

# Transportation risk management

# The Role of Transportation in a Supply Chain

- Movement of products from one location to another
- Products are rarely produced and consumed in the same location
- Significant cost component
- Shipper requires the movement of the product
- Carrier moves or transports the product
- Owner of the infrastructure
- Bodies setting transportation policies
- Seven-Eleven Japan and Dell as examples
- UPS (charges on size and destination) vs. FedEx (charges only on size).

# Modes of Transportation and their Performance Characteristics

- Air
- Package carriers
- Truck
- Rail
- Water
- Pipeline
- Intermodal

# Modes of Transportation and their Performance Characteristics

<b>Mode</b>	<b>Freight Value (\$ billions) in 2002</b>	<b>Freight Tons (billions) in 2002</b>	<b>Freight Ton-Miles (millions) in 2002</b>	<b>Value Added to GNP (billion \$) in 2009</b>
Air (includes truck and air)	563	6	13	61.9
Truck	9,075	11,712	1,515	113.1
Rail	392	1,979	1,372	30.8
Water	673	1,668	485	14.3
Pipeline	896	3,529	688	12.0
Multimodal	1,121	229	233	

# Modes of Transportation and their Performance Characteristics: Air transport

- Small-high value or time-sensitive items that have to travel long distances
- Cost components
  - Fixed infrastructure and equipment
  - Labor and fuel
  - Variable – passenger/cargo
- Key issues
  - Location/number of hubs
  - Fleet assignment
  - Maintenance schedules
  - Crew scheduling
  - Prices and availability

# Modes of Transportation and their Performance Characteristics: Package carriers

- Small packages up to about 150 pounds
- Expensive
- Rapid and reliable delivery
- Door-to-door services
- Small and time-sensitive shipments
- Provide other value-added services (track order status)
- Consolidation of shipments a key factor (use of large sorting centers)
- E-commerce

# Modes of Transportation and their Performance Characteristics: Truck

- Significant fraction of the goods moved (door-to-door, shorter delivery time)
- Ideal for transportation between manufacturing sites and warehouses or between suppliers and manufacturers
- Truckload (TL)
  - Low fixed cost
  - Imbalance between flows
- Less than truckload (LTL)
  - Small lots
  - Hub and spoke system
  - May take longer than TL

# Modes of Transportation and their Performance Characteristics: rail

- Move commodities over large distances
- Large, heavy or high-density products over long distances
- High fixed costs in equipment and facilities
- Scheduled to maximize utilization
- Transportation time can be long
  - Trains 'built' not scheduled

# Modes of Transportation and their Performance Characteristics: water

- Limited to certain geographic areas
- Ocean, inland waterway system, coastal waters
- Very large loads at very low cost
- Slowest
- Dominant in global trade
- Containers
- Demand for new vessels, faster and more specialized
- Ports congestion

# Modes of Transportation and their Performance Characteristics: pipeline

- High fixed cost
- Primarily for crude petroleum, refined petroleum products, natural gas
- Best for large and stable flows
- Appropriate for getting crude oil to a port or refinery
- Not appropriate for sending gasoline to a gas station!!
- Pricing structure encourages use for predictable component of demand

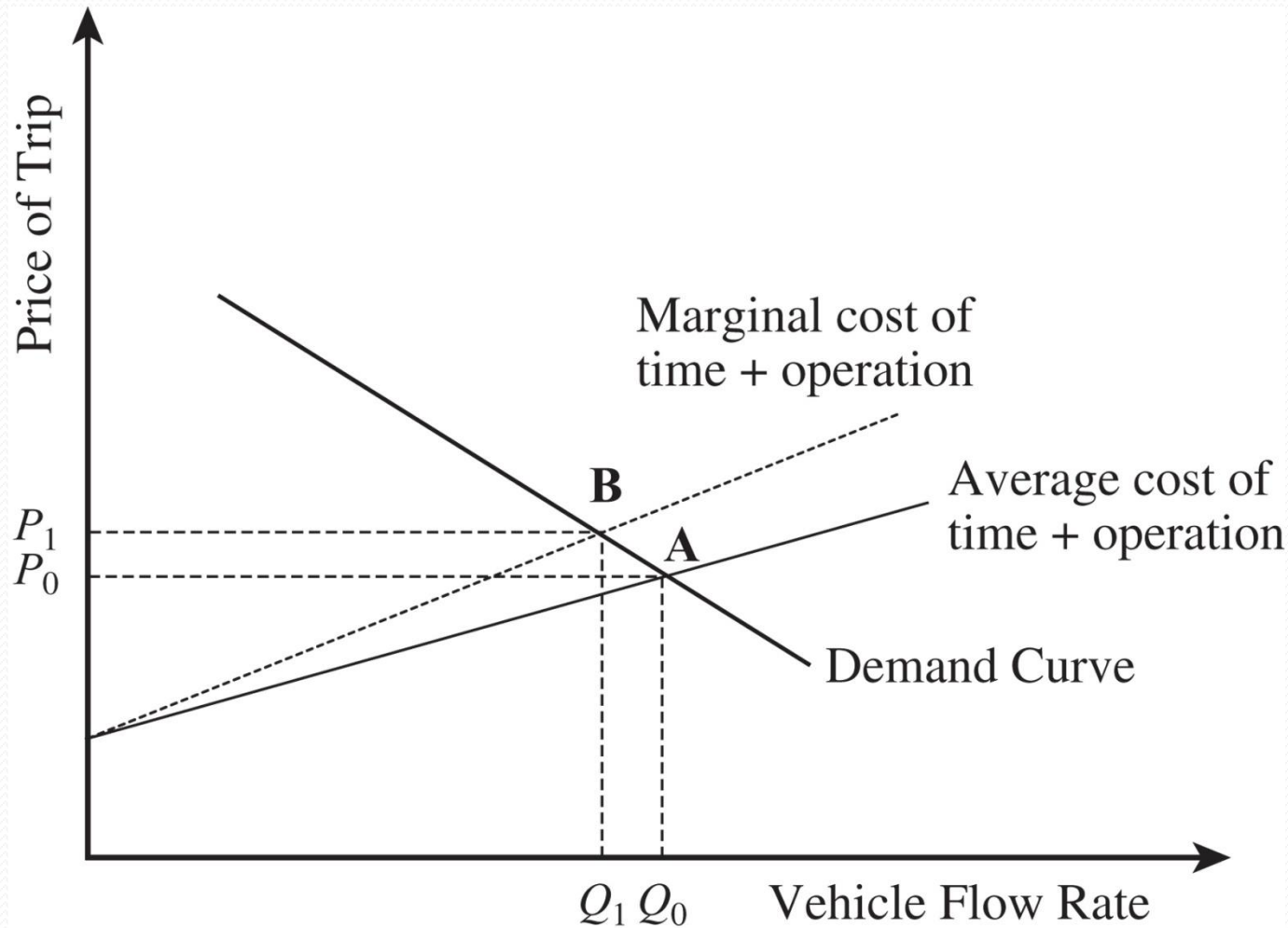
# Modes of Transportation and their Performance Characteristics: Intermodal

