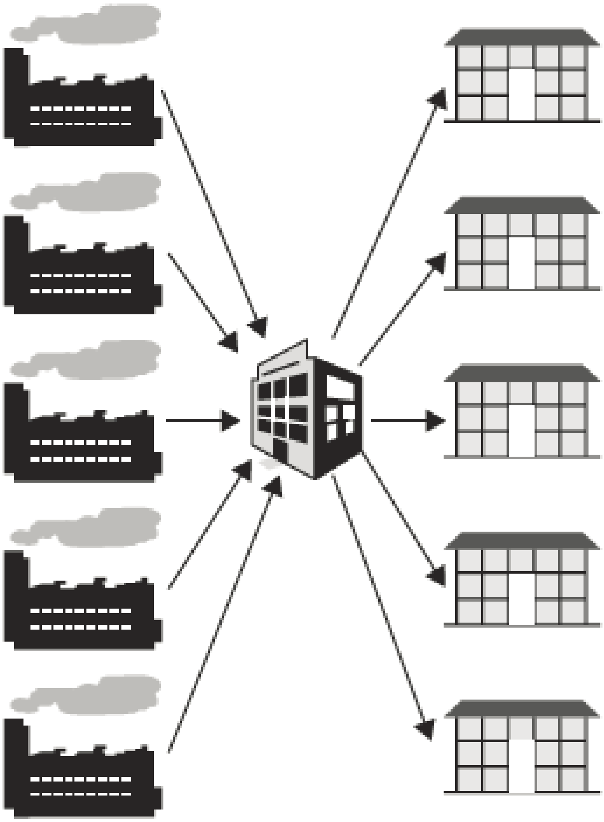
# Distribution Functionality

- Equipment vs. people
- People vs. space

# Distribution Functionality

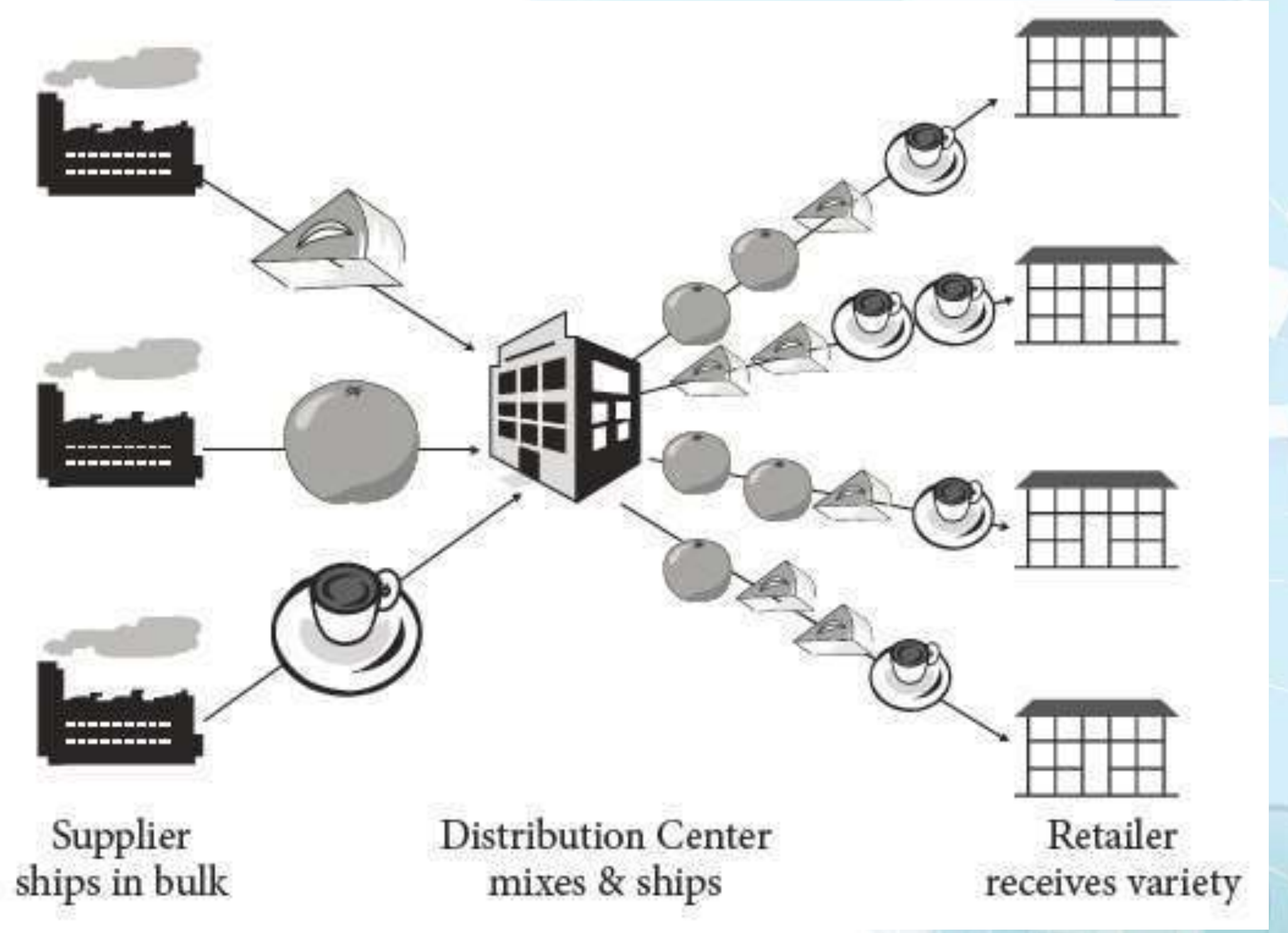


Direct Delivery—No Accumulation



Distribution Center—Accumulation

# Distribution Functionality



# Distribution Functionality

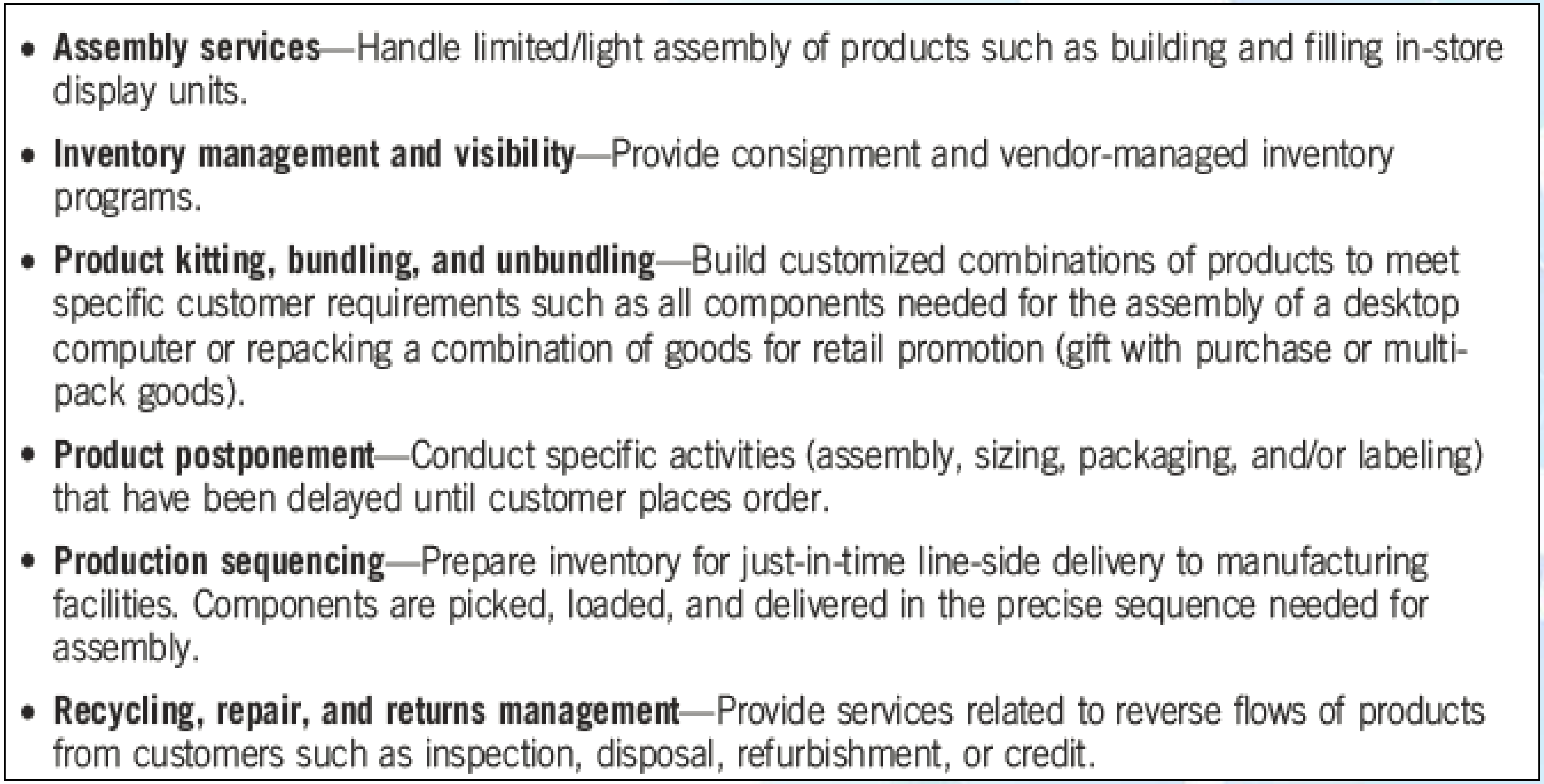
# Value Adding Role of Distribution Operations

- Light assembly services
- Inventory management and visibility
- Product kitting, bundling, and unbundling
- Product postponement

# Value Adding Role of Distribution Operations

- Production sequencing
- Quality control
- Recycling, repair, and returns management

# Value Adding Role of Distribution Operations



- **Assembly services**—Handle limited/light assembly of products such as building and filling in-store display units.
- **Inventory management and visibility**—Provide consignment and vendor-managed inventory programs.
- **Product kitting, bundling, and unbundling**—Build customized combinations of products to meet specific customer requirements such as all components needed for the assembly of a desktop computer or repacking a combination of goods for retail promotion (gift with purchase or multi-pack goods).
- **Product postponement**—Conduct specific activities (assembly, sizing, packaging, and/or labeling) that have been delayed until customer places order.
- **Production sequencing**—Prepare inventory for just-in-time line-side delivery to manufacturing facilities. Components are picked, loaded, and delivered in the precise sequence needed for assembly.
- **Recycling, repair, and returns management**—Provide services related to reverse flows of products from customers such as inspection, disposal, refurbishment, or credit.

# Value Adding Role of Distribution Operations

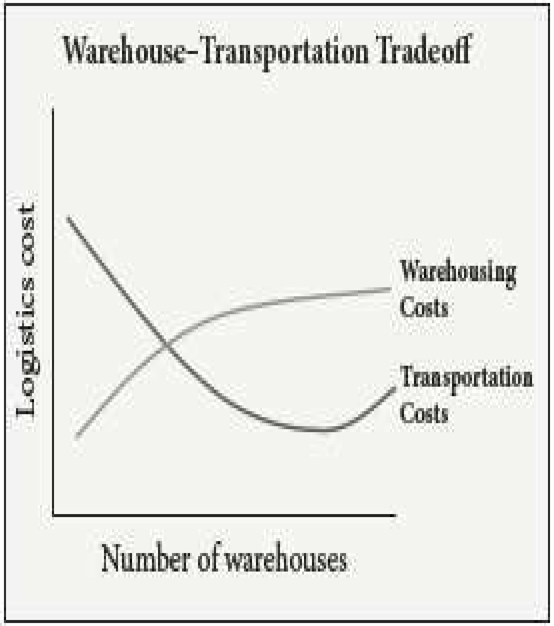
# Key Distribution Tradeoffs

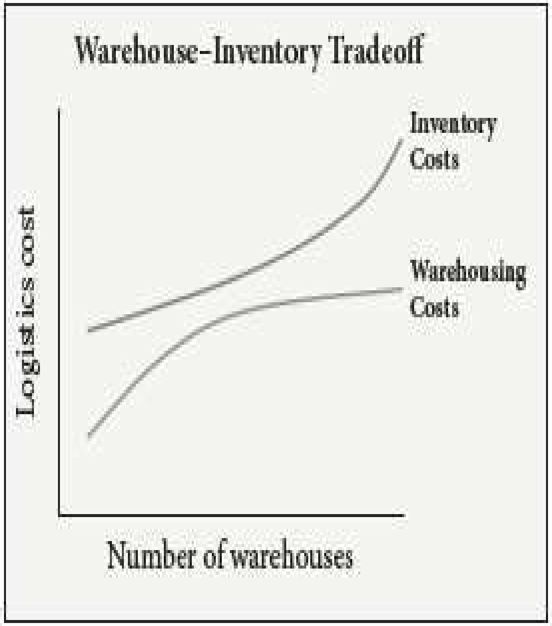
- **Functional Tradeoffs**
- How to best balance customer service and costs.
- Warehouse
- Transportation
- Inventory
- Customer service

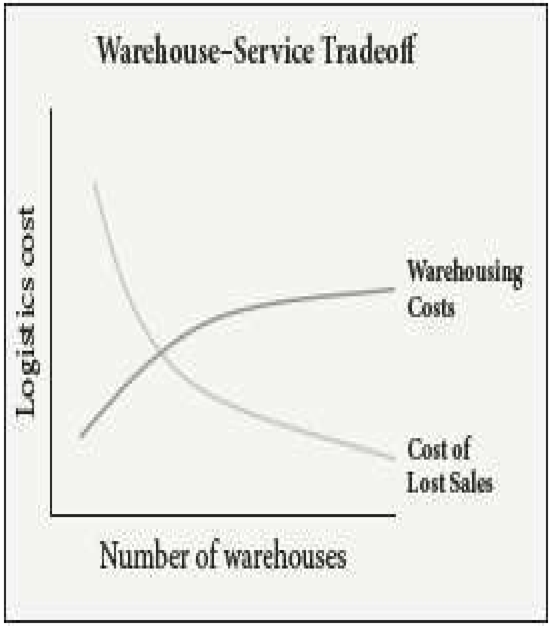
# Key Distribution Tradeoffs

- **Facility-Level Tradeoffs**
- How to best balance financial and performance.
- Space
- Equipment
- People

# Key Distribution Tradeoffs


Warehouse-Transportation Tradeoff


Warehouse-Inventory Tradeoff


Warehouse-Service Tradeoff

# Key Distribution Tradeoffs

- **Space vs. Equipment.**
- The larger the facility and the more space used for distribution operations, the more equipment will be needed in the facility.

# Key Distribution Tradeoffs

- **People vs. Space.** The larger the facility workforce, the larger the facility size and throughput possible.

# Key Distribution Tradeoffs

- **Equipment vs. People.**
- The greater the use of equipment to automate materials handling and distribution activity, the lower the labor requirements of a facility..

# Distribution Challenges

- **Labor availability**
- Nature of DC operations work creates ongoing turnover challenge
- Smaller labor pool due to aging demographic trend in Europe and the United States. ..

# Distribution Challenges

- Solution: DC automation

# Distribution Challenges

- **Demand variation**
- Seasonal demand creates challenges in effectively utilizing the space and equipment resources and retaining labor throughout the year.

# Distribution Challenges

- **Solution:** Balancing the DC requirements of seasonal products with products that have alternate primary selling seasons and/or stable year-round demand products.

# Distribution Challenges

- **Increasing customer requirements**
- Growth in additional capabilities and services. ..

# Distribution Challenges

- Lean strategies creating expectation of smaller, more frequent, and faster fulfillment of orders.
- Solution: Flexible fulfillment processes..

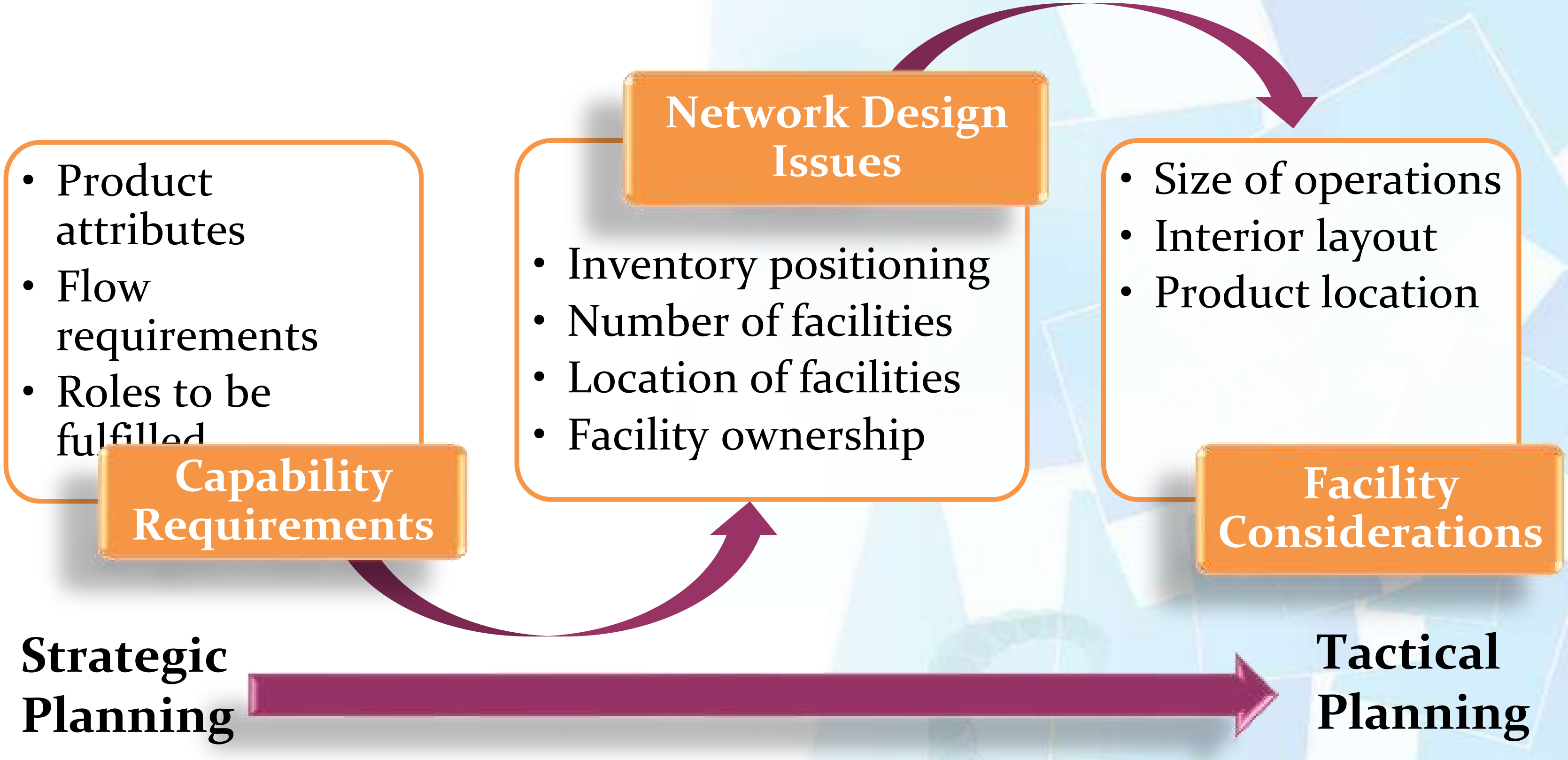
# Distribution Planning and Strategy

- Distribution strategies should tailor to products being handled, customer requirements, and available internal expertise and resources…

# Distribution Planning and Strategy

- A series of interrelated planning decisions must be made to ensure that the strategy can be executed at a reasonable cost while supporting supply chain demands.

# Distribution Planning and Strategy



- Product attributes
- Flow requirements
- Roles to be fulfilled

**Capability Requirements**

**Network Design Issues**

- Inventory positioning
- Number of facilities
- Location of facilities
- Facility ownership

- Size of operations
- Interior layout
- Product location

**Facility Considerations**

**Strategic Planning**

**Tactical Planning**

# Distribution Planning and Strategy

- **Capability requirements**
- Product characteristics e.g., product value, durability, sensitivity, obsolescence, and volume must drive the design of the distribution process.

# Distribution Planning and Strategy

- Two options for product flow:
- Direct shipment of goods
- from the manufacturer to retailer
- from the retailer to consumer…

# Distribution Planning and Strategy

- Movement of goods through distribution facilities to customers…

# Distribution Planning and Strategy

- Must analyze the inventory, transportation, and service trade offs before choosing between direct shipping and the use of distribution facilities..

# Distribution Design Issue

- Inventory positioning focuses on the issue of where inventory is located within the supply chain
- Single location
- Multiple customer-facing positions

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- Single location
- Multiple customer-facing positions.

# Distribution Design Issue

- Number of facilities needed for a supply chain involves the evaluation of cost tradeoffs with other functional areas:

# Distribution Design Issue

- Transportation costs
- Cost of lost sales
- Warehousing costs
- Inventory costs

# Distribution Design Issue

- Own or contract?
- Private DCs are internal facilities owned by the organization
- Public warehousing is the traditional external distribution option…

# Distribution Design Issue

- Contract warehousing is a customized version of public warehousing in which an external company provides a combination of distribution…

# Distribution Design Issue

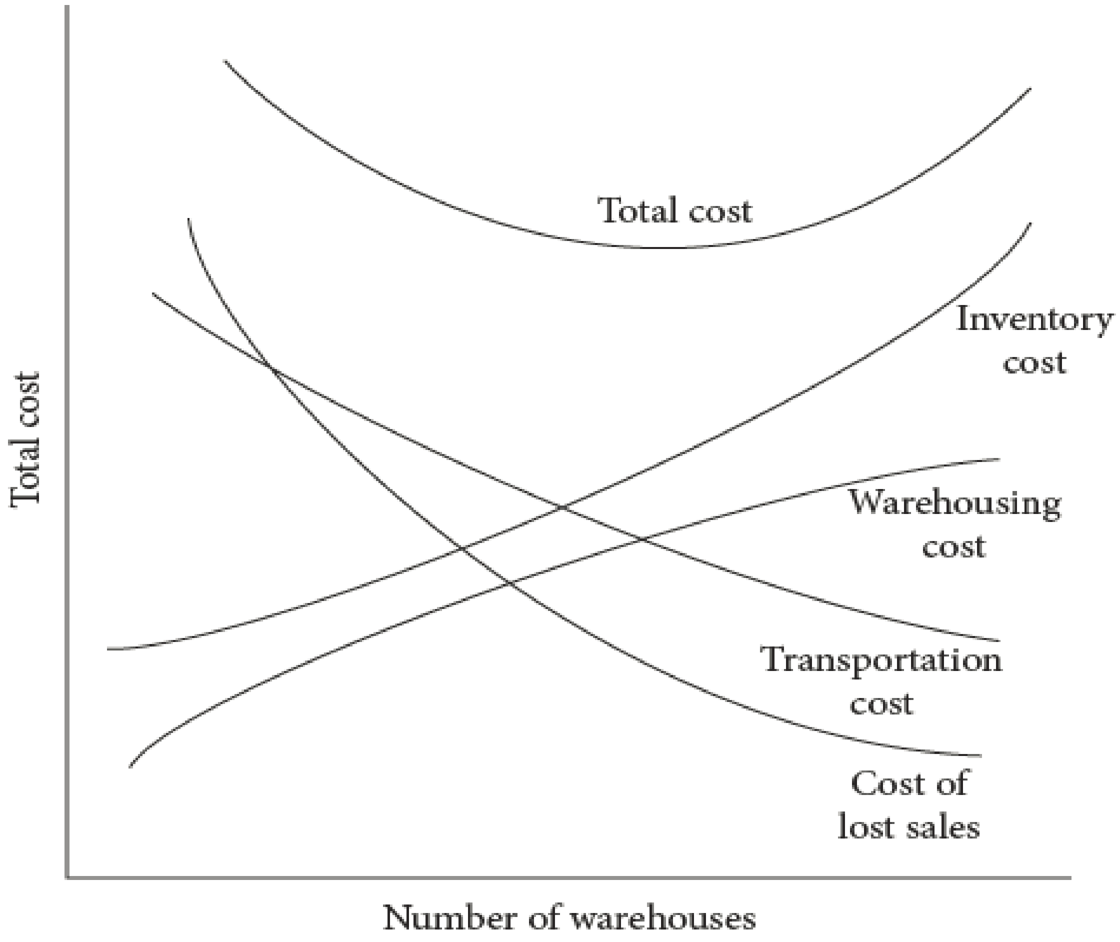
- **Facility Considerations**
- First facility consideration is to determine the size of each operation within the network…

# Distribution Design Issue

- An area may be needed for processing rework and returns
- Office space is needed for administrative and clerical activities
- Space must be planned for miscellaneous requirements..

