

Transportation in a Supply Chain

حمل و نقل در زنجیره تأمین



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Outline

- Importance of Transportation
- Factors Affecting Transportation Decisions
- Key modes of transport and major issues
- Transportation Costs
- Transportation System Design

Importance of Transportation

- USA Freight in 2006: US \$1.4 trillion, ~ 10 % of GDP
 - Employs 22 million people, 16% of all workers
- Accessibility to markets
- Greater competition
 - more distant markets can be served
- Economies of scale (Video)
 - wider markets => greater production volume
 - production points need not be close to markets
- Lower prices
 - increased competition among suppliers
 - lower production and transportation costs
- E-Commerce: managing (global) transportation costs is crucial
 - Dell Computers? IKEA?

* US Bureau of Transportation Statistics

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Factors Affecting Transportation Decisions

- | | |
|---|---|
| <ul style="list-style-type: none"> ■ Carrier شرکت حمل و نقل
(party that performs the move) <ul style="list-style-type: none"> ■ investment decisions ■ operating policies ■ Costs considerations: <ul style="list-style-type: none"> ■ Vehicle-related: Type? Number? ■ Fixed operating: e.g. Terminal facilities ■ Trip-related: labour and fuel ■ Quantity-related: loading/unloading ■ Overhead: planning/scheduling, information technologies ■ Capacity utilisation ■ Responsiveness/Service level offered | <ul style="list-style-type: none"> ■ Shipper شرکت دارنده کالا
(party requiring movement of goods) <ul style="list-style-type: none"> ■ supply chain design ■ transportation mode choice ■ assignment of shipment to transportation mode ■ Cost considerations: <ul style="list-style-type: none"> ■ Transportation: paid to carriers ■ Inventory: at intermediate warehouses, retailers, etc. ■ Facility: e.g. warehouse operating costs ■ Processing: loading/unloading, invoicing, etc. ■ Service level: expediting, safety stock, etc. ■ Responsiveness; Delivery guarantees |
|---|---|

e.g. Dell uses UPS to ship the products from factory to clients.

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Transportation Modes (USA)

Mode	Freight Value in 2002 ^a (\$ billions)	Intercity Ton-miles in 2002 ^a (billions)	Intercity Tonnage ^a (millions)	Revenue / Ton-mile ^b	Average haul length 2002 ^a (miles per ton)
Air	777	15	10	61.20	1429
Truck	6,660	1,449	9197	9.13	158
Multimodal	1,111	226	213		1061
Rail	388	1,254	1,895	2.28	662
Water	867	733	2,345	0.74	313
Pipeline (Oil)	285	753	1,656	1.46	455

^a U.S. Bureau, Statistical Abstract of the United States: 2002

^b Ballou, *Business Logistics Management*, 5th edition, 2004

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Air

- Expensive
 - (2 x truck, 20 x rail)
- High security
- Size of shipment constrained (small, high-value items or time-sensitive emergency shipments)
 - hold space and lifting capabilities
- Key Issues
 - Location/Number of hubs
 - Location of fleet bases / crew bases
 - Schedule optimization
 - Fleet assignment
 - Crew scheduling
 - Maintenance scheduling for planes
 - Yield management

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Package Carriers

- Companies like FedEx, UPS, USPS, that carry small packages ranging from letters to shipments of about 68 kg
- Expensive
- Rapid and reliable delivery
- Small and time-sensitive shipments
- Preferred mode for e-businesses (e.g., Amazon, Dell, McMaster-Carr)
- Consolidation of shipments (especially important for package carriers that use **air** as a primary method of **transport**)

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Truckload (TL)

- Average Capacity = 19,000 - 22,700 kg.
 - Smaller dispatch lots (compared with rail)
- Low fixed cost
 - carriers do not own or maintain roads
- Door-to-door convenience
- Good speed and frequency (small dispatch lots)
- Cannot carry large loads
- Major Issues
 - Utilization
 - Backhauls (برگشت وسیله نقلیه به شرکت (منزل) بعد از تحویل بار به مقصد)

سوال: استفاده از این مد کجا مناسب است؟

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Less Than Truckload (LTL)

- Higher fixed costs (terminals) and low variable costs
- Average Capacity = 68 - 9,072 kg
- Major Issues
 - Location of consolidation facilities
 - Utilization
 - Order assignment/loading
 - Vehicle routing and scheduling
 - Utilization vs. delivery-time and reliability