- Use of more than one modes of transportation to move a shipment
- Grown considerably with increased use of containers
- May be the only option for global trade
- More convenient for shippers – one entity
- Key issue – exchange of information to facilitate transfer between different modes

# Transportation Infrastructure and Policies

- Governments generally take full responsibility or play a significant role in building and managing infrastructure elements
- Without a monopoly, deregulation and market forces help to create an effective industry structure
- Pricing should reflect the marginal impact on the cost to society

# Transportation Infrastructure and Policies



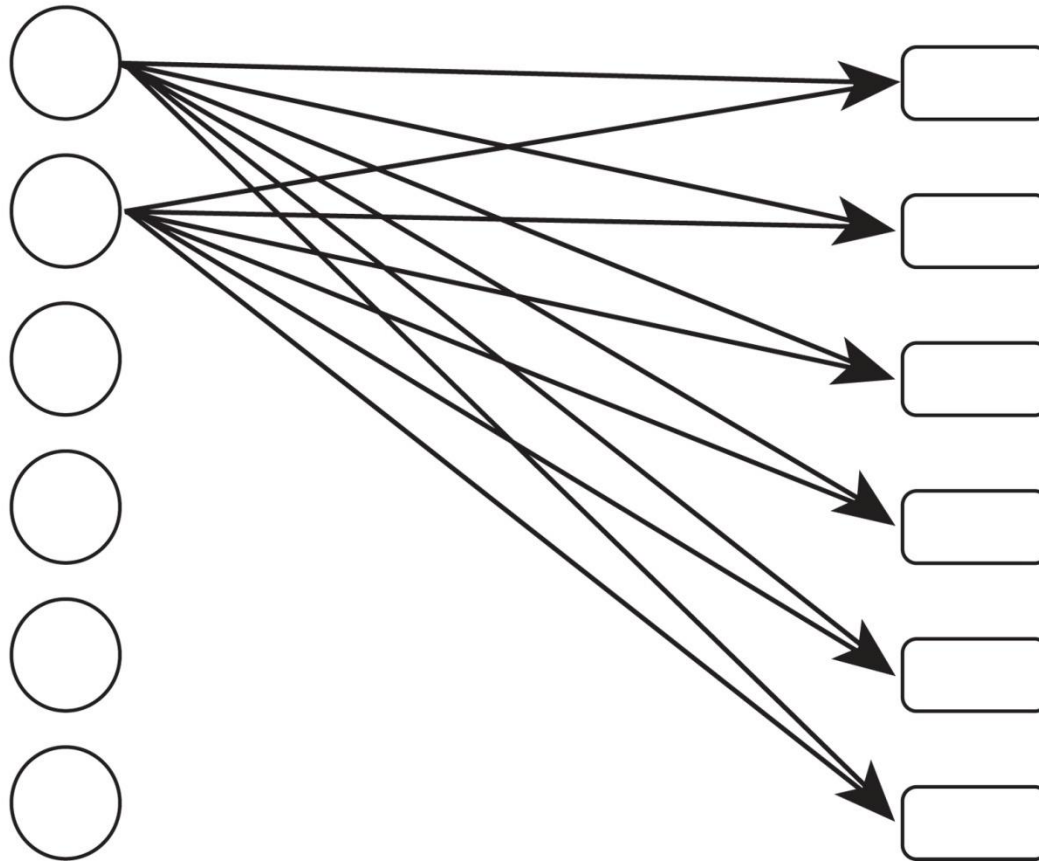
# Design Options for a Transportation Network

- When designing a transportation network
  - Should transportation be direct or through an intermediate site?
  - Should the intermediate site stock product or only serve as a cross-docking location?
  - Should each delivery route supply a single destination or multiple destinations (milk run)?