# Distribution Tradeoffs

# Distribution Tradeoffs



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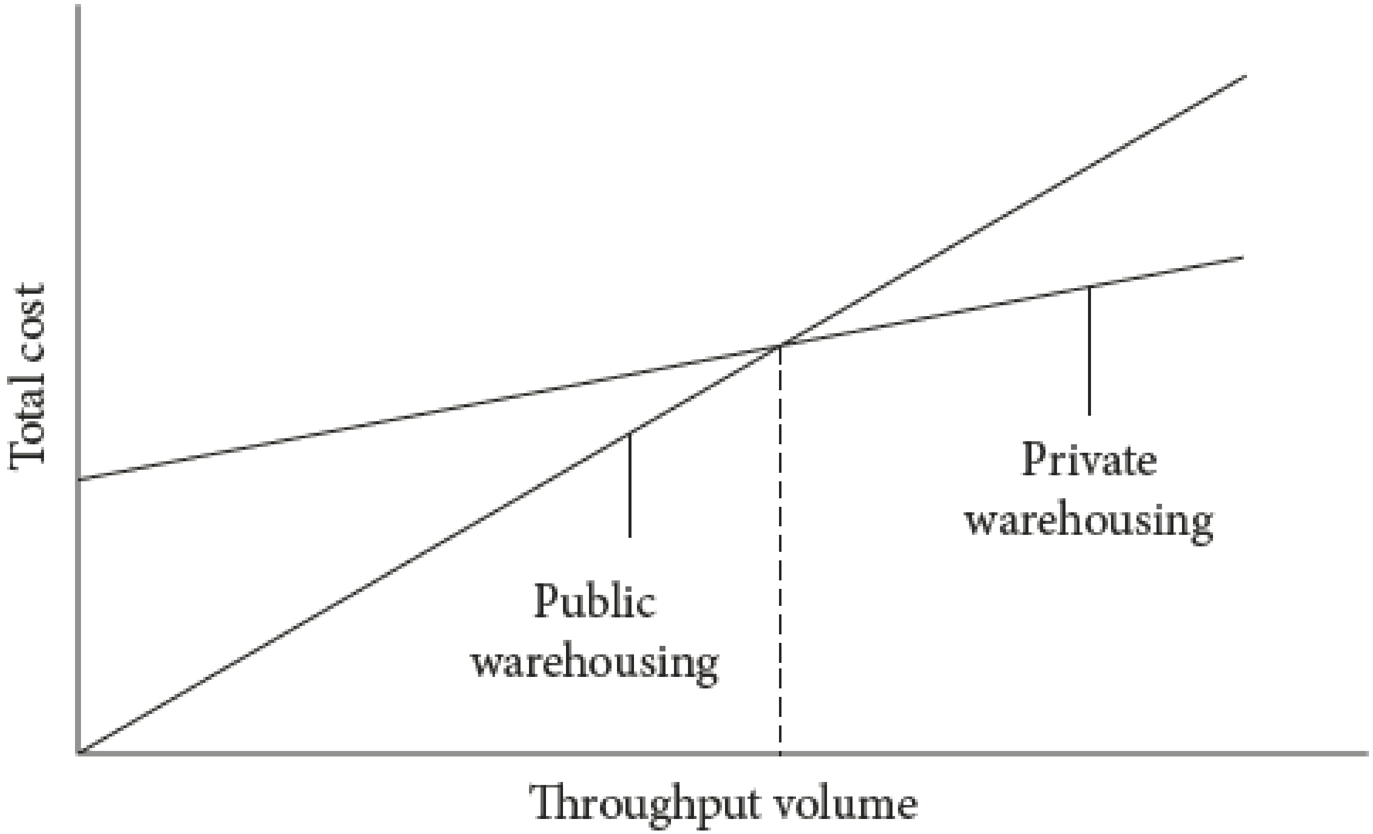

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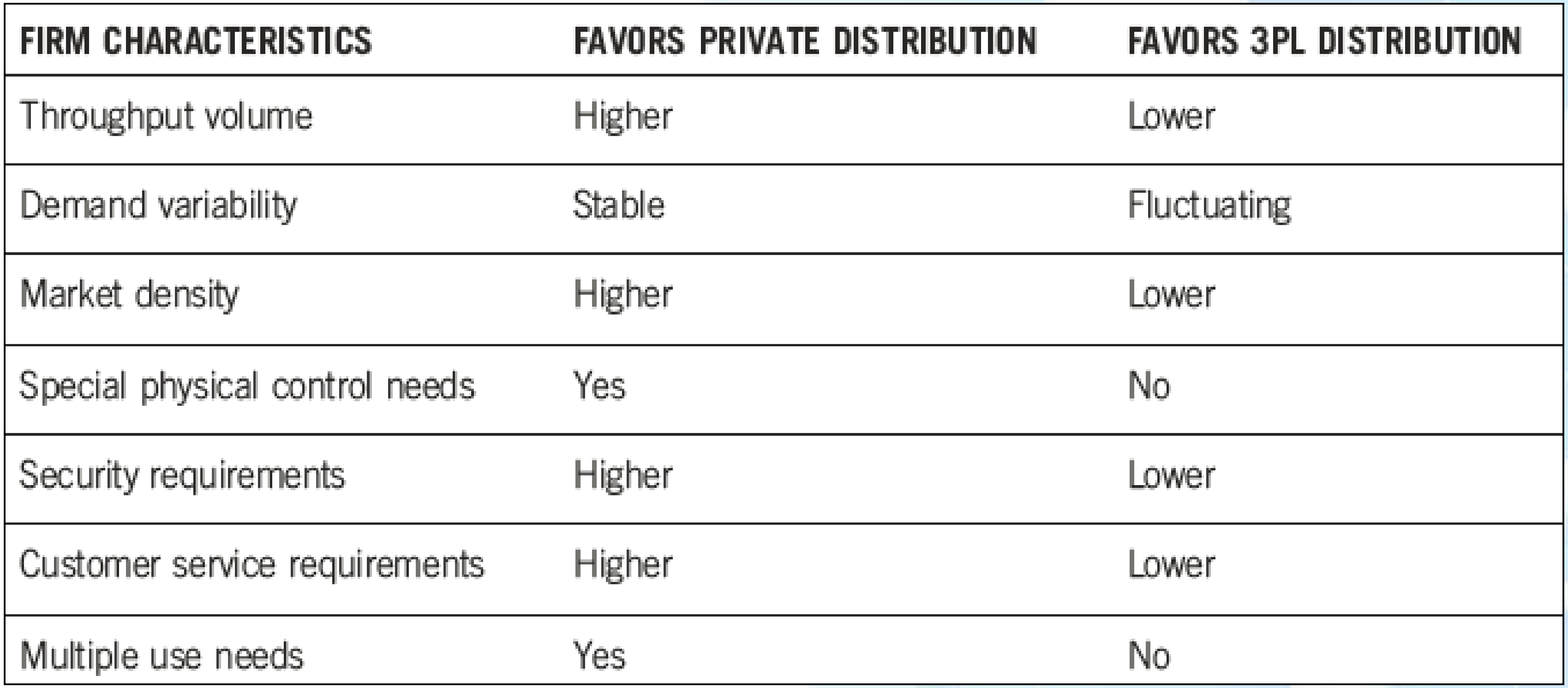
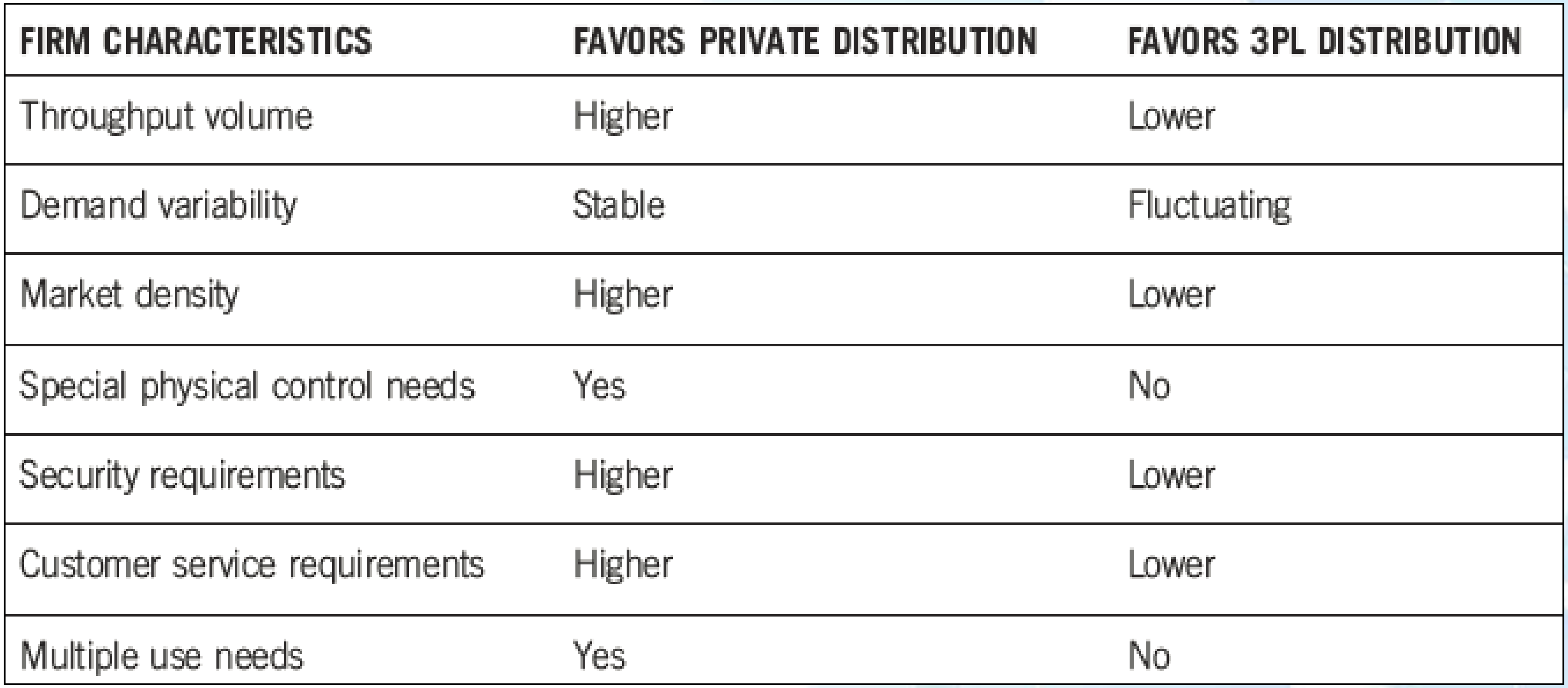


| FIRM CHARACTERISTICS | FAVORS PRIVATE DISTRIBUTION | FAVORS 3PL DISTRIBUTION |
|---|---|---|
| Throughput volume | Higher | Lower |
| Demand variability | Stable | Fluctuating |
| Market density | Higher | Lower |
| Special physical control needs | Yes | No |
| Security requirements | Higher | Lower |
| Customer service requirements | Higher | Lower |
| Multiple use needs | Yes | No |

# Distribution Tradeoffs



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# Distribution Tradeoffs

# Distribution Layout Principles

- Product-Handling Functions
- Receiving – transferring goods into facility
- Put away – moving goods into storage locations…

# Distribution Layout Principles

- Order picking – selecting goods for customers
- Replenishment – moving product from storage locations to picking slots…

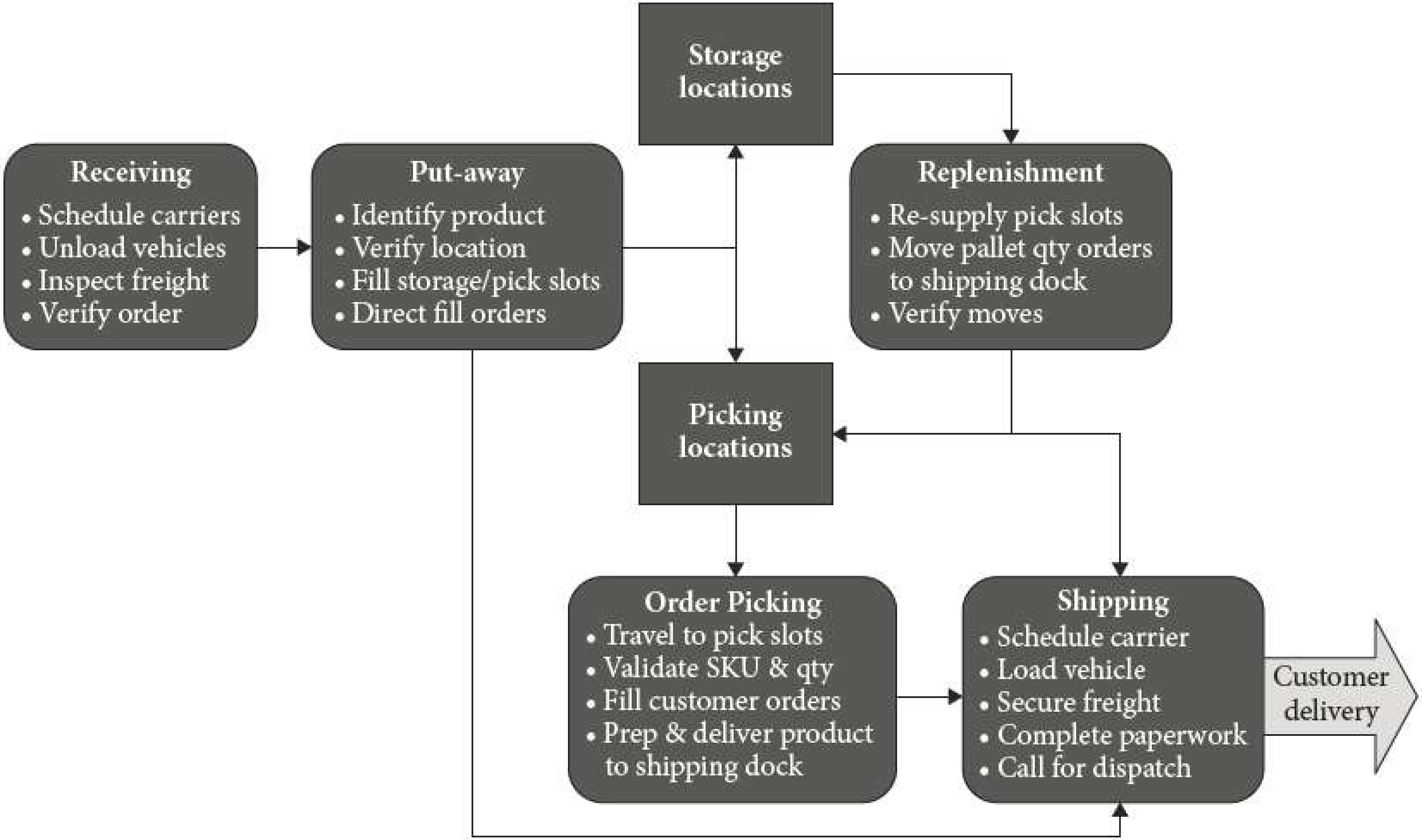
# Distribution Layout Principles

- Shipping – loading goods for delivery
- Support Functions
- Inventory control
- Safety, maintenance, and sanitation.

# Distribution Layout Principles

- Support Functions, Security
- Performance analysis
- Information technology

# Distribution Layout Principles



**Storage locations**

**Receiving**
- Schedule carriers
- Unload vehicles
- Inspect freight
- Verify order

**Put-away**
- Identify product
- Verify location
- Fill storage/pick slots
- Direct fill orders

**Replenishment**
- Re-supply pick slots
- Move pallet qty orders to shipping dock
- Verify moves

**Picking locations**

**Order Picking**
- Travel to pick slots
- Validate SKU & qty
- Fill customer orders
- Prep & deliver product to shipping dock

**Shipping**
- Schedule carrier
- Load vehicle
- Secure freight
- Complete paperwork
- Call for dispatch

Customer delivery

# Distribution Layout Principles

# Distribution Metrics

- Customer Facing Measures
- Order accuracy and order completeness
- Customers want to receive the exact products and quantities that they…

# Distribution Metrics

- ordered, not substitute items, incorrectly shipped items, or wrong quantities
- Timeliness is a critical component of customer service…

# Distribution Metrics

- Perfect order index (POI)
- Perfect order index (POI)
- Delivered to the right place
- at the right time…

# Distribution Metrics

- in defect-free condition
- with the correct documentation, pricing, and invoicing.

# Distribution Metrics

- Internal Measures
- Distribution cost efficiency
- Aggregate cost efficiency
- Total distribution spending versus goal or budget…

# Distribution Metrics

- Asset utilization
- Resource productivity
- Distribution costs averaging nearly 10 percent of a sales dollar
- Resource efficiency.

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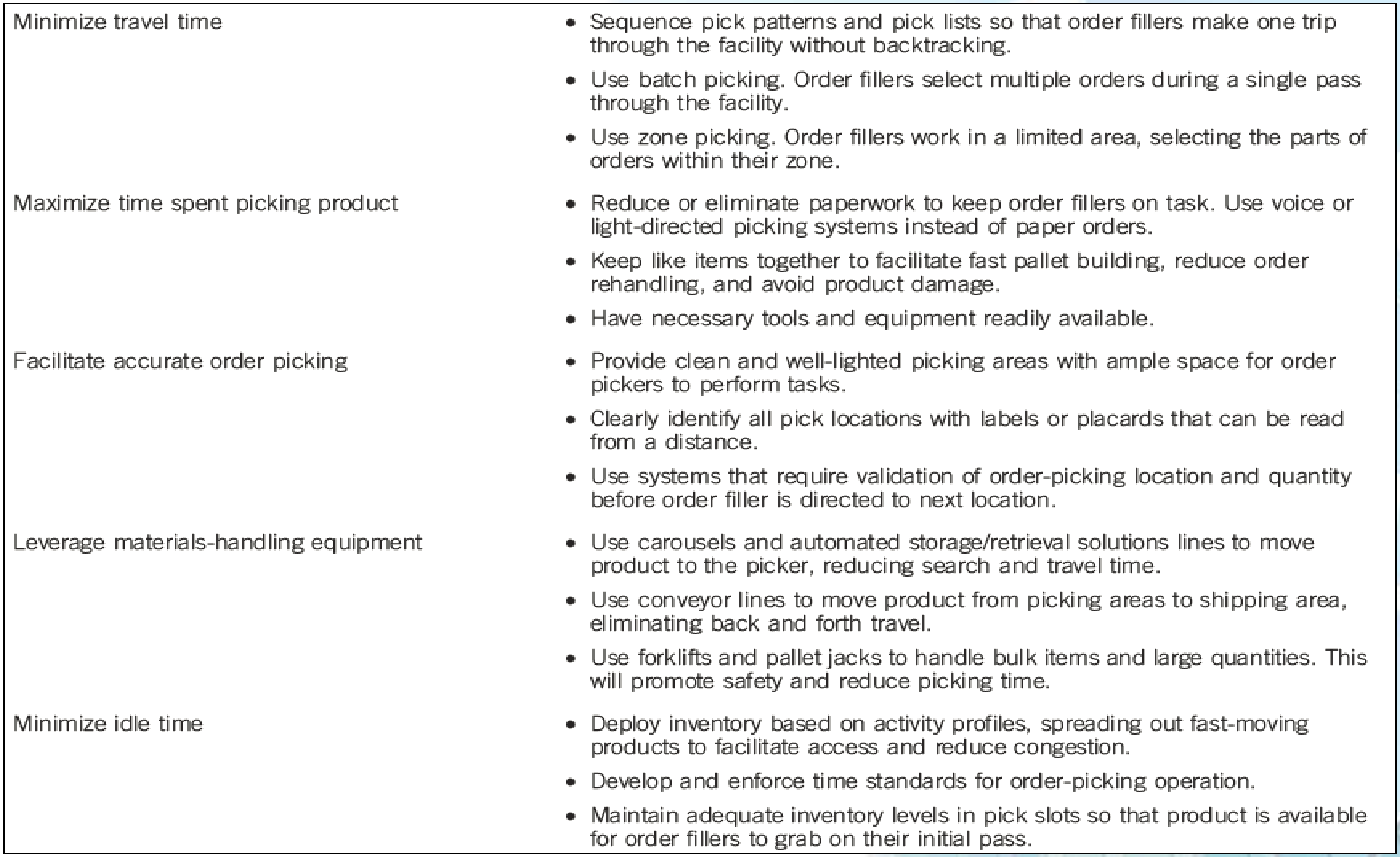
# Distribution Metrics



| | |
|---|---|
| Minimize travel time | • Sequence pick patterns and pick lists so that order fillers make one trip through the facility without backtracking.<br>• Use batch picking. Order fillers select multiple orders during a single pass through the facility.<br>• Use zone picking. Order fillers work in a limited area, selecting the parts of orders within their zone. |
| Maximize time spent picking product | • Reduce or eliminate paperwork to keep order fillers on task. Use voice or light-directed picking systems instead of paper orders.<br>• Keep like items together to facilitate fast pallet building, reduce order rehandling, and avoid product damage.<br>• Have necessary tools and equipment readily available. |
| Facilitate accurate order picking | • Provide clean and well-lighted picking areas with ample space for order pickers to perform tasks.<br>• Clearly identify all pick locations with labels or placards that can be read from a distance.<br>• Use systems that require validation of order-picking location and quantity before order filler is directed to next location. |
| Leverage materials-handling equipment | • Use carousels and automated storage/retrieval solutions lines to move product to the picker, reducing search and travel time.<br>• Use conveyor lines to move product from picking areas to shipping area, eliminating back and forth travel.<br>• Use forklifts and pallet jacks to handle bulk items and large quantities. This will promote safety and reduce picking time. |
| Minimize idle time | • Deploy inventory based on activity profiles, spreading out fast-moving products to facilitate access and reduce congestion.<br>• Develop and enforce time standards for order-picking operation.<br>• Maintain adequate inventory levels in pick slots so that product is available for order fillers to grab on their initial pass. |

# Distribution Metrics

| | | |
|---|---|---|
| Inventory shrink | 0.2% | < .001% |
| Damage rate | 0.2% | < .007% |
| Out of stock (lost sales) | 1.4% | < .001% |
| Distribution cost as proportion of cost of goods sold | 5.1% | < 2.3% |
| Annual workforce turnover | 6.8% | < 0.8% |
| Dock-to-stock cycle time | 9.1 hours | < 2.3 hours |
| Cases picking productivity | 142.5 cases per hour | > 281.4 cases per hour |

# Distribution Metrics

# Warehousing

- Part of firms logistics system that stores products at and between point of origin and point of consumption…

# Warehousing

- Term "Warehousing" is referred as transportation at zero miles per hour

# Warehousing

- Warehousing provides time and place utility for raw materials, industrial goods, and finished products, allowing firms to use customer service as a dynamic value-adding competitive tool.