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Rail

- Long haul (avg. 720 miles)
- Slow mover (22 mph, 64 miles per day)
- Large load: Average load = 80 tons
- carload, less-than-carload, multiple carload
- consolidation, stop-off, re-route
- High fixed costs, low variable costs
- Key Issues
 - Scheduling to minimize delays / improve service
 - Off track delays (at pick up and delivery end)
 - Yard operations (switching of multiple shipments)
 - Variability of delivery times

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Pipeline

- limited capabilities: crude oil, water, refined petroleum products, natural gas
- Would be used for getting crude oil to a port or refinery, but not for getting refined gasoline to a gasoline station (why?)
- slow (3-4 mph)
- high capacity
 - 3 mph, 12-in pipe = 90,000 gal/hr
- reliable, low risk of disruption and damage
- 24-hour service
- high fixed costs
 - pipes, pumping equipment
 - own or lease right-of-way
- Variable costs
 - pump operation
 - depends on throughput and pipe diameter
 - loss through seepage

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Water - Inland and Coastal

- Limited to certain geographic areas
- heavy , bulk commodities
- slow
- affected by weather (freezing, floods)
- Fixed costs
 - mainly transport equipment
 - waterways and harbours publicly owned
 - terminal costs: harbour fees, loading/unloading(high costs if not containerised)
- Variable costs (low)
 - no charge for use of waterways
- Dominant in global trade (autos, grain, apparel, etc.)

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Containerised Freight (COFC)

- first trip:
 - trailers on a WWII tanker from New Jersey to Texas in 1956
- soon after:
 - specially converted ships to stack van-sized boxes on deck
- now:
 - world container fleet capacity 19.3 million TEUs (2004)
 - 75% of US ocean merchandising trade
 - 70 % by weight of cargo movement of Hong Kong
 - mega-ships: *Gudrun Maersk* (world's largest): 8,500 TEUs, 1204 ft. long, 140 ft. wide (30 ft. wider than Panama Canal)
- standard size avoids re-handling
 - 8 x 8 x 20 (TEU)
 - 8 x 8 x 40 or 8 x 8 x 45
- containerised air freight gaining popularity

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Intermodal Transport

- Truck-Rail TOFC
- Truck-water RORO

Trailer on Flat Car (TOFC)

- long haul cost economy of rail
- convenience and accessibility of trucks at origin/destination
- shipper: door-to-door service at lower than truck rates
- rail: more business
 - 17-fold increase 1960-1996
 - now 55% of rail loading in USA

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International Transportation

- Mainly by Water (Container)
 - over 50% by value
 - 99% by weight
- By Air: 21% by value
- 6.76 billion tons shipped seaborne in 2004
- Complexities:
 - customs documentation
 - limited entry/exit points to a country
 - limited carrier liability
 - increased protective packaging

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Transportation Costs

- ~ 63% of total logistics expenditures
- Fixed Costs
 - road/railway acquisition and maintenance, terminal facilities, transport equipment, carrier administration
- Variable Costs
 - fuel, labour, equipment maintenance, handling, pickup and delivery
- Cost Allocation Difficult
 - By shipment? Weight? Volume?
 - Insurance value? Delivery guarantees?

Back Haul Costs?

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Tradeoffs in Transportation Design

- Transportation, facility, and inventory cost tradeoff
 - Choice of transportation mode
 - Inventory aggregation
- Transportation cost and responsiveness tradeoff

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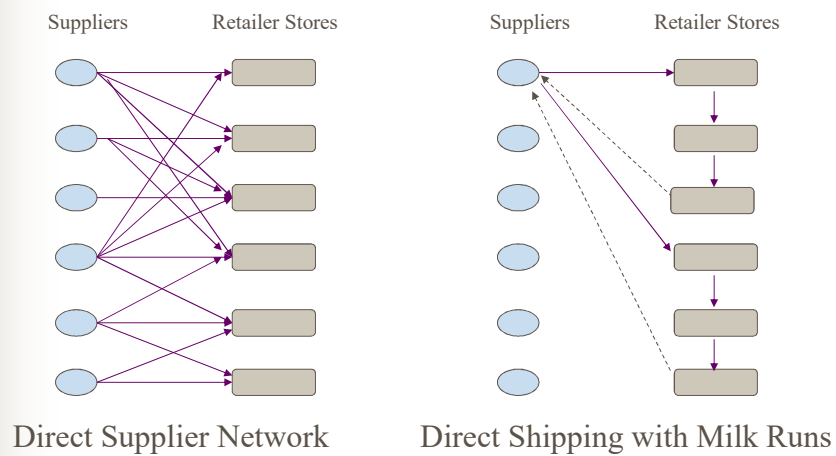
Transportation Network Design

- Direct Shipment Network
 - Delivery direct from a supplier to a retailer
- Direct Shipment with Milk Runs
 - Delivery from single supplier to several retailers
- Central Distribution Centre (DC)
 - Suppliers ship only to DC
 - DC ship direct to retailers
- Central Distribution Centre with Milk Runs

Tradeoffs? Number and location of DC's?