# Design Options for a Transportation Network

Suppliers

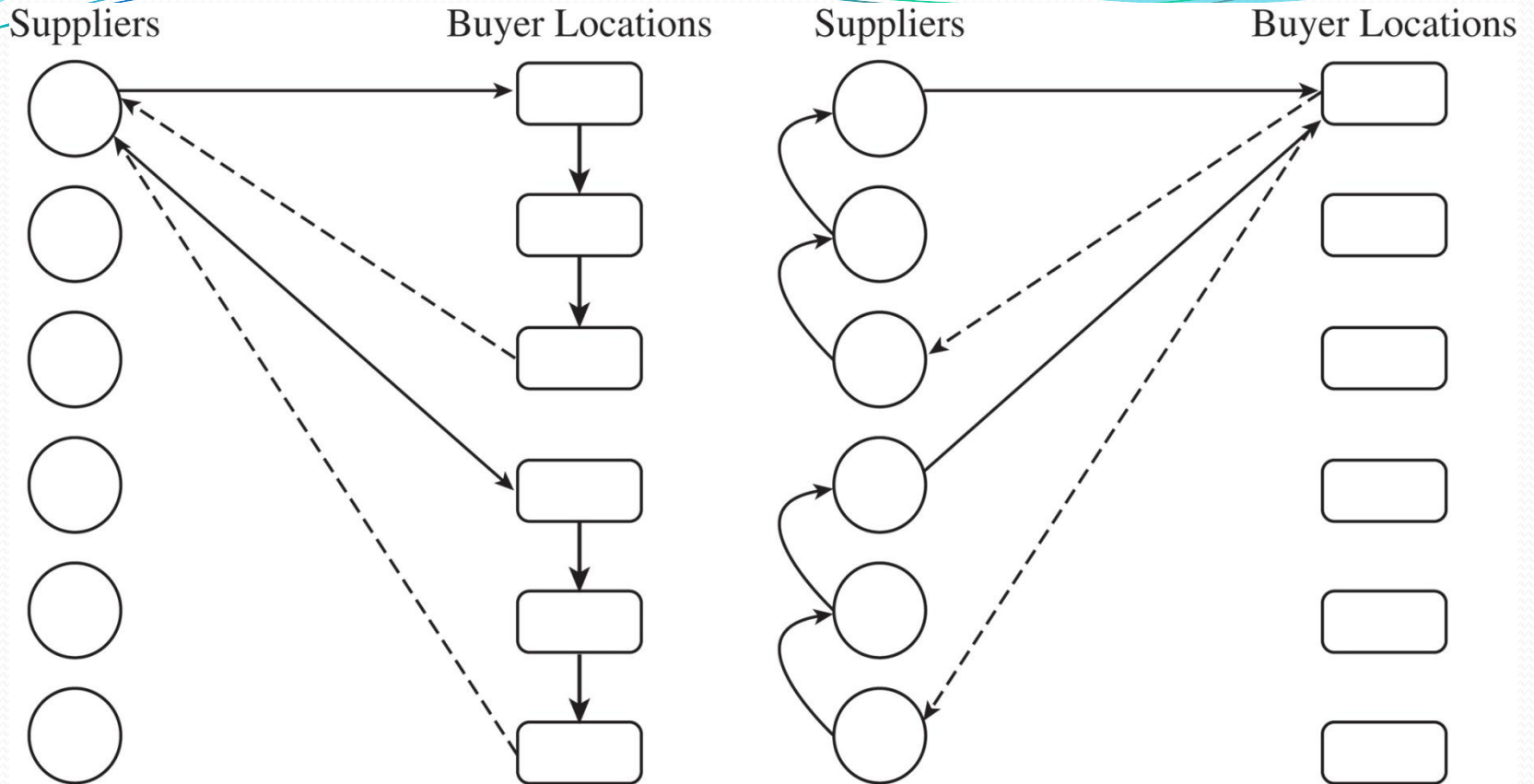
Buyer Locations



- Decisions on quantity and mode of transportation
- Elimination of intermediate warehouses
- Use of LTL, TL or package carriers, different costs incurred in inventory, transportation