# Warehousing

- The warehouse is where the supply chain holds or stores goods.
- Functions of warehousing include:

# Warehousing

- Transportation consolidation
- Product mixing
- Docking
- Service
- Protection against contingencies..

# Warehouse Management Systems

- Software control system that improves product movement and storage operations
- Value-added capabilities
- Generate performance reports…

# Warehouse Management Systems

- Support paperless processes
- Enable integration of materials handling equipment
- Picking systems
- Sorting systems
- Leverage wireless communication.

# Warehouse Management Systems

- **Automatic Identification Tools**
- Technologies helping machines identify objects.
- Barcode scanners
- Mobile computers
- Wireless local area networks (LAN)
- RFID

# Warehouse Management Systems

- Fulfillment support functions provide coordination between key processes and across the supply chain,…

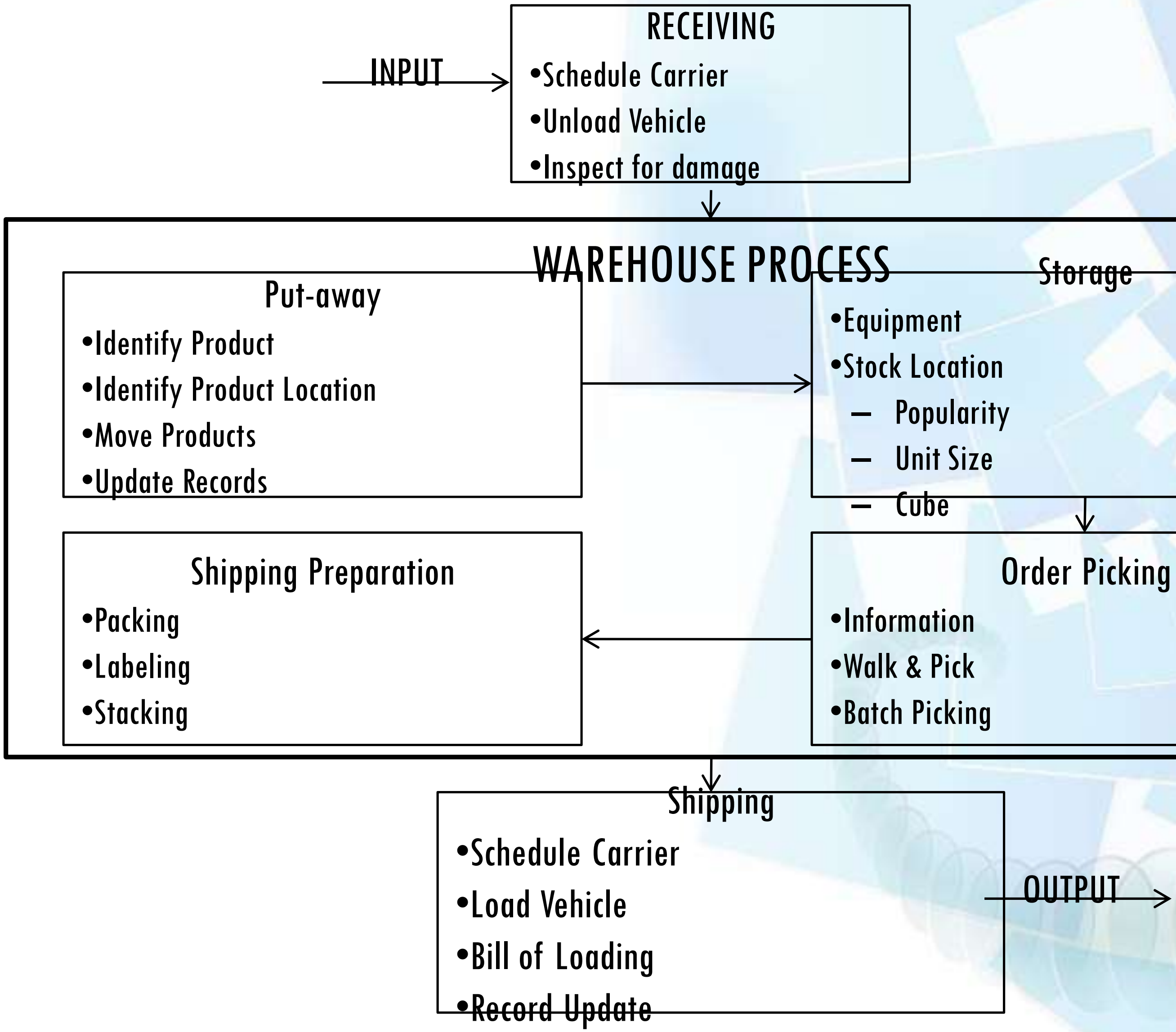
# Warehouse Management Systems

- protect the organization’s inventory investment, and improve working conditions within the facility..

# TYPE OF WAREHOUSING

- Public Warehousing
- Private Warehousing
- Contract Warehousing
- Multi-client Warehousing

# TYPE OF WAREHOUSING



INPUT

RECEIVING

- Schedule Carrier
- Unload Vehicle
- Inspect for damage

WAREHOUSE PROCESS

Put-away

- Identify Product
- Identify Product Location
- Move Products
- Update Records

Storage

- Equipment
- Stock Location
  - Popularity
  - Unit Size
  - Cube

Order Picking

- Information
- Walk & Pick
- Batch Picking

Shipping Preparation

- Packing
- Labeling
- Stacking

Shipping

- Schedule Carrier
- Load Vehicle
- Bill of Loading
- Record Update

OUTPUT

# TYPE OF WAREHOUSING

- Provide timely customer service.
- Keep track of items so they can be found readily & correctly.

# TYPE OF WAREHOUSING

- Minimize the total physical effort & thus the cost of moving goods into & out of storage.
- Provide communication links with customers..

# Design Consideration

- Provide timely customer service.
- Keep track of items so they can be found readily & correctly…

# Design Consideration

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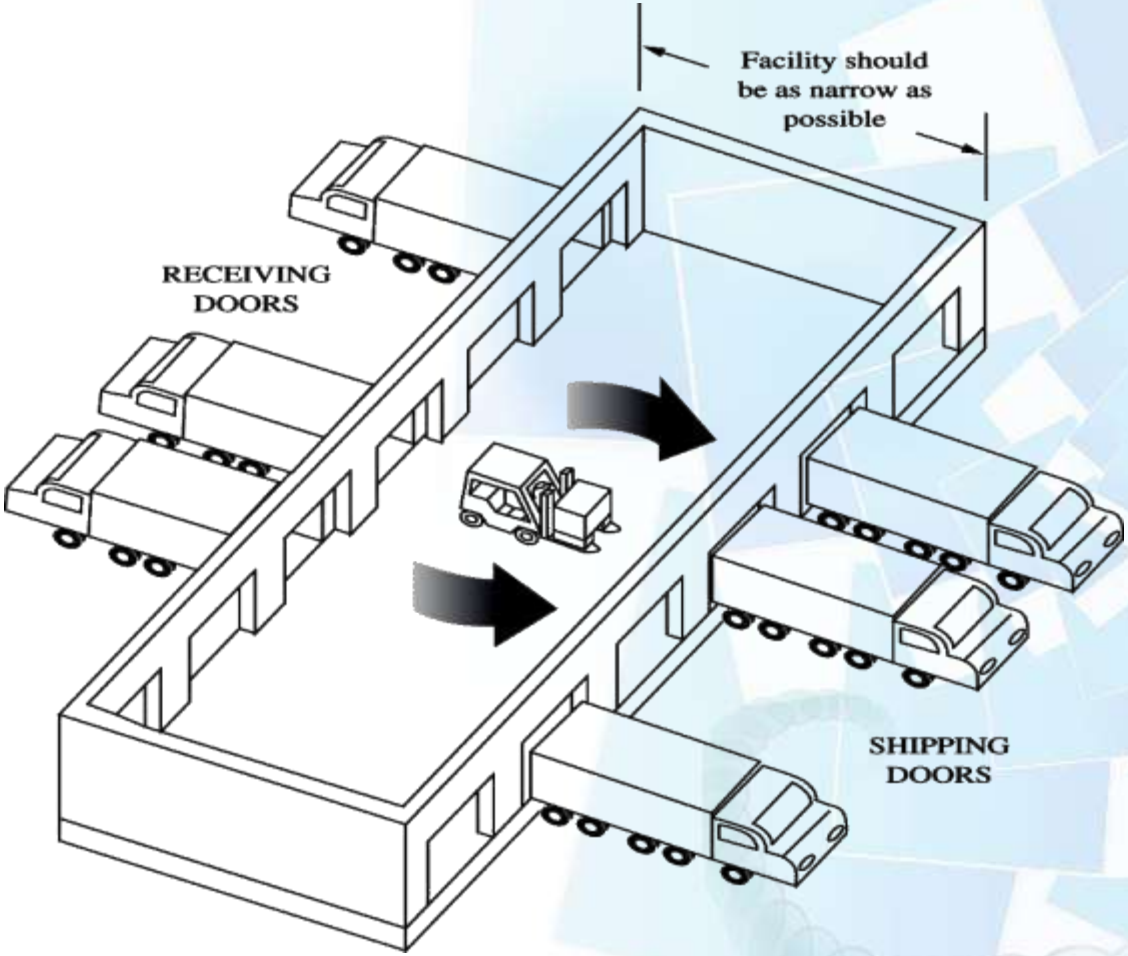
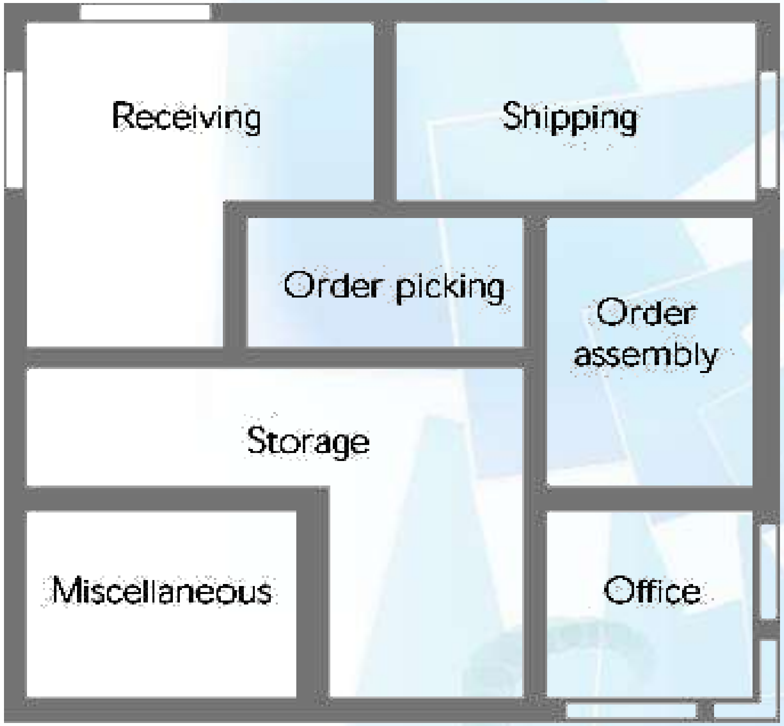
# Design Consideration



# Design Consideration



# Design Consideration

Use one-story facilities

Move goods in a straight line

Use efficient materials-handling equipment

Use an effective storage plan

Minimize aisle space

Use maximum height of the building

# Design Consideration

# Warehouse Activities

- Receive goods
- Identify the goods
- Dispatch goods to storage
- Hold goods
- Pick goods
- Marshal shipment
- Dispatch shipment
- Operate an information system

# Warehouse Activities

- **Receive goods**
- Accepts goods from
- Outside transportation or attached factory & accepts responsibility…

# Warehouse Activities

- Check the goods against an order & the bill of loading
- Check the quantities
- Check for damage & fill out damage reports if necessary
- Inspect goods if required

# Warehouse Activities

- **Identify the goods**
- items are identified with the appropriate stock-keeping unit (SKU) number (part number) & the quantity received recorded

# Warehouse Activities

- **Dispatch goods to storage**
- goods are sorted & put away
- **Hold goods**
- goods are kept in storage & under proper protection until needed

# Warehouse Activities

- **Pick goods**
- goods are sorted & put away
- **Marshal the shipment**
- goods are kept in storage & under proper protection until needed

# Warehouse Activities

- **Pick goods**
- goods are sorted & put away
- **Marshal the shipment**
- goods are kept in storage & under proper protection until needed..

# Public Warehouses

- Breakbulk - shipments are broken down & items are combined into specific customer orders.
- Repackaging
- Assembly
- Incoming & outgoing quality inspections.

# Public Warehouses

- Material handling, equipment maintenance, & documentation services
- Short and long-term storage

# Public Warehouses

- Pro- Provides flexibility & investment cost savings
- Con- Lack of control..

# Private Warehouses

- **Advantages**
- Reduces the purchasing and transportation cost
- Offers greater control of service
- Provides better workforce utilization

# Private Warehouses

- Take advantage of cheaper sources of supply or labor
- Can generate income & tax advantages through leasing of excess capacity &/or asset depreciation

# Private Warehouses

- **Disadvantages**
- Financial risk & loss of flexibility
- Binds firms to locations that may not prove optimal
- Insurance companies do not like insuring goods in private warehouses..

# Risk Pooling & Warehouse Location

- As number of warehouses increases, system becomes more decentralized. Responsiveness & delivery service increase

# Risk Pooling & Warehouse Location

- Warehousing operating & inventory costs also increase. Trade-off between costs & customer service must be considered

# Risk Pooling & Warehouse Location

- **Risk Pooling**
- Describes the relationship between the # of warehouses, inventory, & customer service
- Risk pooling is estimated by square-root rule

# Risk Pooling & Warehouse Location

– square-root rule

$$S_2 = \frac{\sqrt{N_1}}{\sqrt{N_2}} * S_1$$

Where:

$S_1$ = Total system stock for the N1 warehouses

$S_2$ = Total system stock for the N2 warehouses

$N_1$ = # of warehouses in the existing system

$N_2$ = # of warehouses in the proposed system

# Risk Pooling & Warehouse Location

# Warehouse Centralization

- Safety stocks and average inventory levels decrease.
- Delivery lead times increase, increasing the risk of late deliveries to customers.

# Warehouse Centralization

- Customer service levels provided by the warehouses' suppliers are likely to increase, reducing the likelihood of stockout.

# Warehouse Centralization

- Outbound transportation costs increase, as LTL shipments must travel farther to reach customers. Inbound transportation costs decrease.
- Warehouse capital and operating costs decrease.

# Warehouse Centralization

- **Market-positioned strategy -** warehouses close to customers to maximize distribution services & improve transp. economies of scale

# Warehouse Centralization

- **Product positioned strategy** - close to supply source for firm to collect goods & consolidate…

# Warehouse Centralization

- **Intermediately positioned strategy** - midway between supply source & customers when distribution requirements are high & product comes from various locations..

# Lean Warehousing

- Emphasis on warehousing to support responsive operations:
- Commitment to customers & service quality

# Lean Warehousing

- Reduced lot sizes & shipping quantities
- Emphasis on cross docking
- Increased automation
- Increased assembly operations
- Tendency to be green..

# Third Party Logistics (3PL)

- Provide reliable & timely delivery required by SCM
- Used to move items into foreign locations effectively
- Favored by small businesses

# Third Party Logistics (3PL)

- Some firms outsource all of their logistics needs to a lead logistics provider or fourth party logistics provider (4PL)

# Third Party Logistics (3PL)

- Provide services, including network optimization, light manufacturing, and other value-added services…

# Third Party Logistics (3PL)

- Many firms outsource logistics needs to allow more attention placed on core competencies
- Demand for 3PL services is growing rapidly..

# Other Intermediaries

- Freight forwarder – consolidate LTL shipments into FTL
- Freight, transportation, or logistic brokers bring shippers and carriers together

# Other Intermediaries

- Shippers' associations – nonprofit cooperatives which arrange for members' shipping

# Other Intermediaries

- Intermodal marketing companies – purchase blocks of rail capacity and sell it to shippers..

# Environmental Sustainability in Logistics

- Reduction of empty miles to reduce carbon emissions by ensuring trucks move loaded rather than empty.

# Environmental Sustainability in Logistics

- SmartWay certification program reduces transportation emissions and improves supply chain efficiency.

# Environmental Sustainability in Logistics

- The Coalition for Responsible Transportation (CRT), work in partnership with U.S. ports to implement clean truck programs that are environmentally and economically sustainable..

# Reverse Logistics

- Backwards flow of goods from customers in SC when goods are returned by a customer in the supply chain
- Retail returns range 6% to 10% of sales.

# Reverse Logistics

- Online returns range 20% to 30% of sales
- Returns are increasing, because of the growth of online shopping…

# Reverse Logistics

- Returns can have a direct negative impact on the environment, customer service, the firm’s reputation, and profitability

# Reverse Logistics

- Impact of Reverse Logistics on the Supply Chain
- Poor reverse logistics system can affect the entire supply chain financially

# Reverse Logistics

- Can have a large impact on how consumers view a product brand
- Problems include:
- inability of systems to handle returns…

# Reverse Logistics

- lack of worker training in reverse logistics procedures
- little or no identification on returned packages…

# Reverse Logistics

- inadequate inspection and testing of returns
- placing of potentially damaged returned products into sales stocks..

# Reverse Logistics

- Green reverse logistics programs - These programs reduce environmental impact on landfills & deal with dangerous contaminants…

# Reverse Logistics

- Reverse logistics can have a positive impact on the environment through activities such as recycling, reusing materials and products, or refurbishing used products..

# Overview of Service Response Logistics

- Many services are pure services, offering few or no tangible products to customers (e.g., lawyers & entertainers)

# Overview of Service Response Logistics

- Others may have end products with a larger tangible component (e.g., restaurants & repair facilities)
- Customers are often involved in the production of the service

# Overview of Service Response Logistics

- Services may provide state utility - they do something to things owned by the customer (e.g., store supplies & provide healthcare)

# Overview of Service Response Logistics

- Developed countries are become increasingly service oriented
- The important role services play in the global economy is becoming more evident today

# Overview of Service Response Logistics

- Services cannot be inventoried
- Services are often unique (e.g., Insurance policies & legal services

# Overview of Service Response Logistics

- Services have high customer-service interaction
- Services are decentralized due to inability to inventory & transport service products..

# Service Productivity

- The following formula shows the basic measure of productivity:

**Productivity =**

- **Outputs produced/ Inputs used**

# Service Productivity

- Outputs produced (ex. sales amount)
- Inputs (single factor productivity) (ex. labor hours)
- Inputs (multiple-factor productivity) (ex. labor, material, energy, & capital)

# Service Productivity

- **Baumol's disease** – productivity growth in services is low

# Service Productivity

- **The Walmart Effect** – the booming growth in information technology has allowed many big-box retailers to realize large productivity growth rates

# Service Productivity

- Improving service productivity is challenging due to –
- High labor content
- Individual customized services
- Difficulty of automating services
- Problem of assessing service quality

# Global Services Issues

- Global services are increasing all over the world and managing them involves a number of issues –

# Global Services Issues

- Labor, facilities, & infrastructure support
- Legal & political issues: Laws may restrict foreign competitors…

# Global Services Issues

- Domestic competitors & the economic climate: Managers must be aware of local competition and current state of the economy
- Identifying global customers..

# Service Strategy Development

- **Cost Leadership Strategy**
- Requires large capital investment in state-of-the art equipment & significant efforts to control & reduce costs

# Service Strategy Development

- **Differentiation Strategy**
- Unique service is created as companies listen to customers
- **Focus Strategy**
- Serve a narrow niche better than other firms

# Service Strategy Development

- **Bundle of attributes (the combination of) –**
- Explicit services (ex. storage & use of your money)
- Supporting facility (ex. bank w/drive-up tellers)…

# Service Strategy Development

- Facilitating goods (ex. deposit forms, monthly statements),
- Implicit services (ex. security provided, the atmosphere in the bank, privacy, & convenience…

# Service Strategy Development

- Service delivery systems (a continuum) with mass produced, low-customer contact systems at one end & highly customized, high-customer-contact systems at the other…

# Service Strategy Development

- Front-of-the-house staff tend to be customer centric
- Back-of-the-house staff generally do not contact customers
- The service system should be audited often to assess performance..

# Service Location & Layout Strategies

- **Location Strategies**
- Have significance on customer visits & long term monetary impact on the company

# Service Location & Layout Strategies

- Viewed as a moderate- to long-term decision because of high costs of construction, remodeling, and relocation
- Decision should consider relevant factors & reduce intuitive decisions

# Service Location & Layout Strategies

- **Layout Strategies** –
- Service layout strategies tend to be departmentalized to allow specialists to share resources…

# Service Location & Layout Strategies

- Departmental Layouts to Reduce Distance Traveled – ex. A health care clinic…

# Service Location & Layout Strategies

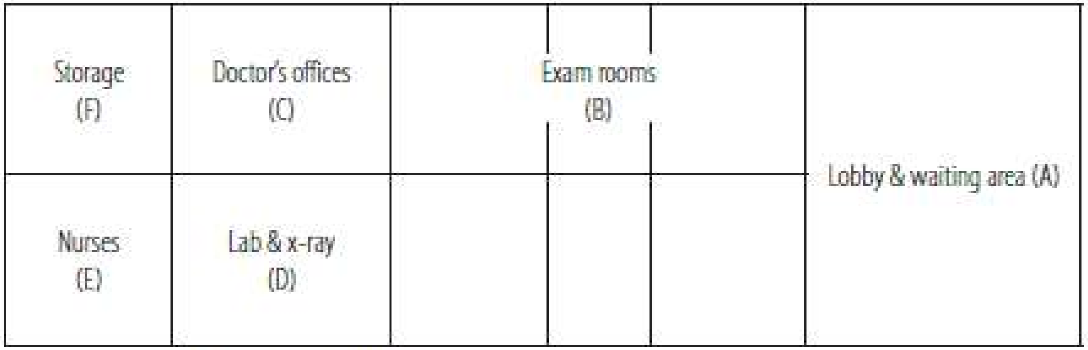
- Departmental Layouts to Maximize Closeness Desirability - A closeness desirability rating between departments used to design a layout that maximizes a rating for the entire office..