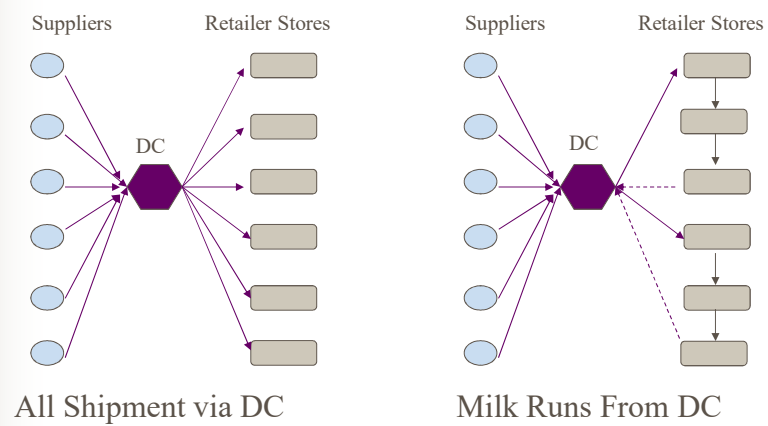
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Transportation Network Designs



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Transportation Network Designs



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Network Design Tradeoffs

- Direct Shipment Network
 - Simple operation
 - Delivery Lot-size ~ truckload
 - High inventories
 - High loading/unloading costs
- Direct Shipment with Milk Runs
 - Small lot-size per retailer
 - Increased co-ordination complexity
- Central Distribution Centre (DC)
 - Inventory consolidation/disaggregation
 - Transfer point (allow transportation mode change)
 - Lower in-bound transportation costs
- Central Distribution Centre with Milk Runs
 - Increased co-ordination complexity

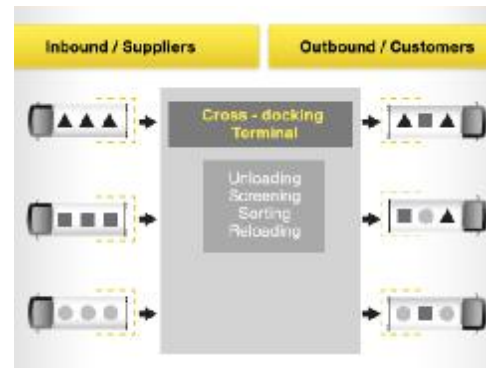
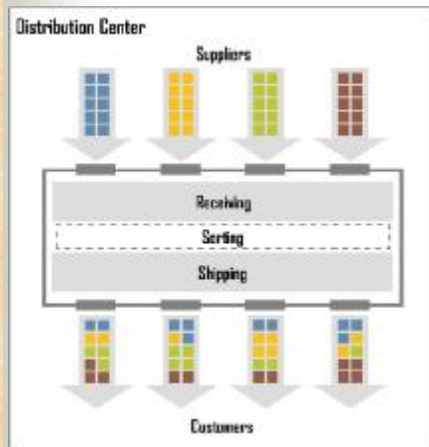
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Cross-docking

- Inbound goods transferred directly into outbound vehicles without being stored in DC
 - Disaggregate goods from one supplier to several retailers
 - Aggregate different goods from respective suppliers to one retailer
 - Economies of scale (both in- and out-bound)
- Wall-Mart has uses Cross-Docking to decrease inventories.

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Cross-docking



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Tailored Network

- Use combination of options to reduce costs and improve responsiveness
- High volume: ship direct
- Low volume: consolidate in DC

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Summary of Learning Objectives

- Strengths and weaknesses of transport modes
- Choices of transportation networks
- Tradeoffs in transportation network design
- Tailored transportation networks

Reference: Chopra & Meindl, *Supply Chain Management, Ch.13: Transportation in a Supply Chain, 2004, Prentice-Hall.*

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