**Direct Shipment Network to a Single Destination**

# Design Options for a Transportation Network

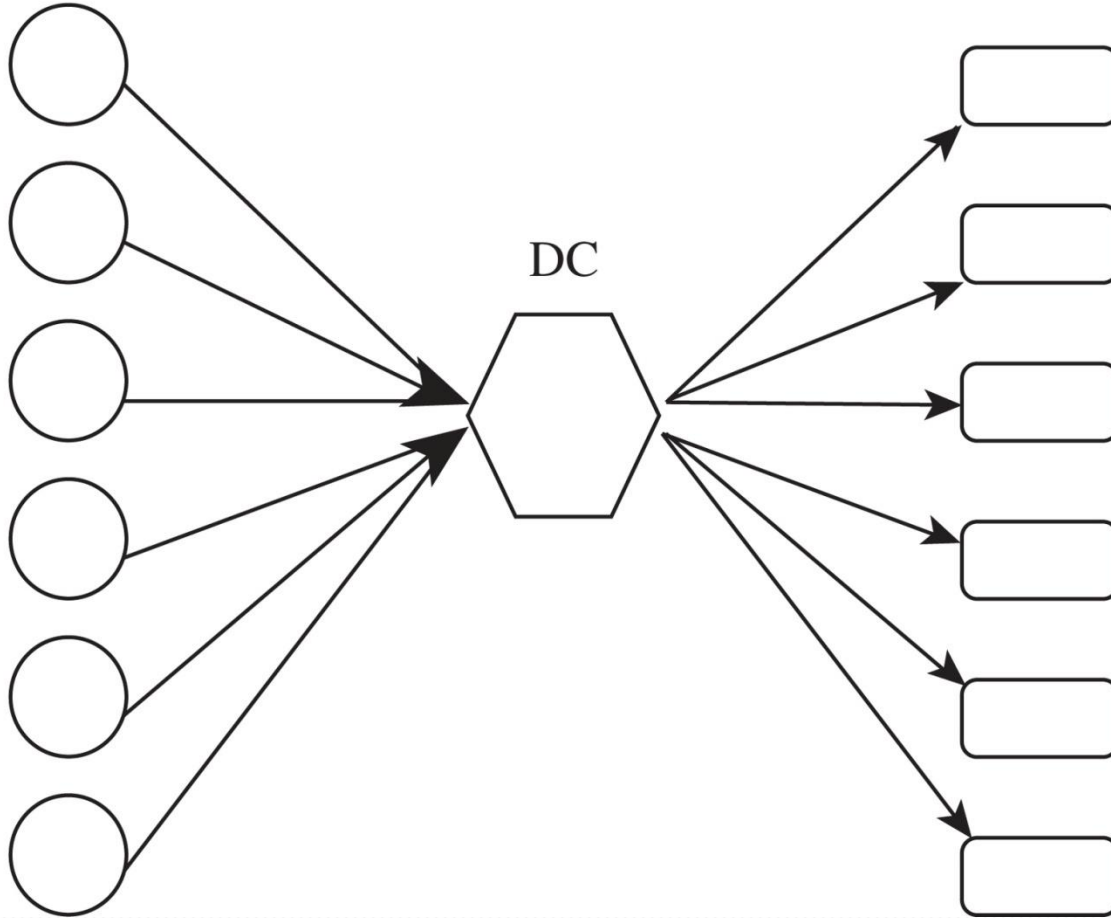


## Direct Shipping with Milk Runs

- Lower transportation cost by consolidating shipments to multiple locations on a single truck (truck utilization)
- Small, regular deliveries, geographic proximity
- Toyota as an example (US vs. Japan)

# Design Options for a Transportation Network

Suppliers



Buyer Locations

1. Geographic region to be served
2. DC serves as inventory facility and transfer location
3. Ideal when suppliers are located far from buyer locations
4. Economies of scale for inbound transportation

**All Shipments via Intermediate Distribution Center with Storage**

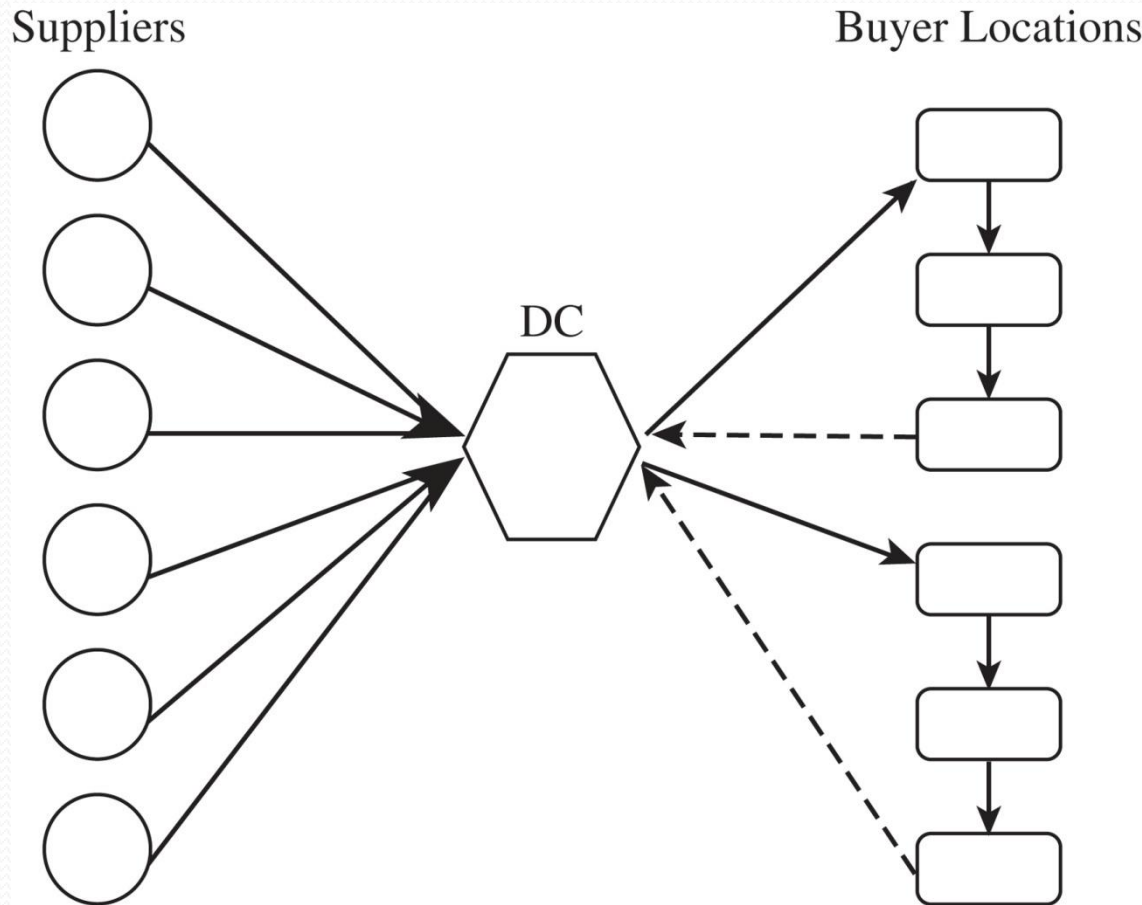
# Design Options for a Transportation Network