# Service Location Example

# Service Location Example

The Bryson Health Clinic wants to see whether there is a better layout that will reduce the time doctors and nurses spend walking throughout the clinic. The existing layout is shown below, along with the number of trips and the distances between each department.

**Existing Layout**



**Interdepartmental Doctors' and Nurses' Trips/Day**

| | B | C | D | E | F |
|---|---|---|---|---|---|
| **A** | 55 | 0 | 0 | 50 | 0 |
| **B** | | 40 | 15 | 40 | 0 |
| **C** | | | 15 | 60 | 10 |
| **D** | | | | 30 | 0 |
| **E** | | | | | 18 |

**Distances between Departments (meters)**

| | B | C | D | E | F |
|---|---|---|---|---|---|
| **A** | 20 | 40 | 40 | 60 | 60 |
| **B** | | 20 | 20 | 40 | 40 |
| **C** | | | 10 | 20 | 20 |
| **D** | | | | 20 | 20 |
| **E** | | | | | 10 |

# Service Location Example

To analyze the existing layout, the total distance traveled per day is calculated as follows:

Total distance traveled = $\sum_{i=1}^{n} \sum_{j=1}^{n} T_{ij} D_{ij}$

Where $n$ = number of departments

$i,j$ = individual departments

$T_{ij}$ = number of trips between departments $i$ and $j$

$D_{ij}$ = distance from department $i$ to department $j$

The objective is to find the layout resulting in the lowest total distance travelled per day.

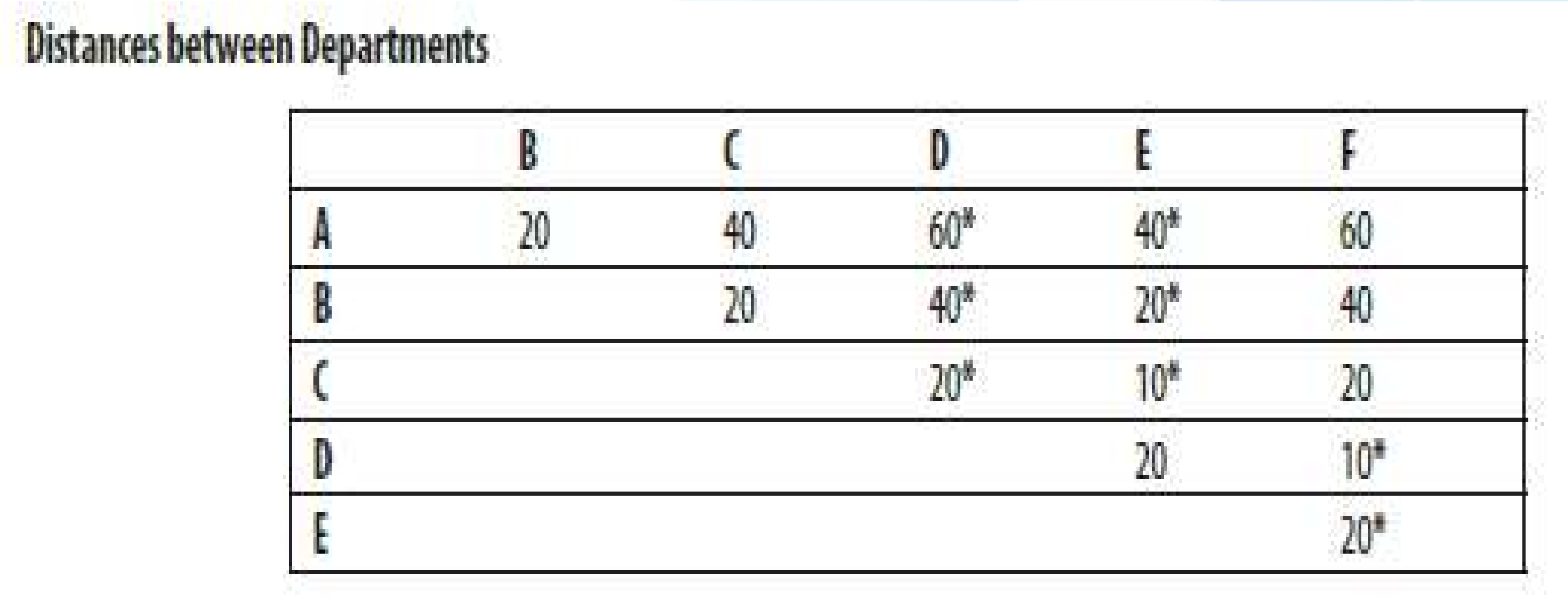
# Service Location Example

For the layout shown on prior slide, we find:
Total distance traveled per day = 55(20) + 50(60) + 40(20) + 15(20) + 40(40) + 15(10) + 60(20) + 10(20) + 30(20) + 18(10) = 9,130 meters

The nursing station should be closer to the lobby and waiting area, exam rooms, doctors' offices. Need to switch departments E and D (nurses and lab/x-ray).

This creates a trade-off, since departments C, B and A will be farther from department D. To calculate the new total distance travelled per day, the distance table must be modified. The asterisks denote changes made to the table.

# Service Location Example



Distances between Departments

|   | B | C | D | E | F |
|---|---|---|---|---|---|
| A | 20 | 40 | 60* | 40* | 60 |
| B |  | 20 | 40* | 20* | 40 |
| C |  |  | 20* | 10* | 20 |
| D |  |  |  | 20 | 10* |
| E |  |  |  |  | 20* |

# Service Location Example

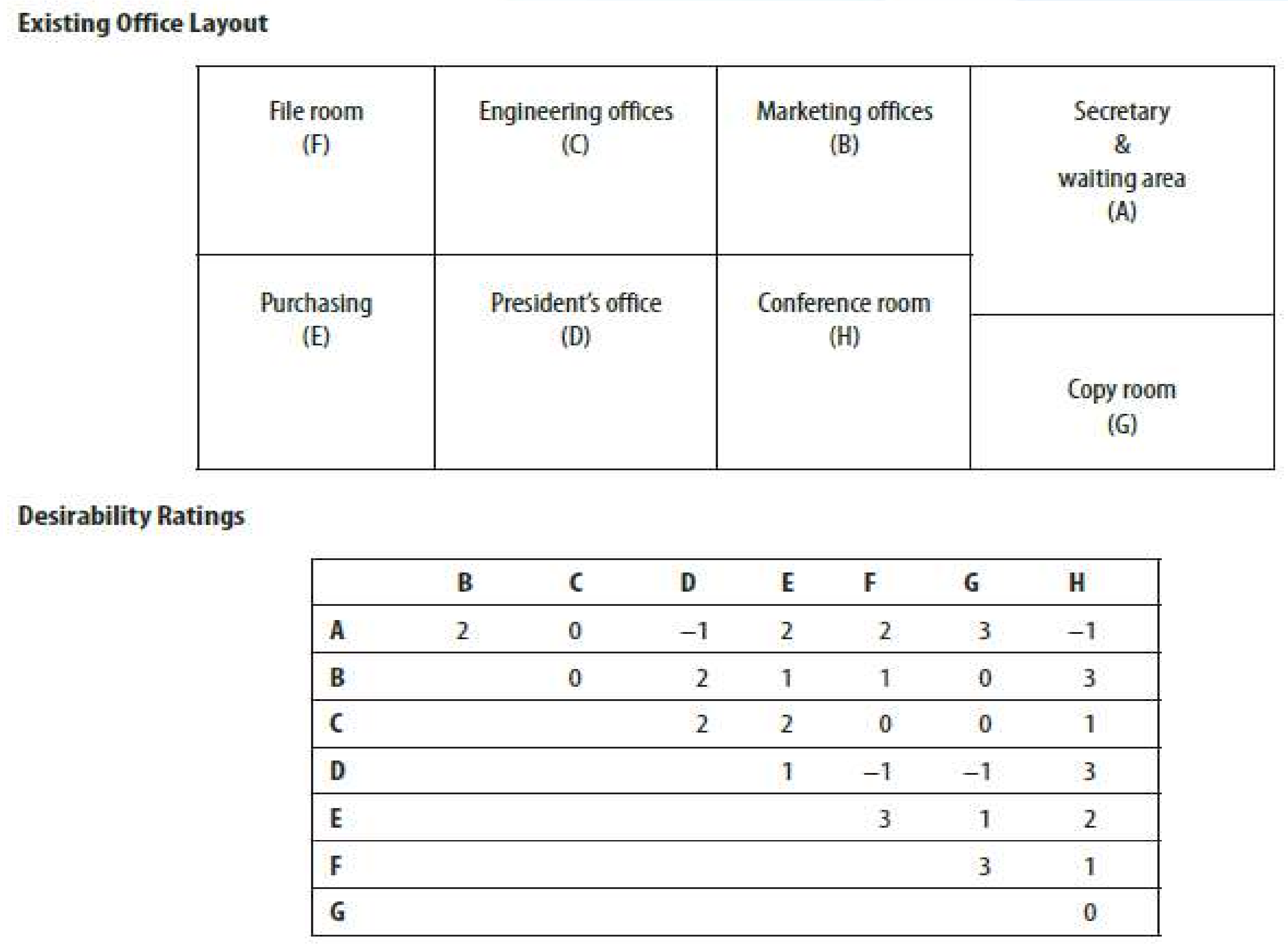
The new total distance can then be calculated as follows:
Total distance traveled per day = 55(20) + 50(40) + 40(20) + 15(40) + 40(20) + 15(20) + 60(10) + 10(20) + 30(20) + 18(20) = 7,360 meters

This is a better layout (not necessarily the best) and only one of a large number of potential layouts.

# Service Location Example

# Service Location Another Example

# Service Location Another Example



**Existing Office Layout**

File room (F)

Engineering offices (C)

Marketing offices (B)

Secretary & waiting area (A)

Purchasing (E)

President's office (D)

Conference room (H)

Copy room (G)

**Desirability Ratings**

| | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| A | 2 | 0 | –1 | 2 | 2 | 3 | –1 |
| B | | 0 | 2 | 1 | 1 | 0 | 3 |
| C | | | 2 | 2 | 0 | 0 | 1 |
| D | | | | 1 | –1 | –1 | 3 |
| E | | | | | 3 | 1 | 2 |
| F | | | | | | 3 | 1 |
| G | | | | | | | 0 |

# Service Location Another Example

The desirability ratings are based on a (–1 to 3) scale, where –1=undesirable, 0=unimportant, 1=slightly important, 2=moderately important and 3=very important.

To calculate the score for the layout on the prior slide, we count the closeness desirability score only when departments are adjacent to each other.

For existing layout:
Closeness desirability score = (A/B:2) + (A/H:-1) + (A/G:3) + (B/C:0) + (B/H:3) + (C/F:0) + (C/D:2) + (D/E:1) + (D/H:3) + (E/F:3) + (G/H:0) = 16 points

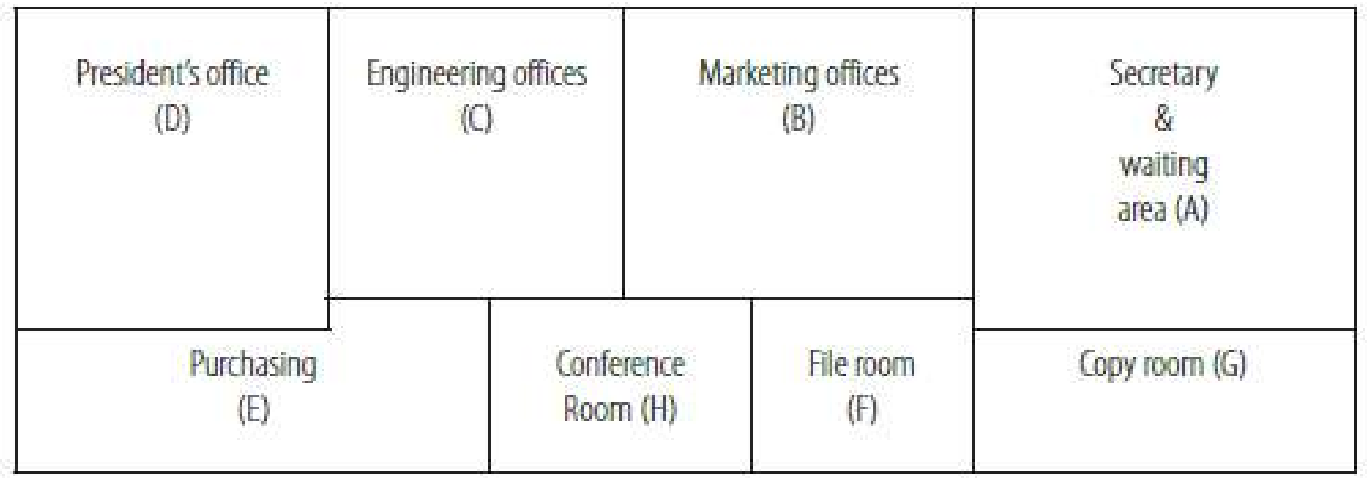
# Service Location Another Example

To find a better layout, place the department pairs with a rating of 3 adjacent to each other, and place adjacent pairs with a rating of –1 such that they are not adjacent.

**For instance,** the file room (F) could be moved adjacent to the copy room (G), and the conference room (H) could be moved farther away from the secretary and waiting area (A).

# Service Location Another Example

**New Office Layout**



The closeness desirability score for the new layout shown above would then be:
= (A/B:2) + (A/F:2) + (A/G:3) + (B/C:0) + (B/H:3) + (B/F:1) + (C/D:2) + (C/E:2) + (C/H:1) + (D/E:1) + (E/H:2) + (H/F:1) + (F/G:3) = 23 points. On the basis of this analysis, it can be concluded that the second layout is better.

# Service Location Another Example

- Service firms interact closely with their customers..

# Service Quality and Customers

- The perceived level of quality a customer experiences with regard to the service is of paramount concern to most services.

# Service Quality and Customers

- Today elements of service quality may include sustainability. Being ”green” allows a firm to stand out.

# Service Quality and Customers

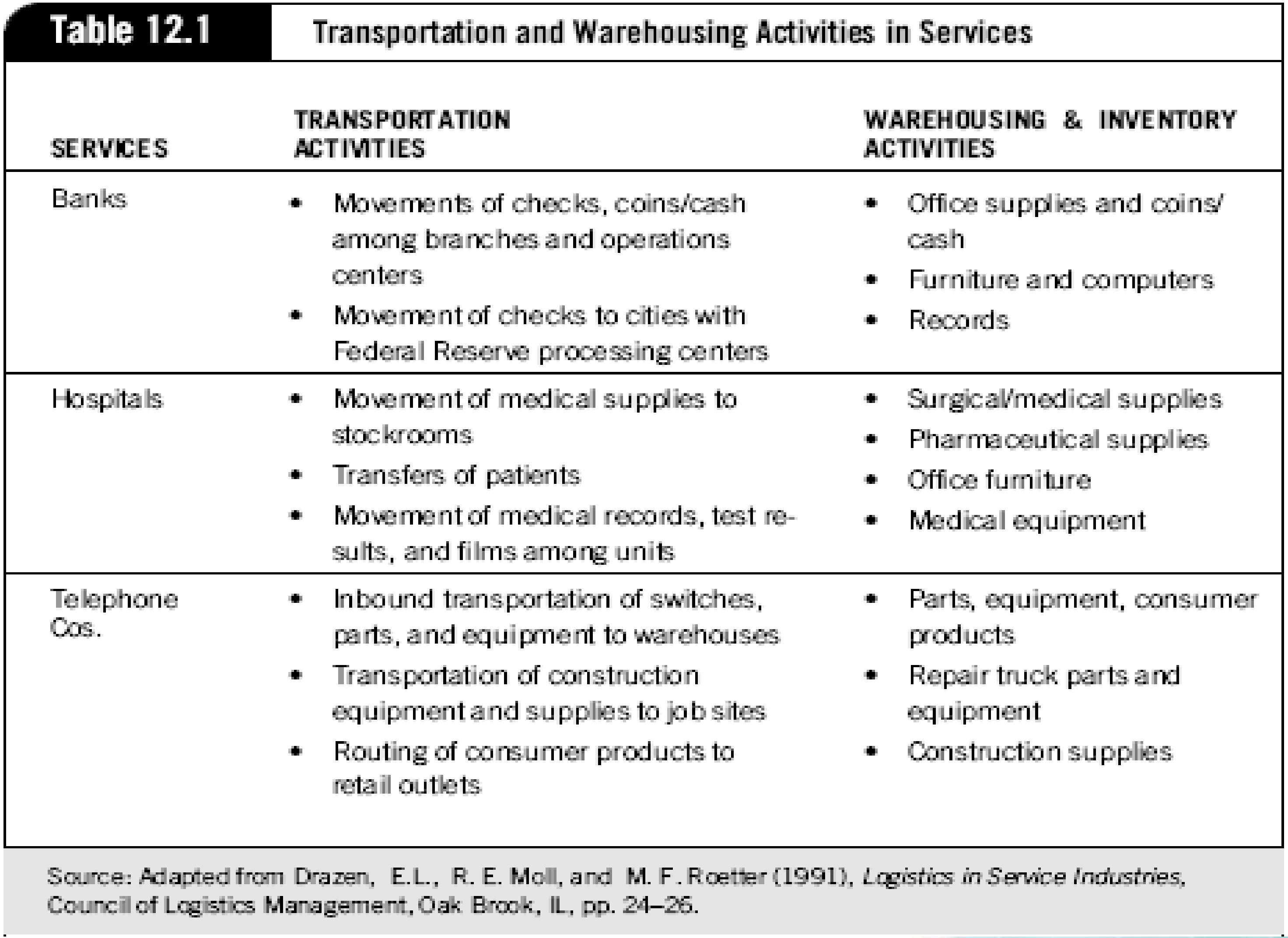


**Table 12.1** Transportation and Warehousing Activities in Services

| SERVICES | TRANSPORTATION ACTIVITIES | WAREHOUSING & INVENTORY ACTIVITIES |
|---|---|---|
| Banks | • Movements of checks, coins/cash among branches and operations centers<br>• Movement of checks to cities with Federal Reserve processing centers | • Office supplies and coins/cash<br>• Furniture and computers<br>• Records |
| Hospitals | • Movement of medical supplies to stockrooms<br>• Transfers of patients<br>• Movement of medical records, test results, and films among units | • Surgical/medical supplies<br>• Pharmaceutical supplies<br>• Office furniture<br>• Medical equipment |
| Telephone Cos. | • Inbound transportation of switches, parts, and equipment to warehouses<br>• Transportation of construction equipment and supplies to job sites<br>• Routing of consumer products to retail outlets | • Parts, equipment, consumer products<br>• Repair truck parts and equipment<br>• Construction supplies |

Source: Adapted from Drazen, E.L., R. E. Moll, and M. F. Roetter (1991), *Logistics in Service Industries*, Council of Logistics Management, Oak Brook, IL, pp. 24–26.

# Service Quality and Customers

# Service Response Logistics (SRL)

- The management and coordination of the organization’s service activities
- The four primary activities of SRL –

# Service Response Logistics (SRL)

- Managing Service Capacity
- Managing Queue Times
- Managing Distribution Channels
- Managing Service Quality..

# Managing Service Capacity

- Service capacity is the number of customers per day the firm’s service system is designed to serve

# Managing Service Capacity

- When demand exceeds capacity, firms turn away customers, create wait line, or hire personnel
- Hiring, training, supervising, & equipping personnel is costly (≈ 75% of ops. costs)…

# Managing Service Capacity

- Therefore, service managers must forecast demand & provide capacity to meet the forecast demand.

# Managing Service Capacity

$$\text{Capacity Utilization} = \frac{\text{Actual customers served per period}}{\text{Capacity}}$$

# Managing Service Capacity

- Optimal capacity utilization should be about 75%
- This leaves some level of capacity unutilized..

# Service Capacity Strategies

- Two most basic strategies for managing capacity
- Level demand strategy
- Capacity remains constant regardless of demand….

# Service Capacity Strategies

- When demand exceeds capacity, queue management tactics deal with excess customers
- Chase demand strategy
- Capacity varies with demand

# Service Capacity Strategies

- Capacity Management when Demand exceeds Capacity
- To minimize the cost of hiring and laying off employees, the following strategies deal with periods of high demand…

# Service Capacity Strategies

- Cross-Training & Sharing Employees
- Using part-Time Employees
- Using Customers-Self-service
- Using Technology…

# Service Capacity Strategies

- Using Employee Scheduling Policies
- Using demand management techniques to smooth or shift demand

# Service Capacity Strategies

- Capacity Management when Available Service Capacity exceeds Demand
- Instead of disposing of excess capacity, the following strategies deal with low demand…

# Service Capacity Strategies

- Finding other uses for service capacity
- Using demand management techniques – (stimulate demand)

# Managing Queue Times

- Consists of the management of actual waiting time & perceived waiting time
- What is the average arrival rate of the customers?
- In what order will customers be serviced?

# Managing Queue Times

- What is the average service rate of providers?
- How are customer arrival & service times distributed?
- How long will customers wait before they either leave or lower their perceptions of service quality?

# Managing Queue Times

- How can customers wait even longer without lowering their perceptions of service quality?

# Managing Queue Times

**Queuing System Design –** The input process

- Poisson distribution is often used to model customer arrival

$$P_{x(T)} = \frac{e^{-\lambda T} (\lambda T)^{x}}{x!}$$

Where $\lambda$ = average customer arrivals in time period T

e = 2.71828 (natural log base)

x = number of arrivals

# Managing Queue Times

# Managing Queue Times Example

- Jay's Quick Lube Shop can service an average of four cars per hour with a partial crew of three employees, and the owner Jay is interested in calculating the…

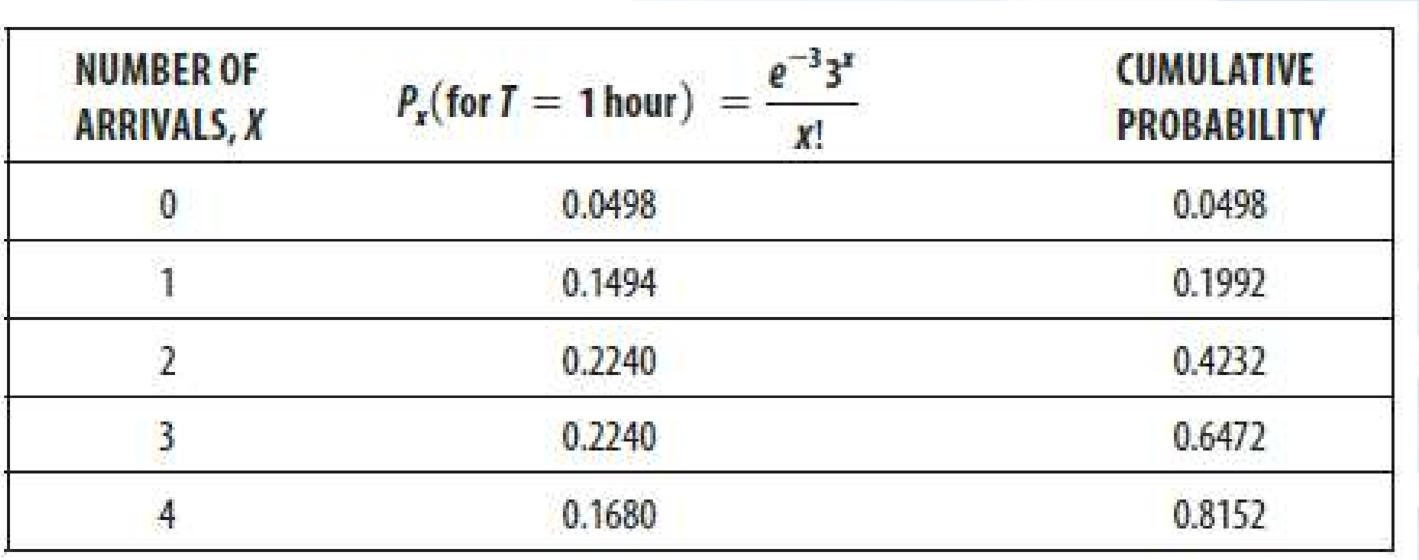
# Managing Queue Times Example

- probability they can handle all the customers on Saturdays with the partial crew, instead of his usual full crew of five.