## All Shipments via Intermediate Transit Point with Cross-Docking

- Suppliers send their shipments to an intermediate transit point
- They are cross-docked and sent to buyer locations without storing them
- Ideal for products with large, predictable demand where DC's set up for inbound and outbound economies of scale



# Design Options for a Transportation Network



Shipping via DC Using Milk Runs

# Tailored Transportation

- The use of different transportation networks and modes based on customer and product characteristics
- Factors affecting tailoring
  - Customer density and distance
  - Customer size
  - Product demand and value

# Tailored Transportation

	<b>Short Distance</b>	<b>Medium Distance</b>	<b>Long Distance</b>
High density	Private fleet with milk runs	Cross-dock with milk runs	Cross-dock with milk runs
Medium density	Third-party milk runs	LTL carrier	LTL or package carrier
Low density	Third-party milk runs or LTL carrier	LTL or package carrier	Package carrier

# Tailored Transportation

<b>Product Type</b>	<b>High Value</b>	<b>Low Value</b>
High demand	Disaggregate cycle inventory. Aggregate safety inventory. Inexpensive mode of transportation for replenishing cycle inventory and fast mode when using safety inventory.	Disaggregate all inventories and use inexpensive mode of transportation for replenishment.
Low demand	Aggregate all inventories. If needed, use fast mode of transportation for filling customer orders.	Aggregate only safety inventory. Use inexpensive mode of transportation for replenishing cycle inventory.

# Pros and cons of different transportation networks

Network Structure	Pros	Cons
Direct shipping	No intermediate warehouse Simple to coordinate	High inventories (due to large lot size) Significant receiving expense
Direct shipping with milk runs	Lower transportation costs for small lots and lower inventories	Increased coordination complexity
All shipments via central DC with inventory storage	Lower inbound transportation cost through consolidation	Increased inventory cost Increased handling at DC
All shipments via central DC with cross-dock	Low inventory requirement Lower transportation cost through consolidation	Increased coordination complexity
Shipping via DC using milk runs	Lower outbound transportation cost for small lots	Further increase in coordination complexity
Tailored network	Transportation choice best matches needs of individual product and storage	Highest coordination complexity

# Trade-offs in Transportation Design

- Transportation and inventory cost trade-off
  - Choice of transportation mode
  - Inventory aggregation
- Transportation cost and responsiveness trade-off

# Trade-offs in Transportation Design

## Choice of transportation mode

- Dell as an example
- Faster modes of transportation are preferred for products with high value-to-weight ratio for which reducing inventories is important

## Inventory aggregation

- Useful for large value-to-weight ratio, high demand uncertainty products (new products in PC industry)
- Useful when customer orders are large enough to achieve economies of scale

## Responsiveness

- Temporal aggregation

# Role of IT in Transportation

- The complexity of transportation decisions demands use of IT systems
- IT software can assist in:
  - Identification of optimal routes by minimizing costs subject to delivery constraints
  - Optimal fleet utilization
  - GPS applications

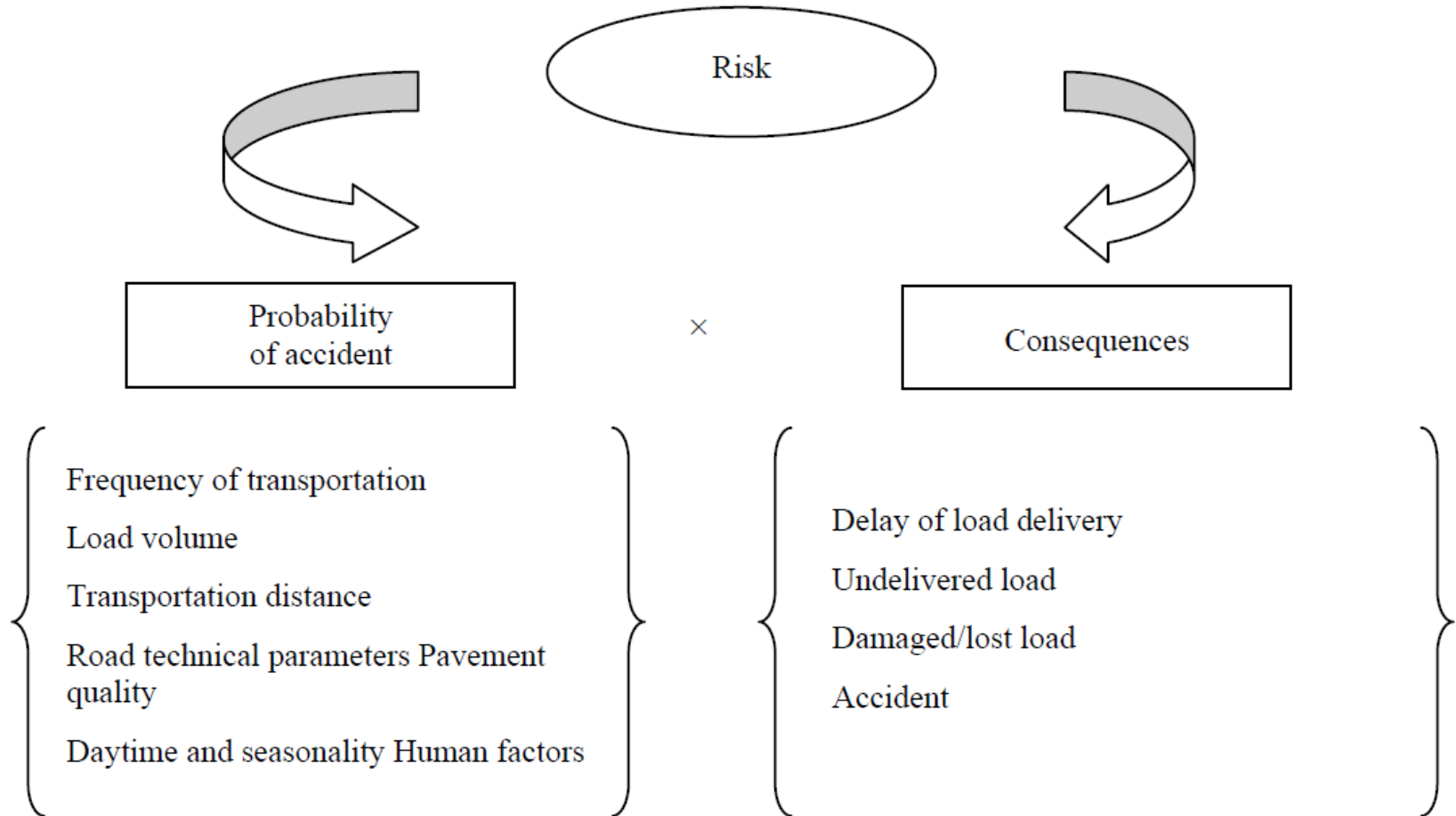
# Risk Management in Transportation

- Three main risks to be considered in transportation are
  - Risk that the shipment is delayed
  - Risk of disruptions
  - Risk of hazardous material
- Risk mitigation strategies
  - Decrease the probability of disruptions
  - Alternative routings
  - In case of hazardous materials the use of modified containers, low-risk transportation models, modification of physical and chemical properties can prove to be effective

# Risk Management in Transportation

- About 90% of the world trade volume is carried by maritime transport and the majority of supply chains involve seaports in the trade flow (Lam and Su 2015).
- In the multimodal transportation supply chain, alternative transportation modes can be used in the case of the failure of a transportation mode. Indeed, many authors have emphasized that redundancy needs to be considered in the design of supply chains in order to prevent supply chain disruptions (Qiang, Nagurney et al. 2009).
- Just in time systems are more vulnerable to transportation disruptions
- A disruption in transportation services could quickly cripple the entire supply chain since inventories are very low throughout the chain.
- Transportation risk management contingency plans would provide for alternative modes of transportation. Thus, if a trucking company failed, alternative modes such as air or rail backups would be in place to guard against supply disruption (Giunipero and Eltantawy 2004).

# Risk Management in Transportation



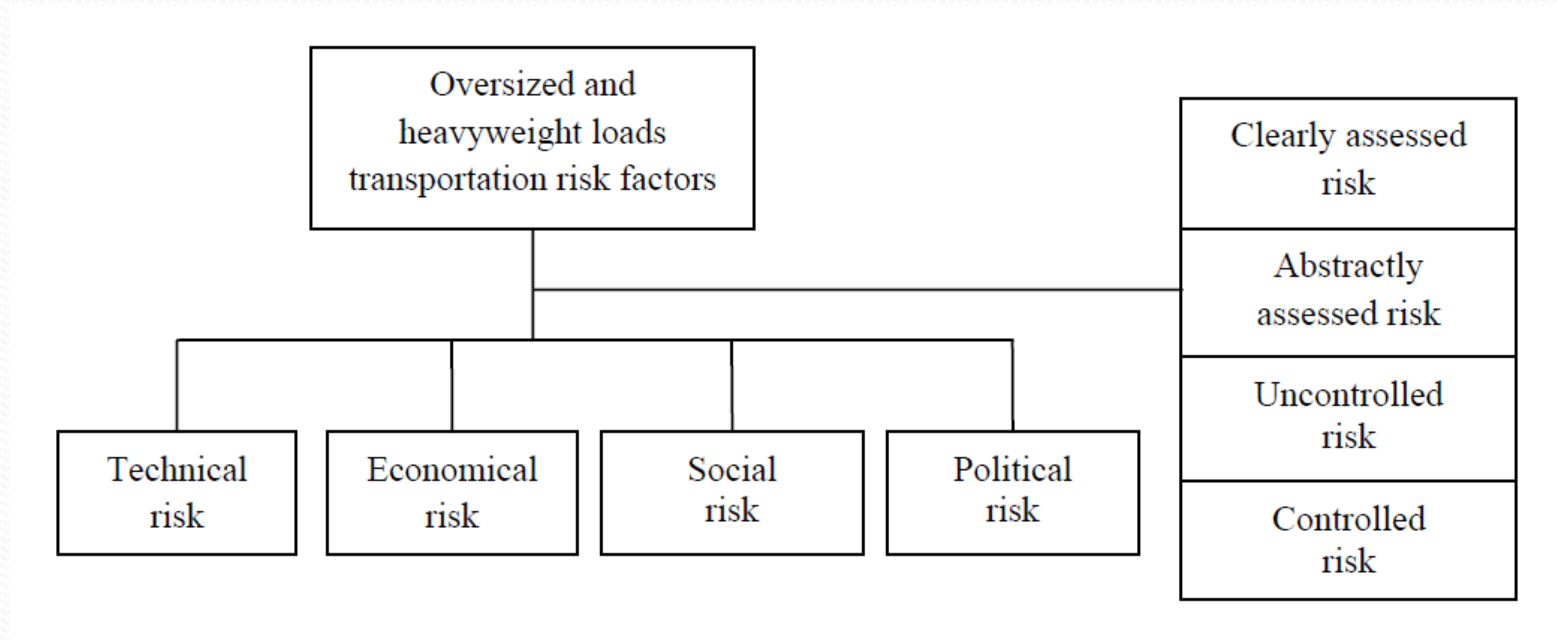
Adapted from: (Pašaitis and Petraška 2012)