# Managing Queue Times Example

- Given an average arrival rate of three customers per hour on Saturdays, he uses the Poisson distribution to calculate the probabilities of various customer arrivals per hour,

# Managing Queue Times Example



| NUMBER OF ARRIVALS, $X$ | $P_x(\text{for } T = 1 \text{ hour}) = \frac{e^{-3}3^x}{x!}$ | CUMULATIVE PROBABILITY |
|---|---|---|
| 0 | 0.0498 | 0.0498 |
| 1 | 0.1494 | 0.1992 |
| 2 | 0.2240 | 0.4232 |
| 3 | 0.2240 | 0.6472 |
| 4 | 0.1680 | 0.8152 |

# Managing Queue Times Example

- By summing the probabilities for each of the arrival levels, Jay figures that he can handle the demand per hour approximately 82% of the time.

# Managing Queue Times Example

- Conversely, he figures that approximately 18% of the time, demand per hour will be greater than four customers, causing queues to develop..

# Queuing System Design

- **Queue Characteristics**
- Queuing models assume infinite length of a queue
- Queuing configuration can contain single or multiple lines

# Queuing System Design

- Queue discipline describes the order in which customers are served
- Virtual queues - Customers’ places in queue are tracked by a…

# Queuing System Design

- computerized system allowing them to roam the premises until signaled by a device

# Queuing System Design

- computerized system allowing them to roam the premises until signaled by a device

# Queuing System Design

- **Service Characteristics**
- Provided either by single server or by multiple servers who act in series or in parallel

# Queuing System Design

- Multiple servers acting in parallel is referred to as a multiple channel queuing system
- Multiple servers acting in series is referred to as a multiple phase queuing system

# Queuing System Design

- The single channel, single phase configuration is the most basic
- Another characteristic of the service is the time required to complete each of the services provided

# Queuing System Design

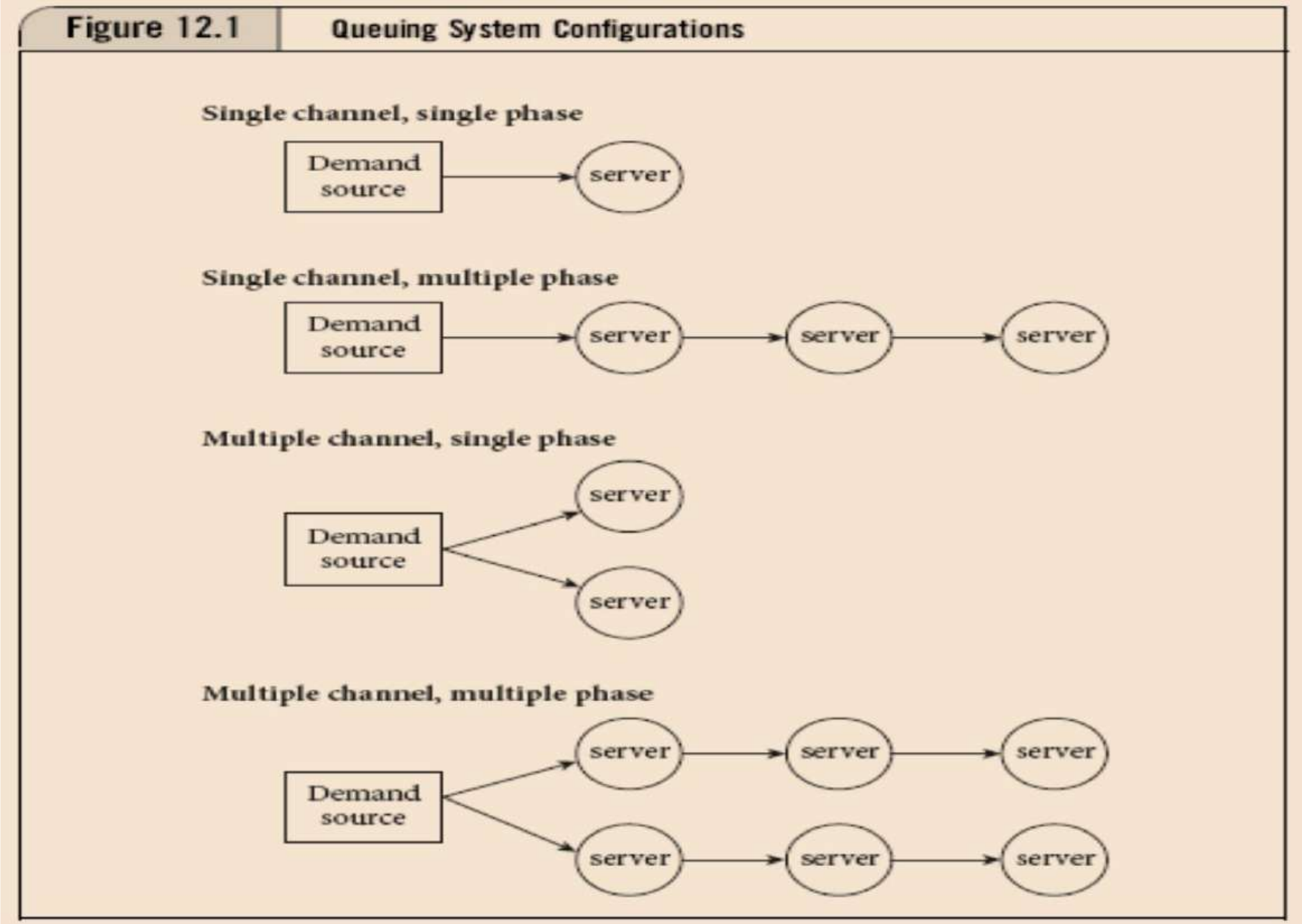


Figure 12.1 Queuing System Configurations

Single channel, single phase

Single channel, multiple phase

Multiple channel, single phase

Multiple channel, multiple phase

# Queuing System Design

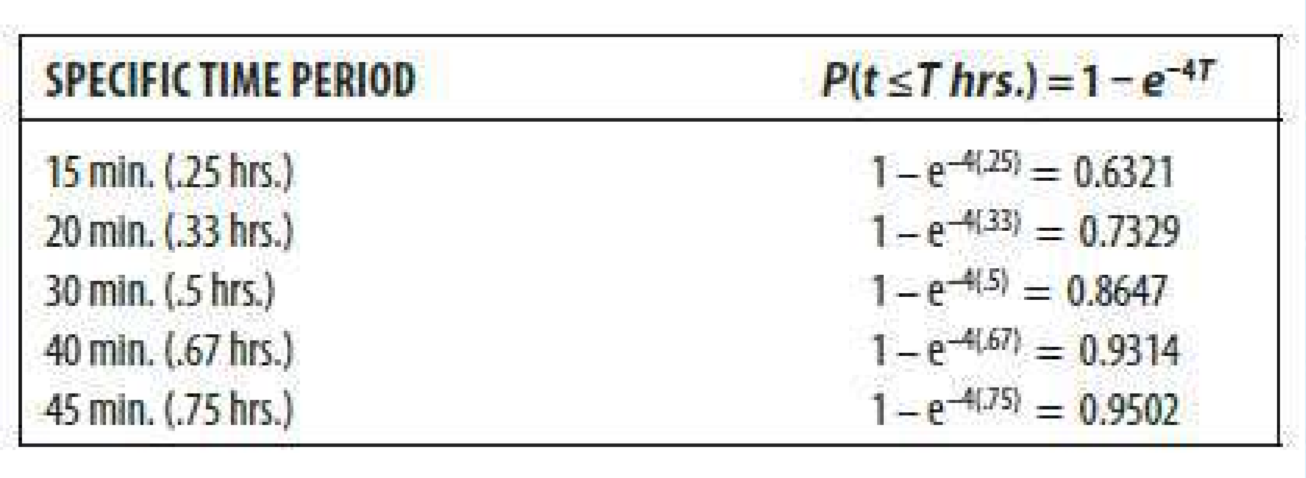
# Managing Queue Times

- Probability that service time t will be less than or equal to a specified time T
- $P(t \le T) = 1 - e^{-\mu T}$

# Managing Queue Times

Jay’s Quick Lube Shop can service an average of four customers per hour, or one customer every fifteen minutes, with a crew of three service personnel. The average customer arrival rate on Saturdays is three customers per hour, or one customer every twenty minutes. Jay is interested in calculating the probability that actual service time, *t*, will be within a specific time period, *T*, and he develops a chart showing these probabilities below, using the negative exponential distribution.

# Managing Queue Times



| SPECIFIC TIME PERIOD | $P(t \le T\ hrs.) = 1 - e^{-4T}$ |
|---|---|
| 15 min. (.25 hrs.) | $1 - e^{-4(.25)} = 0.6321$ |
| 20 min. (.33 hrs.) | $1 - e^{-4(.33)} = 0.7329$ |
| 30 min. (.5 hrs.) | $1 - e^{-4(.5)} = 0.8647$ |
| 40 min. (.67 hrs.) | $1 - e^{-4(.67)} = 0.9314$ |
| 45 min. (.75 hrs.) | $1 - e^{-4(.75)} = 0.9502$ |

Jay thinks that almost 75 percent of the time, they will be able to service a customer in less than or equal to twenty minutes.

# Managing Queue Times

# Queuing System Applications

- **The Single-Channel, Single-Phase Queuing Model**
- The most widely used & simplest of all queuing models

# Queuing System Applications

$\lambda$ – average arrival rate

$\mu$= average service rate

$\rho$= average server utilization = $\lambda/\mu$

Ls = expected customers in system = $\lambda/(\mu-\lambda)$

$L_q$ = expected customers in queue = $\lambda^2/[\mu(\mu-\lambda) = L_s - \lambda/\mu$

$W_s$ = expected waiting time in system = $l(\mu-\lambda) = L_s/\lambda$

$W_q$ = expected waiting time in queue = $\lambda/[\mu(\mu-\lambda)] = L_q/\lambda$

$P_n$ = probability of n units in the queuing system

$= (\lambda/\mu)^n(1 - \lambda/\mu)$

# Queuing System Applications

# Queuing System Example

- The Single-Channel, Single-Phase Queuing Model

# Queuing System Example

**Operating Characteristics for Kathy's Sewing Shop**

Kathy's Sewing Shop can serve about five customers per hour. For the past two weeks Kathy has kept track of the customer arrival rate, and the average has been four customers per hour. Kathy is interested in calculating the operating characteristics for her store. So she asks one of her customers, a business student at the local university, to help her. The student provides the following information:

$\lambda$ = 4 customers per hour

$\mu$ = 5 customers per hour

$\rho = 4/5 = 0.8$ or 80% utilization

$L_s = \lambda/(\mu-\lambda) = 4/(5-4) = 4$ customers

$L_q = L_s - \lambda/\mu = 4 - 4/5 = 3.2$ customers

$W_s = L_s/\lambda = 4/4 = 1$ hour = 60 minutes

$W_q = L_q/\lambda = 3.2/4 = 0.8$ hours = 48 mins

# Queuing System Example

Kathy also wants to know how likely it will be that more than four customers will be in her shop at one time. So the student thinks about this and decides to determine the probabilities of zero, one, two, three and four customers in the shop, and then subtract their sum from 1. She provides the following information:

For $n=0$ $P_0 = (4/5)^0(1-4/5) = 0.200$

$n=1$ $P_1 = (4/5)^1(1-4/5) = 0.160$

$n=2$ $P_2 = (4/5)^2(1-4/5) = 0.128$

$n=3$ $P_3 = (4/5)^3(1-4/5) = 0.102$

$n=4$ $P_4 = (4/5)^4(1-4/5) = 0.082$

For $n>4$ $P_{n>4} = 1-(P_0+P_1+P_2+P_3+P_4)$

$= 1-(.2+.16+.128+.102+.082) = 1-.672 = 0.328$

# Queuing System Example

Kathy can expect that there will be more than four people in her shop about 33 percent of the time.

She can also purchase a barcode scanner with an automated cash register that will increase her service rate to ten customers per hour. She wants to know how this will change the average wait time in the queue and in the system. The student then shows her the very significant change this will make:

$$L_s = \lambda/(\mu - \lambda) = 4/(10-4) = 0.67 \text{ customers}$$

$$W_q = \lambda/[\mu(\mu - \lambda)] = 4/[10(6)] = 0.067 \text{ hours} = 4 \text{ minutes}$$

$$W_s = 1/(\mu - \lambda) = 1/6 \text{ hour} = 10 \text{ minutes}$$

# Queuing System Example

# multiple-channel, single-phase queuing

- With a multiple-channel, single-phase queuing system application the number of servers is now greater than one. The operating characteristics of this queuing system are as follows:

# multiple-channel, single-phase queuing

$\lambda$ = average arrival rate

$s\mu$ = average service rate, where $s$ = number of service channels

$\rho$ = average server utilization = $\lambda/s\mu$

$P_0$ = probability of zero customers in the system

$$= \frac{1}{\sum_{n=0}^{s-1} \frac{(\lambda\mu)^n}{n!} + \frac{(\lambda\mu)^s}{s!}\left[\frac{1}{1-(\lambda s\mu)}\right]}, \text{ for } s\mu > \lambda$$

# multiple-channel, single-phase queuing

$P_n$ = probability of $n$ customers in the system

$$= P_0 \frac{(\lambda/\mu)^N}{n!}, \text{for } n \le s$$

$$= P_0 \frac{(\lambda/\mu)^n}{s!\, s^{n-s}}, \text{for } n > s$$

$L_q$ = expected number of customers in queue

$$= P_0 \frac{(\lambda/\mu)^s (\lambda/s\mu)}{s!\,(1 - \lambda/s\mu)^2}$$

# multiple-channel, single-phase queuing

$L_s$ = expected number of customers in system = $L_q + \lambda/\mu$

$W_q$ = expected waiting time in queue = $L_q/\lambda$

$W_s$ = expected waiting time in the system = $W_q + 1/\mu$

# multiple-channel, single-phase queuing

# Managing Queue Times Rules

- **Managing Perceived Waiting Times**
- Often, demand exceeds expectations & capacity
- First & Second Laws of Service

# Managing Queue Times Rules

- Rule 1: Satisfaction = perception – expectation
- Rule 2: It is hard to play catch-up ball
- **Waiting time management techniques**
- Keep Customers Occupied

# Managing Queue Times Rules

- Start the Service Quickly
- Relieve Customer Anxiety
- Keep Customers Informed
- Group Customers Together
- Design a Fair Waiting System..

# Managing Distribution Channels

- Distribution channels involve traditional methods & new channels that incorporate new Internet technologies

# Managing Distribution Channels

- Eatertainment combines restaurant & entertainment elements
- Entertailing entails retail locations with entertainment elements

# Managing Distribution Channels

- Edutainment (infotainment) combines learning with entertainment to appeal to customers looking for substance along with play

# Managing Distribution Channels

- Franchising
- expand quickly in dispersed geographic markets
- protect existing markets
- build market share & when owners have limited financial resources

# Managing Distribution Channels

- micro franchising is a concept that offers ready-made, low-risk starter jobs for people with little or no education and little available capital

# Managing Distribution Channels

- **International Expansion**
- Operate/partner with firms familiar with the region’s markets, suppliers, infrastructure, government regulations, & customers

# Managing Distribution Channels

- Foreign currency exchange rate fluctuations can pose a problem
- Must address language & cultural barriers…

# Managing Distribution Channels

- **Internet Distribution Strategies**
- Internet retailing is growing faster than traditional retailing

# Managing Distribution Channels

- Primary advantages of the Internet - ability to offer convenient sources of real-time information, integration, feedback, & comparison shopping

# Managing Distribution Channels

- Many retailers today sell products exclusively over the Internet (a pure strategy), while others use it as a supplemental distribution channel (a mixed strategy)

# Managing Distribution Channels

- **Internet Distribution Strategies**
- Advantages of pure Internet distribution strategy
- Internet companies are more centralized,

# Managing Distribution Channels

- Reduced labor, capital & inventory costs
- Decentralized marketing efforts reach a vastly distributed audience

# Managing Distribution Channels

- Today the mixed Internet distribution strategy of combining traditional retailing with Internet retailing seems to be emerging as the stronger business model..

# Managing Service Quality

- Customer satisfaction with the service depends not only on the ability of the firm to deliver what customers want, but on the customers' perceptions of the quality of the service received

# Managing Service Quality

- Service quality depends on the firm’s employees to satisfy customers varying expectations

# Managing Service Quality

- The Five Dimensions of Service Quality
- Reliability - consistently performing the service correctly & dependably
- Responsiveness - promptly & timely service

# Managing Service Quality

- Assurance - ability to convey trust & confidence to customers
- Empathy - providing caring attention to customers

# Managing Service Quality

- Tangibles - the physical characteristics of the service including e.g. facilities, servers, equip., & other customers..

# Managing Service Quality Example

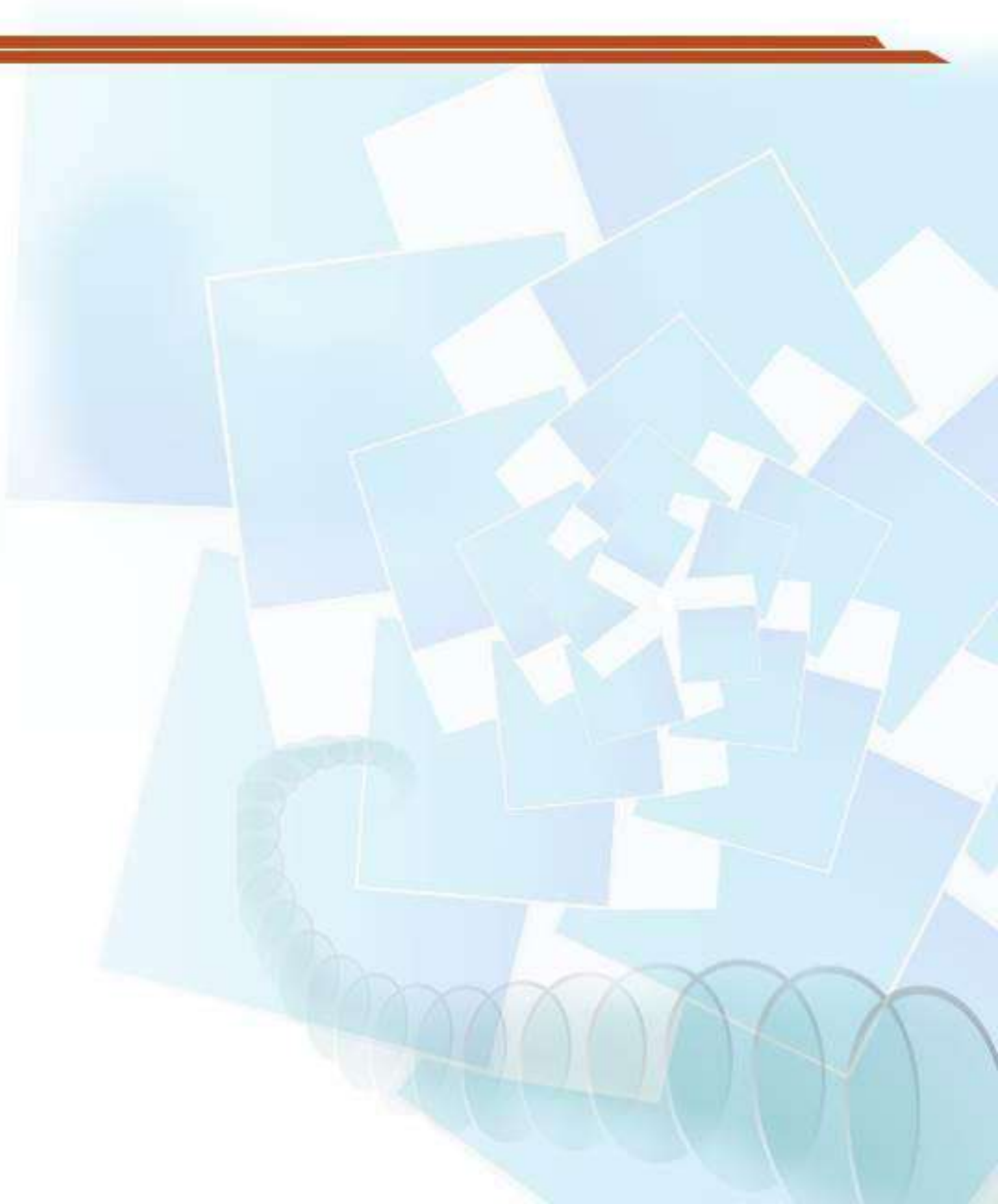
- Recovering from Poor Service Quality
- Keeping customers loyal & coming back serves as good word-of-mouth advertising

# Managing Service Quality Example

- Service Recovery Systems require –
- Developing recovery procedures
- Training employees in these procedures
- Empowering employees to remedy customer problems

# Managing Service Quality Example

| **Examples of Service Quality Criteria** | |
|---|---|
| **Service Quality Dimensions** | **Criteria** |
| Reliability | • billing accuracy<br>• order accuracy<br>• on-time completion<br>• promises kept |
| Responsiveness | • on-time appointment<br>• timely callback<br>• timely confirmation of order |
| Assurance | • skills of employees<br>• training provided to employees<br>• honesty of employees<br>• reputation of firm |
| Empathy | • customized service capabilities<br>• customer recognition<br>• degree of server-customer contact<br>• knowledge of the customer |
| Tangibles | • appearance of the employees<br>• appearance of the facility<br>• appearance of customers<br>• quality of equipment and other goods used |