# Risk Management in Transportation

Overall impact/consequences of transportation accidents:

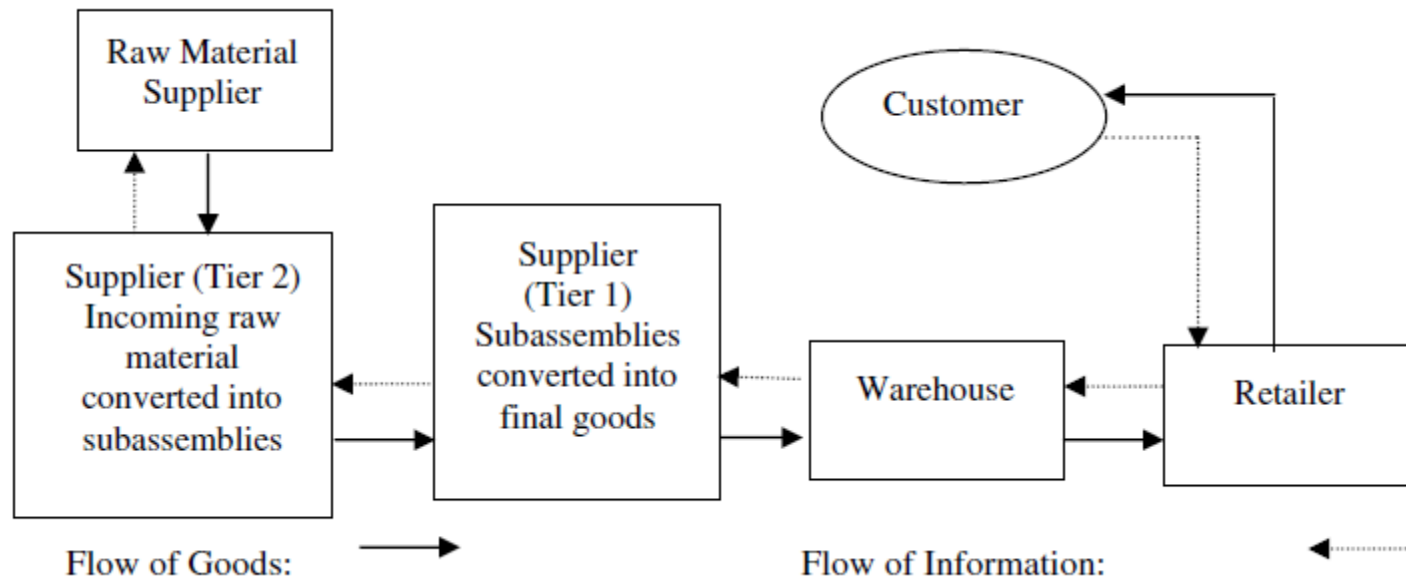
- Fatalities & injuries (acute and long-term)
- Cleanup & disposal costs
- Property & product damage
- Loss due to business interruption
- Environmental degradation & ecosystem damage
- Traffic & community disruption
- Public anxiety
- Diminished agency/company value and image

# Risk Management in Transportation



Adapted from: (Palšaitis and Petraška 2012)

# Risk Management in Transportation



- The greatest impact occurs when transportation is disrupted between the tier 1 supplier and warehouse.
- In the traditional structure the retailer, warehouse and tier 1 supplier experience the greatest inventory fluctuations and the highest goods in transit to their facilities.
- These impacts are less severe for the VMI structure, although unfulfilled orders are approximately the same.