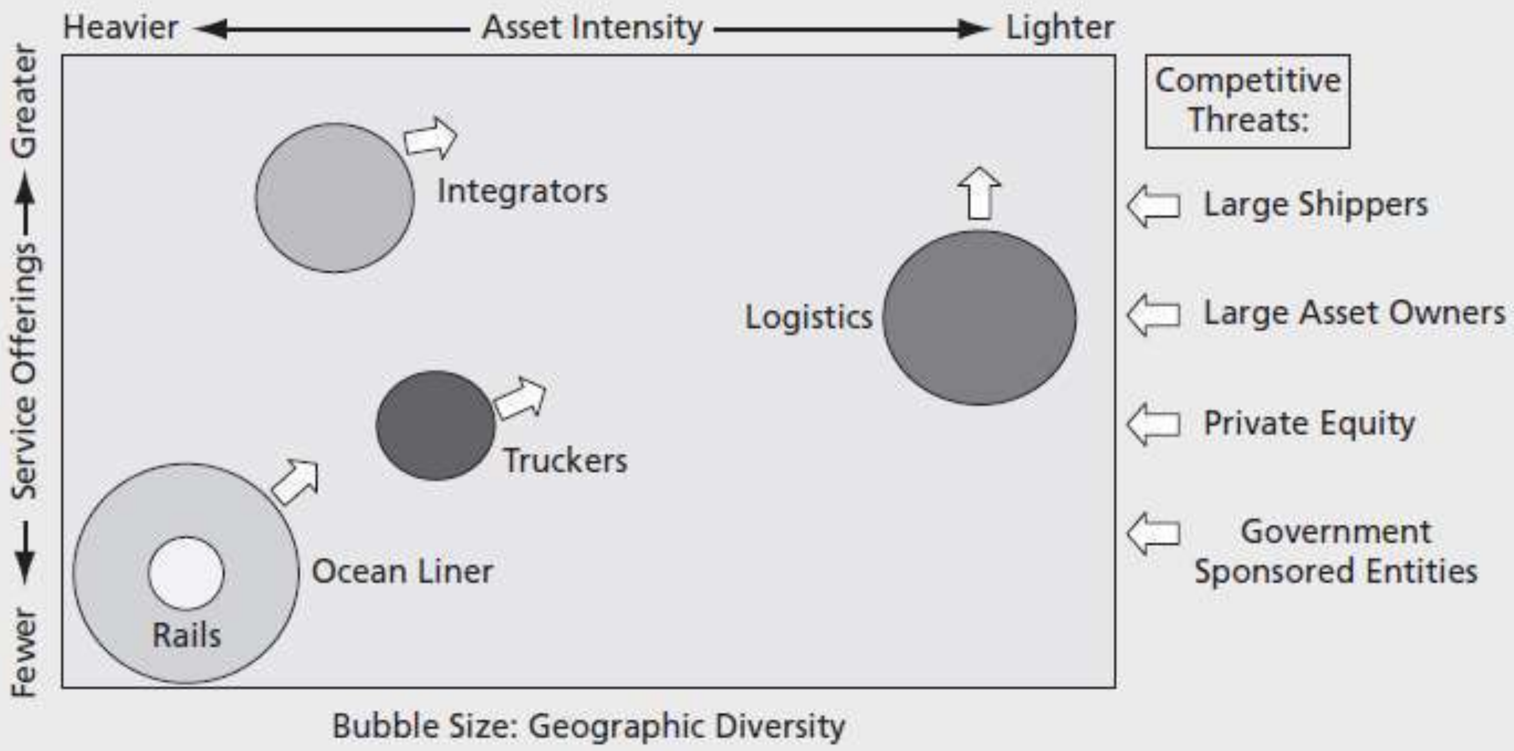
# Role of Outsourced Logistics Providers

# Role of Outsourced Logistics Providers

| | |
|---|---|
| 1PL | • Shipper or consignee |
| 2PL | • Individual, asset-based provider of logistics services |
| 3PL | • Firm that manages and/or provides multiple logistics services for use by customers |
| 4PL | • Firm that provides broader scope of services to help manage elements of supply chain |
| 5PL | • Companies that aggregate demands of 3PLs into bulk volumes to negotiate better rates with airlines and shipping companies |
| LSP | • Logistics service providers can refer to any or all of the above |

# Role of Outsourced Logistics Providers

**FIGURE 12-1** Logistics Service Providers



# Role of Outsourced Logistics Providers

# Types of 3PLs

- **Asset Based**
- Owns assets and labor force needed to run transport and logistics activities
- Examples: UPS, J.B. Hunt, Exel, Ryder, FedEx

# Types of 3PLs

- Advantages: readily available capacity, permanent employees, and direct control of the customers’ freight.

# Types of 3PLs

- User concerns: potential for bias toward 3PL own internal resources in developing solutions for customers.

# Types of 3PLs

- **Non-asset Based**
- Contracts with other firms to provide services rather than owning required assets
- Examples: C.H. Robinson, XPO Logistics, Capgemini, KPMG

# Types of 3PLs

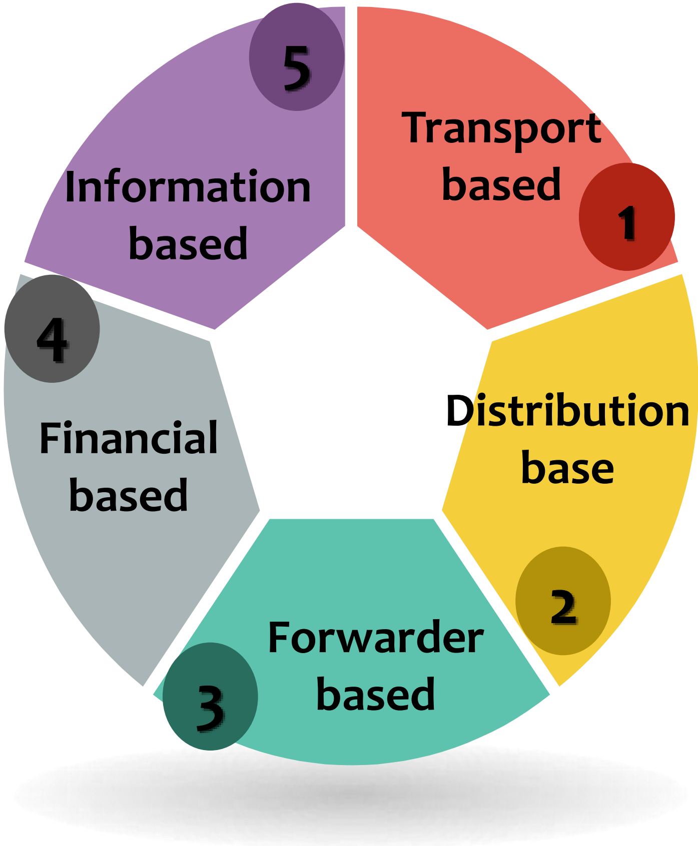
- Advantages: more flexible vs. asset-based 3PLs, unbiased in decision making

# Types of 3PLs

- User concerns: subject to competition for capacity from external providers, more intensive relationship management required..

# Primary Services of 3PLs

# Primary Services of 3PLs



1

- Business origin in freight movement
- **Examples of 3PLs:** UPS Supply Chain Solutions, FedEx Trade Networks, Schneider Logistics Services, Damco (Maersk Group), BNSF Logistics
- **Examples of services:** move freight, manage transportation operations, operate fulfillment centers, develop logistics solutions

# Primary Services of 3PLs

**Distribution base**

2

- Business origin in the public or contract warehousing
- **Examples of 3PLs:** Exel, Saddle Creek, UTi Worldwide, Neovia Logistics Services (by Caterpillar Inc.), Intral (by Gillette Company)
- **Examples of services:** Focus on inventory management, warehousing, and order fulfillment, but may also provide transportation services

# Primary Services of 3PLs

**Forwarder based**

3

- Includes freight forwarders, brokers, and agents that primary facilitate the flow of goods on behalf of customers
- **Examples of 3PLs:** C.H. Robinson Worldwide Inc., Hub Group Inc., Kuehne + Nagel Inc.
- **Examples of services:** arrange transportation services for LTL shipments, air cargo, and ocean freight; facilitate international freight movements

# Primary Services of 3PLs

**Financial based**

4

- Specialize in monetary issues and financial flows in the supply chain
- **Examples of 3PLs:** Cass Information Systems, CT Logistics, US Bank (Syncada), enVista, TranzAct Technologies, GE Capital
- **Examples of services:** freight rating, freight payment, freight bill auditing, accounting , electronic payment, carrier compliance reporting, freight claims

# Primary Services of 3PLs

**Information based**

5

- Digitized activities that were previously performed manually or required the use of licensed software
- **Examples of 3PLs:** Descartes Systems Group, Transplace, MercuryGate
- **Examples of services:** online freight brokerage services, cargo planning, routing & scheduling; internet access (pay per use) to TMS, WMS, performance management tools

# Primary Services of 3PLs

# Primary Types of 3PLs Services

# Primary Types of 3PLs Services

- For hire carriage
- Contract carriage
- Expedited service
- Time definite service
- Intermodal service

**Freight Movement**

- Carrier selection, routing, & scheduling
- Contract compliance
- Performance analysis
- Freight bill auditing & payment

**Freight Management**

- Surface forwarding
- Air forwarding
- Freight brokerage
- Intermodal marketing
- Shippers associations

**Intermediary Services**

- Dedicated contract carriage
- Drayage
- Pool distribution
- Merge in transit
- Last mile delivery

**Specialty Services**

# Primary Types of 3PLs Services

- **Intermediaries Services**
- Surface forwarding – Pick up, assemble & consolidate shipments, then hire carriers to transport & deliver the consolidated shipments.

# Primary Types of 3PLs Services

- Air forwarding – Consolidate small shipments for long-haul movement, primarily using major passenger and freight airlines.

# Primary Types of 3PLs Services

- Freight brokerage – Represent carrier seeking freight or shipper seeking capacity.
- Intermodal marketing – Act as facilitators or arrangers of rail transportation service.

# Primary Types of 3PLs Services

- Shippers associations – Nonprofit transportation membership cooperatives arrange for the domestic or international shipment of members’ cargo.

# Primary Types of 3PLs Services

- Dedicated contract carriage – Serve as a customer’s private fleet with a customized turnkey solution.

# Primary Types of 3PLs Services

- Drayage – Specialize in short-haul movement of intermodal containers from origin to ocean ports and rail yards and from these facilities to their ultimate destination.

# Primary Types of 3PLs Services

- **Specialized Services**
- Pool distribution – Move a large quantity of product in bulk to a specific market or regional terminal, to be offloaded, sorted by customer.

# Primary Types of 3PLs Services

- Merge in transit – Unite shipments from multiple suppliers at a specified merge point located close to the end customer.

# Primary Types of 3PLs Services

- Last mile delivery – A new breed of last mile service providers, covering the final dock-to-door or store-to-door delivery with value-added services such as inside delivery, product assembly, and testing..

# Outsource vs. In-house Logistics

# Outsource vs. In-house Logistics

| USING 3PL SERVICES | AGAINST USING 3PL SERVICES |
|---|---|
| Opportunity for cost reductions | Logistics is a core competency of company |
| Ability to focus on core competencies | Cost reductions would not be experienced |
| Opportunity to improve customer service | Control over outsourced function would diminish |
| Improve return on assets | Service level commitments would not be realized |
| Increase in inventory turns | Company has more expertise than 3PL providers |
| Productivity improvement opportunities | Logistics is too important to consider outsourcing |
| Generate logistics process flexibility | Outsourcing is not a corporate philosophy |
| Access to emerging technology | Global capabilities of 3PL need improvement |
| Expansion to unfamiliar markets | Inability of 3PLs to form meaningful relationships |
| Ability to divert capital investments | Issues related to security of shipments |

# Outsource vs. In-house Logistics

# Primary Activities Outsourced

- Transportation management is the most frequently used 3PL service, with outsourced services overall remaining “tactical” (vs. “strategic”) in nature.

# Primary Activities Outsourced

- Domestic transportation (80%)
- International transportation (70%)
- Warehousing (67%)
- Customs brokerage (53%)
- Freight forwarding (51%)..

# 3PL Relationship Development Process

- Focuses on understanding transportation and logistics needs and the overall business strategies.

# 3PL Relationship Development Process

- Overall role of transportation and logistics in supporting business goals and objectives
- Transportation and logistics needs assessment

# 3PL Relationship Development Process

- Strategic environmental factors and industry trends
- Current logistics network and the firm’s positioning in supply chains

# 3PL Relationship Development Process

- Key performance measurements, target, and current vs. desired performance gap

# 3PL Relationship Development Process

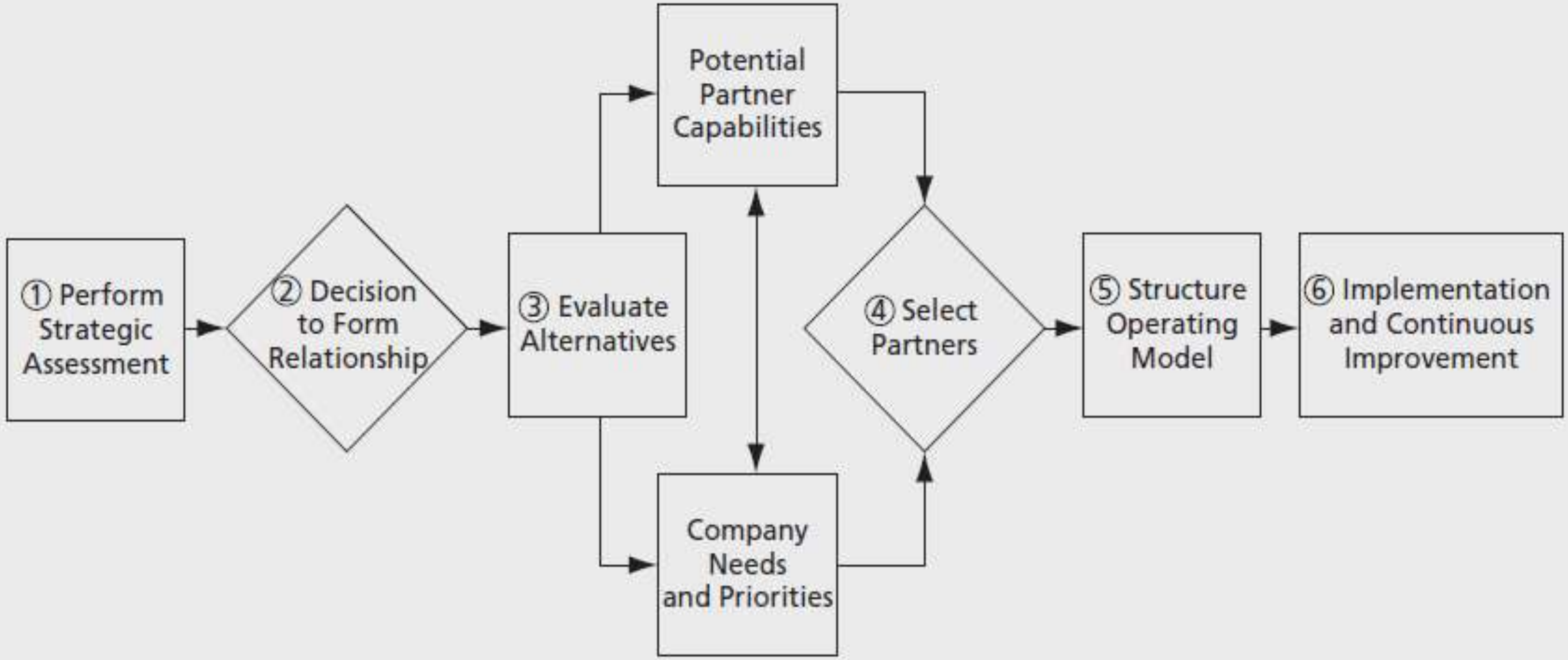


**FIGURE 12-4** 3PL Relationship Development Process

# 3PL Relationship Development Process

- **Decision to Form Relationship**
- Evaluate whether transportation and logistics is core competency in terms of expertise, …

# 3PL Relationship Development Process

- strategic fit, and ability to invest. The absence of any of these may suggest that the use of 3PL services is appropriate.

# 3PL Relationship Development Process

- strategic fit, and ability to invest. The absence of any of these may suggest that the use of 3PL services is appropriate.

# 3PL Relationship Development Process

- **Drivers** – Compelling reasons to partner
- Asset/Cost efficiency
- Customer service
- Marketing advantage
- Profit stability/Grow

# 3PL Relationship Development Process

- **Facilitators** – Supportive corporate environmental factors
- Corporate compatibility

# 3PL Relationship Development Process

- Management philosophy and techniques
- Mutuality of commitment to relationship
- Symmetry on key factors

# 3PL Relationship Development Process

- **Evaluate Alternatives**
- Uses drivers and facilitators to identify the most appropriate type of 3PL relationship.

# 3PL Relationship Development Process

- Transactional or "arm's length" relationships
- Drivers not present
- Facilitating factors not present

# 3PL Relationship Development Process

- **Structured, formal relationship**
- Share common drivers
- Facilitating factors present

# 3PL Relationship Development Process

- **Select Partners** Partner should be selected only after close consideration of the credentials of the top candidate 3PLs is made.
- Interact with the final candidates on a professionally intimate basis.

# 3PL Relationship Development Process

- Achieve consensus on the final selection from all involved executives.
- Establish consistent understanding of the final selection and what is expected from the chosen service provider.

# 3PL Relationship Development Process

- **Structure Operating Model**
- Clarify each party’s responsibilities, activities, processes, and priorities that will drive day-to-day operations.

# 3PL Relationship Development Process

- **Suggested operating model elements**
- Planning
- Joint operating controls
- Communication

# 3PL Relationship Development Process

- Risk/Reward sharing
- Trust and commitment
- Contract style
- Scope of the relationship
- Financial investment

# 3PL Relationship Development Process

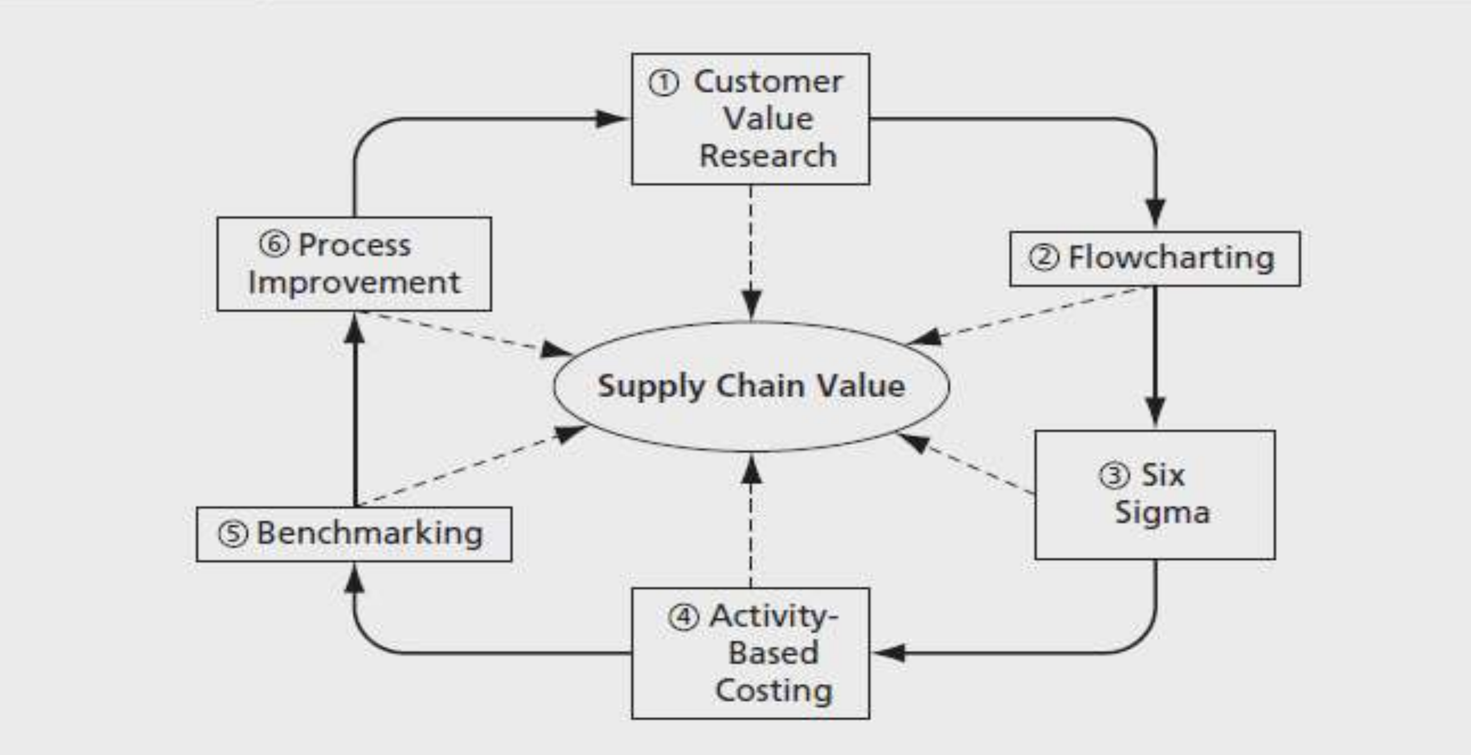
- **Implementation & Continuous Improvement**
- Duration of the overall implementation process depends on the complexity of…

# 3PL Relationship Development Process

- the new relationship, and continuous improvement is key to the future success of the relationship.

# 3PL Relationship Development Process

FIGURE 12-6 3PL Continuous Improvement Process

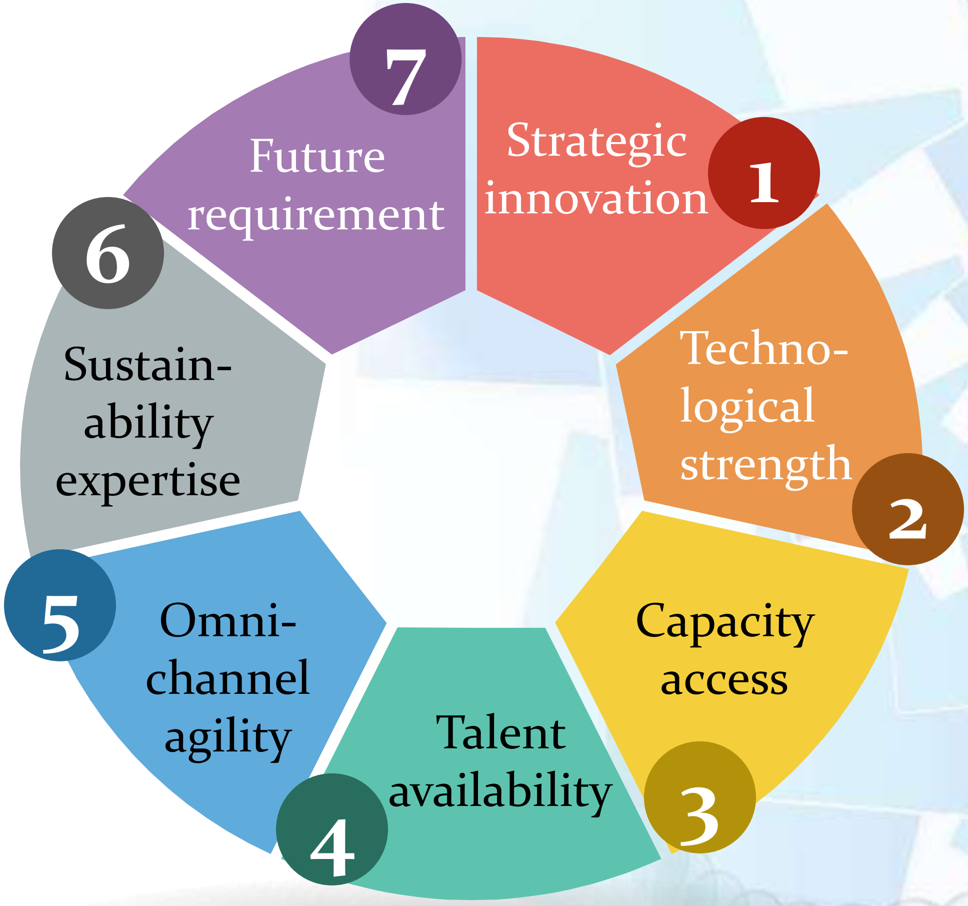


# 3PL Relationship Development Process

# Strategic Needs of 3PL Users

The ultimate goal of the development and implementation of 3PL relationship process is to develop outstanding customer service capabilities and cost-efficient operations.