Adapted from (Wilson 2007)

# Risk Management in Transportation: delays

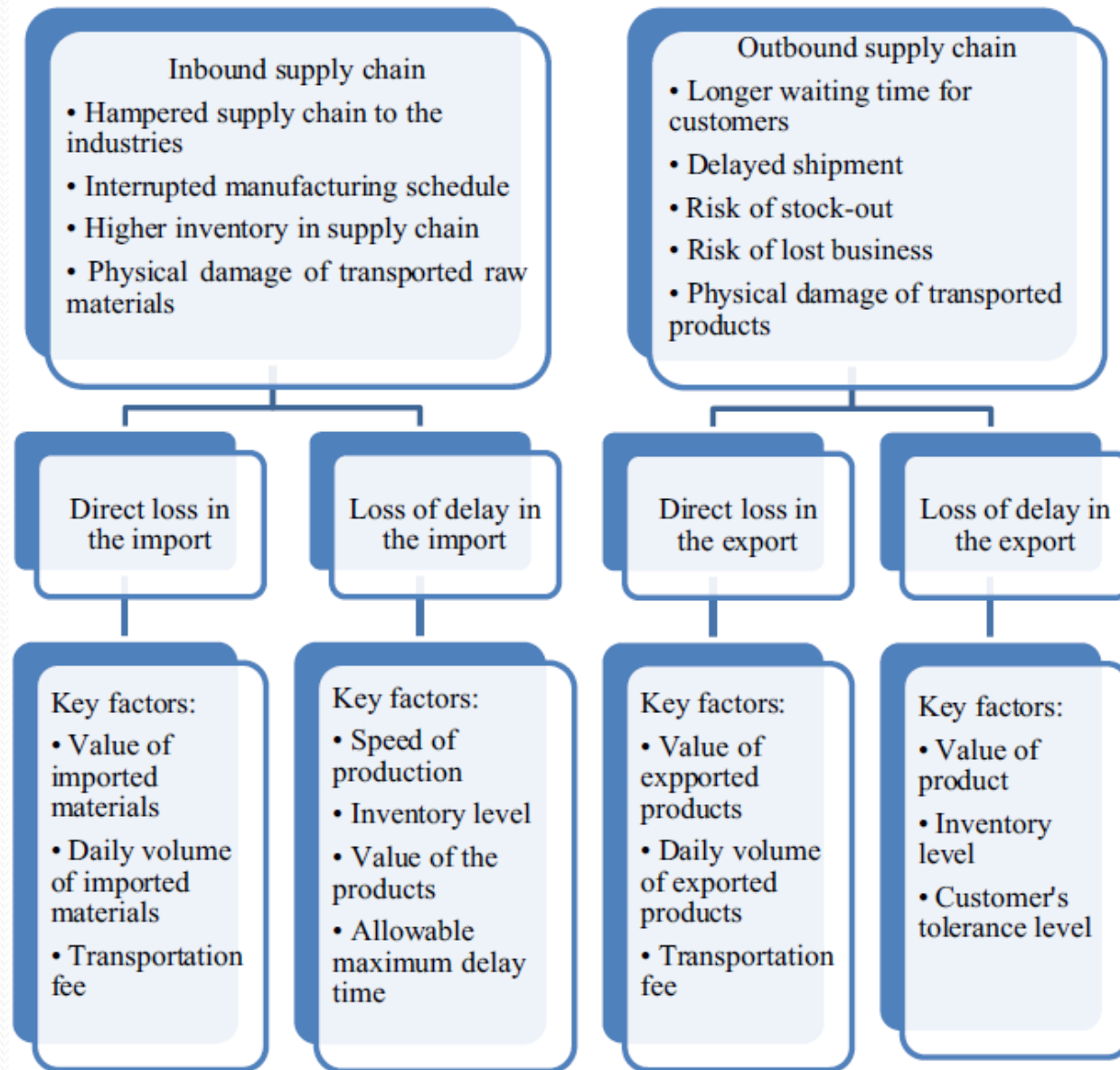
Seaport operations are highly important for industries which rely heavily on imports and exports.

A reliable evaluation of port risks is essential to govern the normal running of seaborne transportation and thus the industrial economies.

The occurrence of a breakdown in the trade facilitators, such as ports, will disrupt the smooth flow of supply chains for the industries.

The estimation of the economic loss for an industry when a port gets disrupted is a challenging task as the relationship between the port and industry clusters is complex (Lam and Su 2015).

# Risk Management in Transportation: delays



(Zhang and Lam 2016)

# Risk Management in Transportation: hazardous material

An environmental health and safety risk to the public occurs when a hazardous chemical or gas is released from its packaging during transportation.

For this reason, a Transportation Risk Analysis (TRA) is conducted for highly hazardous products and raw materials.

The TRA evaluation addresses:

- package integrity
- product security
- emergency response preparedness (Lutostansky, Miller et al., 2016)

# Risk mitigation strategies in transportation

- reducing the total distance the product is transported (for example, the number of trips per year)
- selection of the mode of transport (rail, road, barge)
- selection of the route of transport (for example, to maximize the distance travelled in areas with low accident frequency statistics)
- selection of the carrier (assessed for performance attributes)
- training of people involved in the transportation process (drivers, loaders, etc.)
- maintenance and inspection of the transport equipment
- systems increasing the stability of the vehicle (Lutostansky, Miller et al., 2016)

# Risk mitigation strategies in transportation

When defining a supply chain and risk management strategy regarding logistics outsourcing, certain trade-offs have to be considered by shippers (König and Spinler, 2016):

1. known supplier vs. lowest bidder: known LSP can provide a higher level of security, but also at higher cost than the arm's length relationship;
2. managing risks vs. delivering value: additional costs for LSP and shipper on a daily basis to mitigate risks;
3. collaboration vs. secrecy: collaboration with LSP improves the resilience, but also increases the risks of lost information; and
4. redundancy vs. efficiency: redundancy (e.g. stock buffers or multi-carrier approach) increases the resilience, but at higher costs.

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