# Strategic Needs of 3PL Users



1 Strategic innovation

2 Techno-logical strength

3 Capacity access

4 Talent availability

5 Omni-channel agility

6 Sustain-ability expertise

7 Future requirement

# Strategic Needs of 3PL Users

# Transportation infrastructure issues

# Transportation infrastructure issues

Transportation Infrastructure

Supply Chain Technology

Sustainability

Fuel Cost

# Transportation infrastructure issues

**Collaboration is a powerful tactic or strategy that has led to many improvements in supply chain performance.**

- Reduce loading & unloading times at shipping and receiving facilities.
- Increase hours of operation for drop yards and warehouse facilities
- Allow faster payment for carriers
- Reduce driver-assist times
- Share capacity forecasts with carriers

- Vendor-managed-inventory (VMI)
- Electronic Data Interchange (EDI)
- Radio Frequency Identification (RFID)
- Global Positioning System (GPS)
- Mobile communication technologies
- Intelligent Robotics

# Transportation infrastructure issues

## Green Supply Chain and Transportation

- Consolidation
- Packaging

**Don’t ship air**

- Market-oriented locations
- Product design

**Don’t ship water**

- Improve fuel efficiency
- Clean fuel
- Network mileage optimization
- The Smart-Way Transport Partnership

**Green transport**

# Transportation infrastructure issues

# Supply chain Sustainability

- Appreciate the importance of sustainable supply chains for the protection of the ecology of the planet.

# Supply chain Sustainability

- Understand how effective logistics management can contribute to sustainability.

# Supply chain Sustainability

- Understand how effective logistics management can contribute to sustainability.
- Understand the established frameworks for sustainable supply chains.

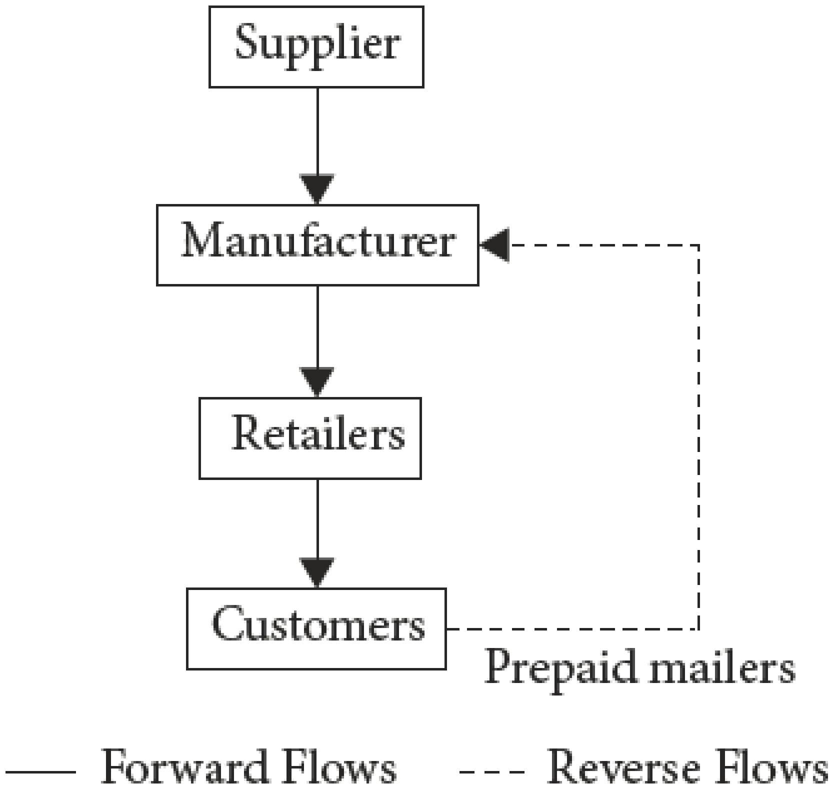
# Supply chain Sustainability

- Discuss the importance and challenges of reverse flows in supply chains.

# Supply chain Sustainability

- Understand why there has been a significant increase in the number and volume of items moving in reverse flows and supply chains.

# Supply chain Sustainability



Supplier

Manufacturer

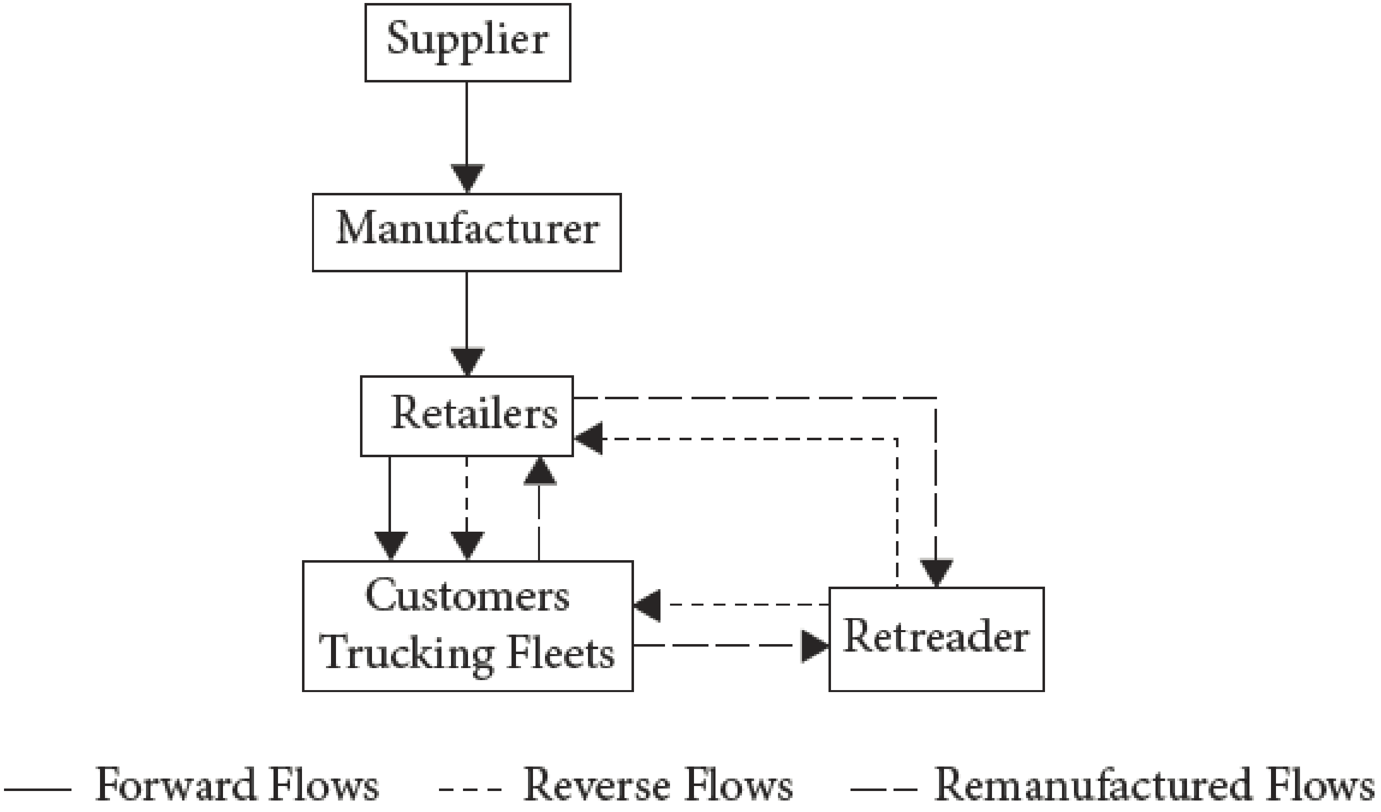
Retailers

Customers

Prepaid mailers

—— Forward Flows   - - - Reverse Flows

# Supply chain Sustainability



# Supply chain Sustainability

# Reverse Logistics Systems

- Reverse flows are goods and materials moving upstream in the supply chain.
- Reverse flows were traditionally ignored, but regulation and economics have increased attention on them.

# Reverse Logistics Systems

- Estimates are that returns range from 3 – 50% depending on the product.
- Retailers lose 3 to 5% of gross sales to returns accounting for about 4.5% of the cost of logistics.

# Reverse Logistics Systems

- Internet returns are about double the counter sale returns..

# Categories of reverse flows

- Products that have failed; are unwanted, damaged, or defective; but can be repaired or remanufactured and resold.

# Eight categories of reverse flows

- Products that are unsold from retailers, usually referred to as overstocks that have resale value.
- Products being recalled due to a safety or quality defect that may be repaired or salvaged.

# Eight categories of reverse flows

- Products needing "pull and replace" repair before being put back in service.
- Products that can be recycled such as pallets, containers, computer inkjet cartridges, etc.

# Eight categories of reverse flows

- Products or parts that can be remanufactured and resold.
- Scrap metal that can be recovered and used as a raw material for further manufacturing..

# Reverse Logistics Systems vs. Closed Loops

- Reverse logistics—The process of moving or transporting goods from their final destination for the purpose of capturing value or for proper disposal.

# Reverse Logistics Systems vs. Closed Loops

- Reserve logistics involves the processes for sending new or used products “back up stream” for repair, reuse, refurbishing, resale, recycling, or scrap/salvage.

# Reverse Logistics Systems vs. Closed Loops

- Closed loop supply chains—Designed and managed to explicitly consider both forward and reverse flows activities in a supply chain.
- Explicitly designed and managed for both flows.

# Reverse Logistics Systems vs. Closed Loops

- **Customer Returns**
- A variety of reasons for customer returns can be given (as indicated previously) including defective or unwanted items, warranty problems, recalls, and miss-shipments.

# Reverse Logistics Systems vs. Closed Loops

- **Environmental Challenges**
- Recycling and environmental concerns are frequently viewed simultaneously because of their association with regulatory policy at the local, state, and/or federal level.

# Reverse Logistics Systems vs. Closed Loops

- **Economic Value**
- Value has become an important for businesses and even some nonprofit organizations.
- Making reverse flows profitable is a challenge as well as an opportunity..

# Achieving a Value Stream for Reverse Flows

- Barriers to implementing a reverse flows program may be internal or external and may including the following:
- Priority relative to other issues and potential projects or programs in the organization

# Achieving a Value Stream for Reverse Flows

- Inattention or lack of “buy-in” from top level management in the organization
- Financial resources necessary for operations and asset infrastructure

# Achieving a Value Stream for Reverse Flows

- Personnel resources required to develop and implement the reverse flows program
- Adequacy of material and information systems to support the returns program

# Achieving a Value Stream for Reverse Flows

- Personnel resources required to develop and implement the reverse flows program
- Adequacy of material and information systems to support the returns program..

# Managing Reverse Flows

- The Reverse Logistics Educational Council recommends consideration of the following:

# Managing Reverse Flows

- Avoidance—Producing high-quality products and developing processes to minimize or eliminate returns

# Managing Reverse Flows

- Gatekeeping—Checking and screening merchandise at the entry point into the reverse flows process to eliminate unnecessary returns or minimize handling

# Managing Reverse Flows

- Reducing reverse cycle times—Analyzing processes to enable and facilitate compression of time for returns to enhance value recapture

# Managing Reverse Flows

- Information systems—Developing effective information systems to improve product visibility, reduce uncertainty, and maximize economies of scale.

# Managing Reverse Flows

- Returns centers—Developing optimum locations and facility layouts for returns centers to facilitate network flow

# Managing Reverse Flows

- Asset recovery—Classifying and disposing of returned items, surplus, scrap, and obsolete items to maximize returns and minimize cost

# Managing Reverse Flows

- Pricing—Negotiating the best price for products being returned and resold

# Managing Reverse Flows

- Outsourcing—Considering a relationship with a third-party organization to handle and manage reverse flows in cases where existing personnel,…

# Managing Reverse Flows

- infrastructure, experience, and/or capital may not be adequate to implement a successful program

# Managing Reverse Flows

- Zero returns—Developing a policy to exclude returns by giving a returns allowance and/or “destroying” the product in the field

# Managing Reverse Flows

- Financial management—Developing guidelines and financial procedures to properly account…

# Managing Reverse Flows

- for charges against sales and related financial issues when items are returned by customers..

# Integration Model for Logistics

- Firms in the supply chain must integrate processes to create value for the services and products provided to end customers.

# Integration Model for Logistics

- Process integration means sharing information and coordinating resources to jointly manage a process or processes.

# Integration Model for Logistics

- The benefits of collaboration and information sharing between trading partners can be significant.

# Integration Model for Logistics

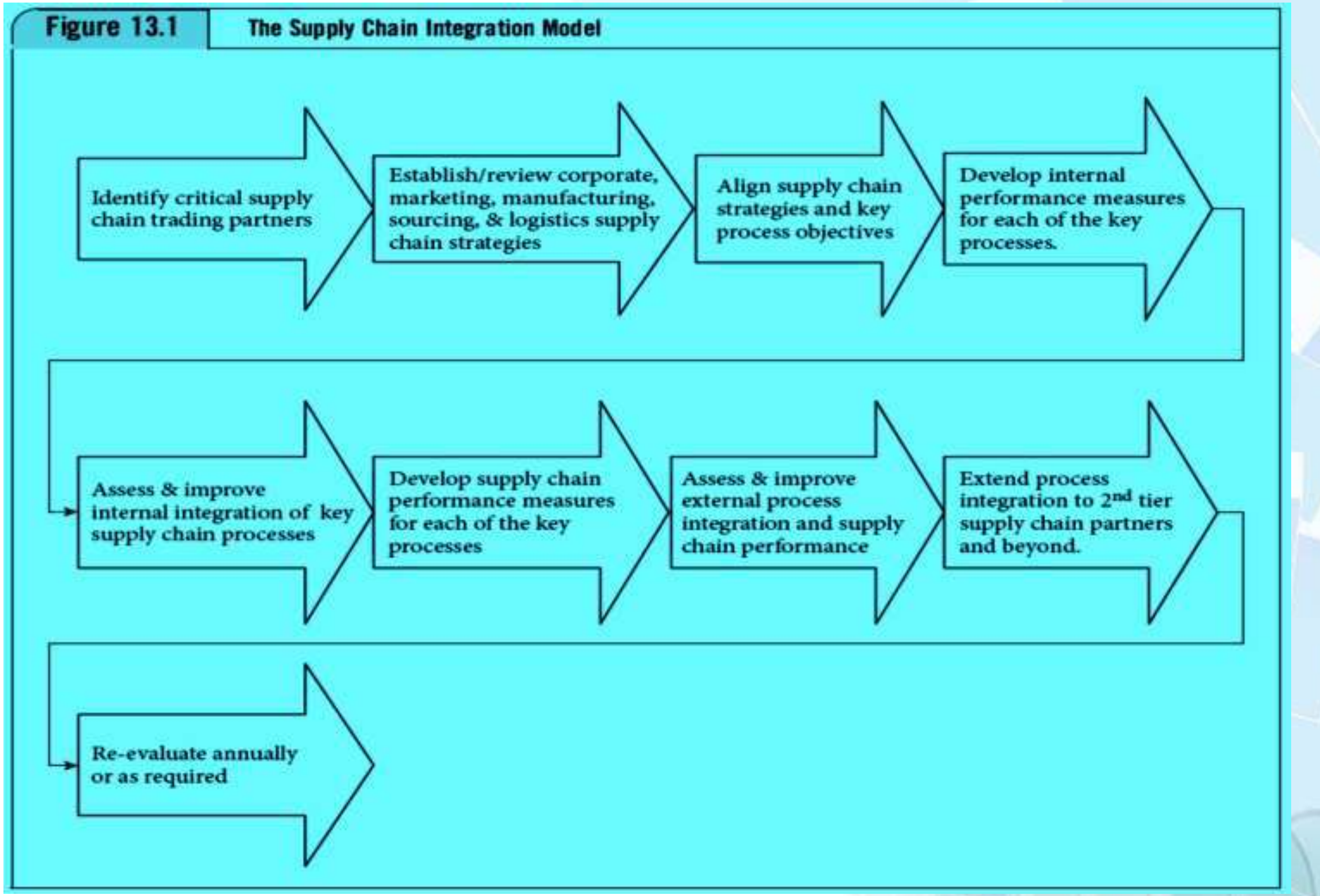


**Figure 13.1** **The Supply Chain Integration Model**

Identify critical supply chain trading partners

Establish/review corporate, marketing, manufacturing, sourcing, & logistics supply chain strategies

Align supply chain strategies and key process objectives

Develop internal performance measures for each of the key processes.

Assess & improve internal integration of key supply chain processes

Develop supply chain performance measures for each of the key processes

Assess & improve external process integration and supply chain performance

Extend process integration to 2nd tier supply chain partners and beyond.

Re-evaluate annually or as required

# Integration Model for Logistics

- **Identify Critical SC Trading Partners**
- Sell & deliver products to final customers
- Identifying primary trading partners allows the firm to concentrate on managing links with these companies

# Integration Model for Logistics

- **Review & Establish SC Strategies for:**
- Parts purchased & suppliers
- Manufacturing processes
- Design of the products manufactured…

# Integration Model for Logistics

- Mode of transportation
- Warranty & return services
- Outsourcing
- Sustainability..

# Aligning SC Strategies

- Lambert et al. identified 8 key SC processes:
- Customer relationship management
- Customer service management
- Demand management

# Aligning SC Strategies

- Order fulfillment
- Manufacturing flow management
- Supplier relationship management
- Product development & commercialization
- Returns management..

# Key Supply Chain Business Processes -I

- **Customer Relationship Management**
- Tailoring product and service agreements to meet customer needs

# Key Supply Chain Business Processes -I

- Measuring customer profitability and firm’s impact on customers

# Key Supply Chain Business Processes -I

- Monitor the impact of customer relationship management (CRM) efforts in terms of both the financial impact and customer satisfaction

# Key Supply Chain Business Processes -I

- **Customer Service Management**
- Providing information to customers such as product availability, shipping dates and order status

# Key Supply Chain Business Processes -I

- Administering product and service agreements
- Monitoring and reporting customer service performance

# Key Supply Chain Business Processes -I

- **Demand Management**
- Balancing customer demand with the firm's output capacity
- Forecasting demand and coordinating with production, purchasing and distribution

# Key Supply Chain Business Processes -I

- Increase the accuracy of forecasts
- To track the success of various demand management activity implementations

# Key Supply Chain Business Processes -I

- **Order Fulfillment**
- Meeting customer requirements by synchronizing the firm’s marketing, production and distribution plans
- Location of suppliers, production facilities and distribution centers

# Key Supply Chain Business Processes -I

- Modes of inbound and outbound transportation used
- System used for entering, processing, communicating, picking, delivering and documenting customer orders..

# Key Supply Chain Business Processes -II

- **Manufacturing Flow Management**
- Determining manufacturing process requirements to enable the right mix of flexibility and velocity to satisfy demand

# Key Supply Chain Business Processes -II

- A good set of performance metrics to track the capability of the manufacturing flow process to satisfy demand

# Key Supply Chain Business Processes -II

- **Supplier Relationship Management**
- Screening and selecting suppliers
- Developing close working relationships with key suppliers

# Key Supply Chain Business Processes -II

- Negotiating product and service agreements
- Managing suppliers
- Monitoring supplier performance and improvement.

# Key Supply Chain Business Processes -II

- **Product Development and Commercialization**
- Selecting new product ideas
- Developing new products and getting them to market quickly and effectively

# Key Supply Chain Business Processes -II

- Assessing the success of each new product
- Developing customer feedback mechanisms

# Key Supply Chain Business Processes -II

- **Returns Management**
- Managing used product disposition, product recalls, and packaging requirements
- Environmental compliance with substance disposal and recycling

# Key Supply Chain Business Processes -II

- Collecting returns data
- Minimizing future returns..

## DEFINITIONS/GLOSSARY OF MGMT615

### ABC Classification system

A method of classifying inventory items relative to their impact on total control. ABC typically uses movement and cost data to calculate the value of stock usage over the prior period, and uses the result as an element in ranking items under an 80/20 Pareto rule for cycle counting purposes to focus efforts on those selected items and possible reduce the cost associated with frequent counting of slow moving items. The group is divided into classes called A, B, and C (and sometimes D) with The A group represents the highest value with 10 to 20% by number of items. The B, C and D (if used) groups are each lower values but typically higher populations. Items with higher usage value are (the 20%) are counted more frequently. Specific bars to be used in setting ABC levels will vary by organization as they will impact the financial control applied to inventory and the level of effort spent counting. Also see: Cycle Counting

### ABC Frequency of Access

Location method where the determination of a product’s location within the warehouse, or distribution center, is based on 1) product’s ABC Classification and 2) the number of times or rate of which the product is accessed.

### ABC Inventory Control

A method of inventory control which divides items into categories based on value of usage, something like a Pareto division where the items which constitute the highest dollar value are tracked more closely than those with lower value movement. In this method an item with high volumes of movement, but low cost, such as a small cheap fastener would likely be counted less frequently than a slower mover which has a very high cost. Items are typically divided by a company defined set of values into “A”, “B” and “C” groups, and sometimes a “D” group. The count frequencies are then applied to the groups. For example “A” class items may be counted weekly, “B” monthly, “C” quarterly, etc. as a part of a cycle counting program.

### ABC Model

In cost management, a representation of resource costs during a time period that are consumed through activities and traced to products, services, and customers or to any other object that creates a demand for the activity to be performed.

### ABC System

In cost management, a system that maintains financial and operating data on an organization's resources, activities, drivers, objects and measures. ABC models are created and maintained within this system.

**Abnormal Demand**

Abnormal Demand: Demand for a product which is either greater or lower than expected by a given percentage which is determined by the organization. When observed, it should be determined whether it may be a one-time spike, or if the effect is part of a trend which should be considered during future forecasts.

**Absorption Costing**

A cost accounting approach which captures overhead and other indirect costs as separate from unit costs for a given period, and then applies (absorbs) those costs into unit costs at the period end based on various factors such as movement and COGS elements

**Acceptable Quality Level (AQL)**

In quality assessment, acceptable quality level, also known as assured quality level, describes the maximum number of defects acceptable during the random sampling of an inspection

**Acceptable Sampling Plan**

A quality management procedure which defines the sample sizes and acceptable defect levels for validating quality of products.

**Acceptance Sampling**

A statistical quality control method which tests samples of products at defined points as opposed to testing each product.

**Accessibility**

The ability of a carrier to provide service between an origin and a destination

**Accessory**

A choice or feature added to the good or service offered to the customer for customizing the end product. An accessory enhances the capabilities of the product but is not necessary for the basic function of the product. In many companies, an accessory means that the choice does not have to be specified before shipment but can be added at a later date. In other companies, this choice must be made before shipment.

**Accreditation**

The process in which certification of competency, authority, or credibility is presented. An example of accreditation is the accreditation of testing laboratories and certification specialists that are permitted to issue official certificates of compliance with established standards.

**Accumulation bin**

An area where item to be used in assembly of a product are staged prior to work being done.

**Acquisition Cost**

The net price plus other costs needed to purchase the item and get it to the point of use. These other costs can include: the item's purchasing costs (closing, research, accounting, commissions and legal fees), transportation, preparation and installation costs.

**Action Plan**

A specific method or process to achieve the results called for by one or more objectives. An action plan may be a simpler version of a project plan.

**Active Inventory**

Materials held in a facility which are intended to be consumed in manufacturing / assembly, or sold in a specified period.

**Active Stock**

Goods in active pick locations and ready for order filling.

**Activity**

Work performed by people, equipment, technologies or facilities. Activities are usually described by the “action-verb-adjective-noun” grammar convention. Activities may occur in a linked sequence and activity-to-activity assignments may exist

**Activity Analysis**

The process of identifying and cataloging activities for detailed understanding and documentation of their characteristics. An activity analysis is accomplished by means of interviews, group sessions, questionnaires, observations, and reviews of physical records of work

### Activity Based Budgeting (ABB)

An approach to budgeting where a company uses an understanding of its activities and driver relationships to quantitatively estimate workload and resource requirements as part of an ongoing business plan. Budgets show the types, number of and cost of resources that activities are expected to consume based on forecasted workloads. The budget is part of an organization's activity-based planning process and can be used in evaluating its success in setting and pursuing strategic goals.

### Activity Based Planning (ABP)

Activity-based planning (ABP) is an ongoing process to determine activity and resource requirements (both financial and operational) based on the ongoing demand of products or services by specific customer needs. Resource requirements are compared to resources available and capacity issues are identified and managed. Activity-based budgeting (ABB) is based on the outputs of activity-based planning

### Activity-Based Management (ABM)

A discipline focusing on the management of activities within business processes as the route to continuously improve both the value received by customers and the profit earned in providing that value. ABM uses activity-based cost information and performance measurements to influence management action. See also: Activity-Based Costing

### Actual Demand

The known demand for a specific product based on customer orders and production orders which are open. Once an order is shipped or production is completed, specific demand quantity will become usage. Actual demand should be netted against any forecast for the same period, meaning that as orders are received they are considered to be part of an earlier forecast and forecasts should be considered as satisfied.

### Actual to Theoretical Cycle Time

The ratio of the measured time required to produce a given output divided by the sum of the time required to produce a given output based on the rated efficiency of the machinery and labor operations.

**Advance Material Request**

A request for materials which is created in advance of formal need due to long lead times for components, etc.

**Advanced Planning and Scheduling (APS)**

Refers to a manufacturing management process by which raw materials and production capacity are optimally allocated to meet demand. APS is especially well-suited to environments where simpler planning methods cannot adequately address complex trade-offs between competing priorities.

**Advanced Shipping Notice (ASN)**

Detailed shipment information transmitted by the shipper to a customer or consignee in advance of delivery, designating the contents (individual products and quantities of each) and nature of the shipment. In EDI data standards this is referred to as an 856 transaction. May also include carrier and shipment specifics including time of shipment and expected time of arrival. The ASN data can be valuable in providing digital knowledge about what is in a shipment in a way that it can be used to eliminate manual data entry of each shipment

**Aftermarket**

A market for parts and accessories used in the repair or enhancement of a product. A secondary market created after the original market sales are finished.

**Agency tariff**

A publication of a rate bureau that contains rates for many carriers.

**Agent**

An enterprise authorized to transact business for, or in the name of, another enterprise.

**Aggregate Inventory**

The total inventory available for any given product across multiple locations and/or multiple stock-keeping units.

**Aggregate Plan**

A plan for the production process, 2 to 18 months in advance to give management an idea to of what quantity of materials and other resources are to be procured and when, so that the total cost of operations of the organization is kept to the minimum over that period.

**Aggregate Planning**

An operational activity which compiles an aggregate plan for the production process.

**Agile Manufacturing**

Tools, techniques, and initiatives that enable a plant or company to thrive under conditions of unpredictable change. Agile manufacturing not only enables a plant to achieve rapid response to customer needs, but also includes the ability to quickly reconfigure operations-and strategic alliances-to respond rapidly to unforeseen shifts in the marketplace. In some instances, it also incorporates "mass customization" concepts to satisfy unique customer requirements. In broad terms, it includes the ability to react quickly to technical or environmental surprises.

**Air Cargo**

Refers to freight that is moved via air transportation.

**Air Cargo Containers**

Containers designed to conform to the inside of an aircraft. There are many shapes and sizes of containers. Air cargo containers fall into three categories: 1) air cargo pallets 2) lower deck containers 3) box type containers.

**Air Taxi**

An exempt for-hire air carrier that will fly anywhere on demand: air taxis are restricted to a maximum payload and passenger capacity per plane.

**All-cargo carrier**

An air carrier that transports cargo only.

**American Customer Satisfaction Index (ACSI)**

Released for the first time in October 1994, an economic indicator and cross industry measure of the satisfaction of U.S. household customers with the quality of the goods and services available to them-both those goods and services produced within the United States and those provided as imports from foreign firms that have substantial market shares or dollar sales. The ACSI is co-sponsored by the University of Michigan Business School, ASQ and the CFI Group.

**American National Standards Institute (ANSI)**

A non-profit organization chartered to develop, maintain, and promulgate voluntary U.S. national standards in a number of areas, especially with regards to setting EDI standards. ANSI is the U.S. representative to the International Standards Organization (ISO).

**American Society for Quality (ASQ)**

A professional organization with more than 100,000 members which advances learning, quality improvement, and knowledge exchange to improve business results, and to create better workplaces and communities worldwide.

**American Society of Transportation & Logistics**

A professional organization in the field of logistics.

**American Trucking Association, Inc. (ATA) :**

A motor carrier industry association that is made up of sub conferences representing various sectors of the motor carrier industry.

**Anti-Dumping Duty**

An additional import duty imposed in instances where imported goods are priced at less than the normal price charged in the exporter's domestic market and cause material injury to domestic industry in the importing country.

**Anticipation Inventories**

Extra stocks of inventory which are being held above known requirement in order to accommodate trends or promotions. May also be used to hedge against risk of supply problems.

**Appointment Freight**

Shipments which are held at the carrier's terminal to be delivered at a specific date and time. Typically this occurs when a shipment is received by the carrier facility 1 or more days prior to the agreed upon delivery schedule. The shipment cannot immediately be delivered and must be held at the facility.

**Assembly Line**

A manufacturing process where products are completed from components as a result of a series of continuous activities. Henry Ford is widely recognized as the father of the assembly line.

**Assignment**

A distribution of costs using causal relationships. Because cost causal relationships are viewed as more relevant for management decision-making, assignment of costs is generally preferable to allocation techniques. Synonym: Tracing Contrast with: Allocation

**Available Inventory**

Also called net inventory, this is the quantity of stock which is available to use after considering allocations, reservations, backorders, and quantities set aside to compensate for quality problems. Synonym: Net Inventory Synonym: Available-to-Promise

**Available to Promise (ATP)**

The quantity of a product which is or will be available to promise to a customer based on their required shipment date. ATP is typically 'time phased' to allow for promising delivery at a future date based on anticipated purchase or production receipts.

**Average Annual Production Materials Related A/P (Accounts Payable)**

The value of direct materials acquired in that year for which payment has not yet been made. Production-related materials are those items classified as material purchases and included in the Cost of Goods Sold (COGS) as raw material purchases. Calculate: Calculate: Use the 5-point Annual Average

**Back Order**

Product which has been ordered by a customer but out of stock and promised to ship when the product becomes available.

**Backorder**

1) The act of retaining a quantity to ship against an order when other order lines have already been shipped. Backorders are usually caused by stock shortages. 2) The quantity remaining to be shipped if an initial shipment(s) has been processed. Note: In some cases backorders are not allowed, this results in a lost sale when sufficient quantities are not available to completely ship and order or order line. See also: Balance to Ship

**Backsourcing**

The process of recapturing and taking responsibility internally for processes that were previously outsourced to a contract manufacturer, fulfillment or other service provider. Backsourcing typically involves the cancellation or expiration of an outsourcing contract and can be nearly as complex as the original outsourcing process.

**Balance to Ship (BTS)**

Balance or remaining quantity of a promotion or order that has yet to ship. See also: Backorder

**Bar Code**

A symbol consisting of a series of printed bars representing values. A system of optical character reading, scanning, and tracking of units by reading a series of printed bars for translation into a numeric or alphanumeric identification code. A popular example is the UPC code used on retail packaging.

**Bar code scanner**

A device to read bar codes and communicate data to computer systems.

**Base Stock System**

An inventory system in which a replenishment order is issued each time a withdrawal is made, and the order quantity s equal to the amount of the withdrawal. . This type of system is also referred to as a par- stock system (bringing stock back to par level).

**Batch Processing**

A computer term which refers to the processing of computer information after it has been accumulated in one group, or batch. This is the opposite of “real-time” processing where transactions are processed in their entirety as they occur.

**Belly Cargo**

Air freight carried in the belly of passenger aircraft.

**Benchmarking**

The process of comparing performance against the practices of other leading companies for the purpose of improving performance. Companies also benchmark internally by tracking and comparing current performance with past performance. Benchmarking seeks to improve any given business process by exploiting "best practices" rather than merely measuring the best performance. Best practices are the cause of best performance. Studying best practices provides the greatest opportunity for gaining a strategic, operational, and financial advantage.

**Bill of Lading**

A bill of lading that covers goods from point of origin to final destination, when interchange or transfer from one carrier to another is necessary to complete the journey.

**Bill of Lading (BOL)**

A transportation document that is the contract of carriage containing the terms and conditions between the shipper and carrier.

**Bill of Material (BOM)**

A structured list of all the materials or parts and quantities needed to produce a particular finished product, assembly, subassembly, or manufactured part, whether purchased or not.

**Bill of Resources**

A listing of resources required by an activity. Resource attributes could include cost and volumes.

**Bin**

An inventory location which is typically a box or tray used to hold quantities of smaller parts.

**Bin Location**

A generic term which may be used to identify the actual physical location where a product is stored. See also: Warehouse Location

**Block Stacking**

A storage method which uses no formal racking or shelves to contain the products. Items to be stored (pallets, cases or cartons) are stacked upwards from the floor surface to whatever height is practical.

**Bonded Warehouse**

Warehouse approved by the Customs or Treasury Department and under bond/guarantee for observance of revenue laws. Used for storing goods until duty is paid or goods are released in some other proper manner. In many cases the bonded warehouse is a building adjacent to the main warehouse, or a separate secure area within the main warehouse. Incoming goods should be received to this location as usual, but flagged as in quarantine or quality hold.

**Break-Even Point**

A chart which graphically represents the point at which cost or expenses and revenue are equal: there is no net loss or gain, and one has "broken even". See also: Total Cost Curve

**Bullwhip Effect**

Also known as “Whiplash Effect” it is an observed phenomenon in forecast-driven distribution channels. The oscillating demand magnification upstream a supply chain is reminiscent of a cracking whip. The concept has its roots in J Forrester's Industrial Dynamics (1961) and thus it is also known as the Forrester Effect.

**Business Intelligence**

The set of skills, technologies, applications and practices used to help a business acquire a better understanding of its commercial context to make better business decisions.

**Business Logistics**

The systematic and coordinated set of activities required to provide the physical movement and storage of goods (raw materials, parts, finished goods) from vendor/supply services through company facilities to the customer (market) and the associated activities-packaging, order processing, etc.-in an efficient manner necessary to enable the organization to contribute to the explicit goals of the company.

**Business Performance Measurement (BPM)**

A technique which uses a system of goals and metrics to monitor performance. Analysis of these measurements can help businesses in periodically setting business goals, and then providing feedback to managers on progress towards those goals. A specific measure can be compared to itself over time, compared with a preset target or evaluated along with other measures.

**Capacity Management**

The concept that capacity should be understood, defined, and measured for each level in the organization to include market segments, products, processes, activities, and resources. In each of these applications, capacity is defined in a hierarchy of idle, non-productive, and productive views.

**Cargo**

Subject of a shipment. The materials being carried.

**Carriage and Insurance Paid To (CIP)**

This term is used primarily for multimodal moves and is the same as CPT, except the seller must also purchase cargo insurance in the buyer's name.

**Carriage Paid To (CPT)**

Similar to CIF, except that the buyer pays for insurance. The seller, however, is responsible for export clearance.

**Carrier**

A firm which transports goods or people via land, sea or air

**Catalog Channel**

A call center or order processing facility that receives orders directly from the customer based on defined catalog offerings and ships directly to the customer.

**Certified Supplier**

A supplier who has demonstrated the ability to consistently meet established quality, cost, delivery, financial, and count objectives, and has therefore been awarded the “certified” designation. Suppliers in this group may be able to bypass incoming quality inspection.

**Collaborative Planning, Forecasting and Replenishment (CPFR®)**

A concept that aims to enhance supply chain integration by supporting and assisting joint practices. CPFR seeks cooperative management of inventory through joint visibility and replenishment of products throughout the supply chain. Information shared between suppliers and retailers aids in planning and satisfying customer demands through a supportive system of shared information. This allows for continuous updating of inventory and upcoming requirements, essentially making the end-to-end supply chain process more efficient. Efficiency is also created through the decrease expenditures for merchandising, inventory, logistics, and transportation across all trading partners.

**Collect Freight**

Freight payable to the carrier at the port of discharge or ultimate destination. The consignee does not pay the freight charge if the cargo does not arrive at the destination.

**Commercial Invoice**

A document created by the seller. It is an official document which is used to indicate, among other things, the name and address of the buyer and seller, the product(s) being shipped, and their value for customs, insurance, or other purposes.

**Common Carrier**

Any carrier engaged in the interstate transportation of persons/property on a regular schedule at published rates, whose services are for hire to the general public.

**Competitive Benchmarking**

The practice of comparing and rating a company's products or services against those of competitors.

**Complete Manufacture to Ship Time**

Average time from when a unit is declared shippable by manufacturing until the unit actually ships to a customer.

**Computer-Aided engineering (CAE)**

The use of computers to model design options to stimulate their performance.

**Computer-Aided Manufacturing (CAM)**

Computerized systems in which manufacturing instructions are downloaded to automated equipment or to operator workstations.

**Computer-Integrated Manufacturing (CIM)**

A variety of approaches in which computer systems communicate or interoperate over a local-area network. Typically, CIM systems link management functions with engineering, manufacturing, and support operations. In the factory, CIM systems may control the sequencing of production operations, control operation of automated equipment and conveyor systems, transmit manufacturing instructions, capture data at various stages of the manufacturing or assembly process, facilitate tracking and analysis of test results and operating parameters, or a combination of these.

**Configuration Excellence**

Focuses on establishing and maintaining consistency of a product or service's performance. It also looks at the functional and physical attributes of a product with its requirements, design, and operational information throughout the product's life.

**Confirming Order**

A document similar to, or same as a purchase order, which is provided to a supplier as confirmation of a previous verbal purchase request.

**Consignee**

The party to whom goods are shipped and delivered. The receiver of a freight shipment.

**Consignment**

The act of consigning—placing a person or thing in the possession of another, but retaining ownership until the goods are sold. This may apply to shipping or sale in a store (i.e., a consignment shop). See also: Consignment Inventor

**Consignment Inventory**

Goods or product that are paid for when they are sold by the reseller, not at the time they are shipped to the reseller. 2) Goods or products which are owned by the vendor until they are sold to the consumer.

**Consignor**

The party who originates a shipment of goods (shipper). The sender of a freight shipment, usually the seller.

**Consular Invoice**

A document, required by some foreign countries, describing a shipment of goods and showing information such as the consignor, consignee, and value of the shipment. Certified by a consular official of the foreign country, it is used by the country's custom

**Consumer Packaged Goods (CPG)**

Consumable goods such as food and beverages, footwear and apparel, tobacco, and cleaning products. In general, CPGs are things that get used up and have to be replaced frequently, in contrast to items that people usually keep for a long time, such as cars and furniture.

**Container**

A "box," typically 10 to 40 feet long, which is primarily used for ocean freight shipments. For travel to and from ports, containers are loaded onto truck chassis or on railroad flatcars. 2) The packaging, such as a carton, case, box, bucket, drum, bin, bottle, bundle, or bag, that an item is packed and shipped in.

**Continuous Flow Manufacturing**

A production system organized and sequenced according to the steps involved in the manufacturing process where the product moves seamlessly and continuously through the entire manufacturing process.

**Continuous Improvement (CI)**

A structured measurement driven process that continually reviews and improves performance.

**Continuous Order Release**

A process for releasing orders as soon an order is available, versus releasing all orders in batches at specific times.

**Continuous Replenishment**

Continuous Replenishment is the practice of partnering between distribution channel members that changes the traditional replenishment process from distributor-generated purchase orders, based on economic order quantities, to the replenishment of products based on actual and forecasted product demand.

**Continuous Replenishment Planning (CRP)**

A program that triggers the manufacturing and movement of product through the supply chain when the identical product is purchased by an end user

**Contract Carrier**

Carrier engaged in interstate transportation of persons/property by motor vehicle on a for-hire basis, but under continuing contract with one or a limited number of customers to meet specific needs.

**Contract Line Items Number (CLIN)**

Specific items or services separately priced under a contract.

**Contract Manufacturing**

A relationship where a third party manufactures products that are packaged under another company's label.

**Contract Provisions**

Stipulations typically located at the end of the contract document, specifying how the parties to the contract should govern their relationship and administer the contract.

**Contractor**

One that agrees to furnish materials or services at a specified price

**Contractor Logistics Support (CLS)**

A term in performance based logistics which refers to support in which maintenance operations for a particular military system are performed exclusively by contract support personnel.

**Controllable Returns**

These are errors or problems caused by the company or a member of the company’s supply chain and often can be resolved by the company. Example of errors or problems are picking and packing errors, improper forecasting, product handling, poor quality control and lack of communication with customers.

**Coordinated transportation**

Two or more carriers of different modes transporting a shipment.

**Costs per Unit Moved**

A measure to calculate the cost of moving one unit of product. Calculation [Total Costs to Move Units] / [Total Number of Units Moved]

**Gross Inventory**

Value of inventory at standard cost before any reserves for excess and obsolete items are taken.

**Gross Margin**

The amount of contribution to the business enterprise, after paying for direct-fixed and direct- variable unit costs, required to cover overheads (fixed commitments) and provide a buffer for unknown items. It expresses the relationship between gross profit and sales revenue.

**Gross National Product (GNP)**

A measure of a nation's output; the total value of all final goods and services produced during a period of time.

**Handling Costs**

The cost involved in moving, transferring, preparing, and otherwise handling inventory.

**Inbound logistics**

The management of materials from suppliers and vendors into production processes or storage facilities.

**Less-Than-Truckload (LTL)**

Trucking companies that consolidate and transport smaller (less than truckload) shipments of freight by utilizing a network of terminals and relay points.

**Logistics**

The process of planning, implementing, and controlling procedures for the efficient and effective storage of goods, services, and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements. This definition includes inbound, outbound, internal, and external movements.

**Logistics Channel**

The network of supply chain participants engaged in storage, handling, transfer, transportation, and communications functions that contribute to the efficient flow of goods

**Production Lead Time**

The time taken to manufacture or produce an item after an external order has been received until the item is available for packing.

**Reorder Costs**

The total cost of placing a repeat order for an item either externally on a supplier or for internal manufacture. The costs may include elements to cover: order preparation, administration, IT overheads, correspondence, telephone, transportation, goods inward processing, inspection and for manufacture, batch et up costs and other production overheads

**Reverse logistics**

Reverse logistics is for all operations related to the reuse of products and materials. It is "the process of moving goods from their typical final destination for the purpose of capturing value, or proper disposal.

**Routing**

A process of optimizing transport delivery routes to make better use of time and capacity to reduce overall costs. This type of fleet optimization is generally supported with specialist software tools

## Safety Stock

Safety stock is an additional quantity of an item held in the inventory in order to reduce the risk that the item will be out of stock, safety stock act as a buffer stock in case the sales are greater than planned and/or the supplier is unable to deliver the additional units at the expected time.

## Sales forecasting

Sales forecasting is the process of estimating future sales. Accurate sales forecasts enable companies to make informed business decisions and predict short-term and long-term performance. Companies can base their forecasts on past sales data, industry-wide comparisons, and economic trends.

## Transit Time

The time taken to move goods physically between different locations in a supply chain or laterally to another facility.

**What is Inbound Transportation and its process?**

Inbound Transportation - You should choose a logistics management service provider who will give out quotes for the inbound transportation costs of components - This might include the delivery of individual components to your production line - For a better price comparison, you may also ask if they can deal with clients who buy some or all of their components from a particular supplier - You can look for cost and time frame quotations that you can use to consider the service provider that is most cost-effective

**What is Out-bound transportation and how it is managed?**

Outbound Transportation Outbound transportation refers to the carriers who meet the customer's needs. Different clients need various freight and carrier services, and a logistics management service provider should be able to provide these individual needs. The deal can either be on an over-all operational basis, or on a per-shipment basis. This provides a comprehensive solution for a company's primary need for logistics. Choose a logistics management service provider who will provide rate comparisons from different couriers to meet and handle the customer's goals. The main point here is that you need to have somebody to handle and ship out your main products in a safe and timely manner.

**What are consequences for an organization for NOT having a sound logistic system?**

Without great logistic management, your customers might not receive their orders on time. Worse yet, they might receive the wrong order, due to accounting or tracking errors. All of these mistakes damage your reputation and a company with a history of poor logistics rarely lasts long. When you’re competing in a specific niche area, this is a stigma that you simply cannot risk getting associated with your brand

**What is Logistics Management?**

Logistics Management is a component of supply chain management that deals with meeting customer demands through planning, controlling and implementing efficient movement and storage of relevant information, goods & services from origin of production to final destination

**What is transportation management?**

The transportation management deals with operations related to transportation like tracking and managing vehicle maintenance, warehousing, fuel management, communications, routing, mapping, cargo handling and selection activities

**What benefits can be reaped after studying this course?**

After studying this course, the students will be able to understand about different functional areas of Transportation & Logistic Management which are being practiced in manufacturing industries and the services sector. It includes fulfilling customer demands, ordering and managing inventory, reducing costs, saving time, controlling inbound and outbound shipments while meeting the company overall business objectives. The course will equip you with logistic functions as well as will let you know about different strategies and tactics to achieve business excellence

**Please tell me what this entire course is about?**

This course will give you a comprehensive view of different elements of Transportation & Logistic Management like physical distribution, inventory management, warehouse management, order fulfillment, material handling, packaging, customer service, bar codes and transportation modes will also be discussed in this course