- Goal of Transportation: to transform the geographical attributes of freight, people or info from an origin to a destination conferring them an added value in the process

Importance of Transportation

1. **Historical**
   a. Rise of civilizations
2. **Social**
   a. Access to social services
3. **Political**
   a. Government funding and regulations
4. **Economic**
   a. Production/ movement of goods and services
5. **Environmental**

Distance: A Core Transportation Feature

1. Euclidean Distance- straight line between 2 locations
2. Transport Distance- accounts for existing structure of the transport network (Pickup, Transhipment, Delivery, Etc.)
3. Logistical Distance- includes physical flows, but also a set of activities necessary for the management of these flows (Geographical distance units are less important)
   - For freight, significant tasks are order processing, packing, sorting and inventory management

Transportation Networks

- Term network refers to the framework of routes within a system of locations (nodes)
- A route is a single link (edge/arc) between 2 nodes that are part of a larger network that can refer to
  - Tangible routes (roads and rail)
  - Less tangible (air and sea)

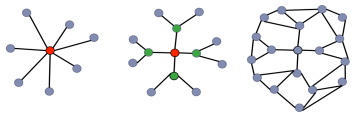
Topology of a Network

- Arc= unidirectional
- Edge= bi-directional

3 Types of Physical Space

1. **Clearly defined and Delimited**- strictly reserved for its exclusive usage (road, canal, railway)
2. **Vaguely Defined and Delimited**- no ownership, only goes by right of way (air and bike routes)
3. **Without Definition**- no tangible meaning (radio, wifi)

Network Structure



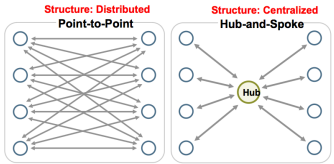
Centralized Decentralized Distributed

Centralized (left): one center has privileged accessibility

Decentralized (middle): center is still the point of highest accessibility but other sub centers also have accessibility

Distributed (right): no center of accessibility, everything is even

2 Major Types of Network



Advantages of Hubs

- Economies of scale on connections- unit cost reductions
- Economies of scale at the hubs
- Economies of scope- important and commonly achieved when a transporter is able to bundle several different loads into a fewer load

Disadvantages of Hubs

- Higher risks
- Increased travel time
- Increase in delays and coordination errors

Network Expansion

Type	Origin	Destination
Landbridge	Foreign	Foreign (not common)
Mini Landbridge	Foreign	At end of landmass
Micro Landbridge	Foreign	Inland (common for N.A.)
Reverse Landbridge	Foreign	Inland using maritime facade

Time/Space Relationship

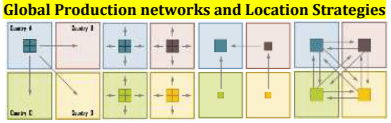
5 Major factors:

1. **Speed**- less significant since many modes have not seen much improvement
2. **Economies of scale**- transporting larger amounts at lower costs
3. **Expansion of transport infrastructure**-serving areas that couldn't be served before
4. **Efficiency of transport terminals**- growing capacity to handle larger quantities in a timely manner
5. **Info tech**- improvement of traffic flows and better management of transport assets

Concept of Flow

- **Geographical** - each flow has origin and destination
- **Physical** - physical characteristics in terms of load units
- **Transactional** - negotiate with providers of transport services for slots and times
- **Distribution** - organized in sequences where more complex are involving different modes and terminals

Global Production networks and Location Strategies



(1)Centralized Global Production- production occurs within one nation and is exported to the global market
(2)Regional Production- takes place within each region that manufactures a good with size of the production system relative to size of the regional market
(3)Regional Specialization- each region specializes in the production of a specific good and imports from other regions what it requires
(4)Vertical Transnational Integration- different stages of the production occur at locations offering the best comparative advantages

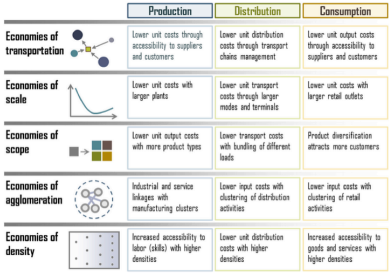
Spatial Organization (relies on 2 dimensions)

1. Spatial differentiation- Attributes such as location, size and density are illustrative of the distribution inequalities of features such as resources and pop.
2. Spatial Interactions- Attributes of flows are illustrative of inequalities of the origins and destinations

Major Economic Sectors

- Primary- mainly natural resources-related
- Secondary- Manufacturing-related
- Tertiary- retail-oriented/related
- Quaternary- service related

Main Types of Economies



Activities involved in production (manufacturing), distribution (transportation) and consumption (retail)

Advantages of Road Transportation

- Capital cost of vehicles is relatively small, which means a low barrier of entry
- High speed
- Flexibility of route

Limitations

- Limit potential to achieve economies of scale
- Road congestion

Transport Modes

1. Land (rail, road, pipeline)
2. Water (Shipping)
3. Air (Plane)

Rail Transportation

3 important components:

1. Physical infrastructure – tracks and stations
2. Engines
3. Space - rail cars

Geographical Settings of Rail Lines

1. Penetration Lines – main purpose is to link a port city to access natural resources
2. Regional Networks- service high density areas
3. Transcontinental Lines- helpful for landbridges

Advantages of Rail Transport

- Ability to transport large quantities over long distances
- Once assembled it may offer high speed-high capacity service
- Passenger service is effective
- Freight traffic dominated by bulk cargo, shipments, agriculture and industrial raw materials
- Green system

Limitation

- Involves using regular but rigid services
- Technical and operational constraints
  - Space consumption at terminal
  - Gradient and turns
  - Gauge (Wheels)
  - Network structure (public vs. private)

Types of Cars

(TL) Boxcar: carry general goods
(TR) Flat Car: wood, agricultural equipment, manufactured goods, containers, etc.
(ML) Gondola: Because of its low sidewalls, gondolas are used to carry either very dense material, such as steel plates or coils, or bulky items such as prefabricated pieces of rail track.
(MR) Hopper: carry loose bulk commodities such as coal, ore, and grain.
(BL) Reefer: carry fresh food (meat, fruit).
(BR) Tank cars: carry liquids

2 Main Markets

1. **Bulk Cargo**
   a. Dry and liquid freight that is not packaged (i.e. minerals and grains)
2. **Break-Bulk Cargo**
   a. General cargo that has been packaged

Shipping Routes

- **Circum Equatorial Route**- Global east-west freight movements through the Panama Canal
- **North-South Connectors**- reflect existing commercial relations, namely raw materials such as North-South American, Europe-Africa or Australia-Asia
- **Transoceanic Connectors**- connect a series of ports along ranges of large oceanic masses
  - **Transpacific**
  - **Asia-Europe**
  - **Transatlantic**
- **Transhipment Markets**- connect regional port systems to transoceanic and circum equatorial routes

Modal Competition and Modal Change

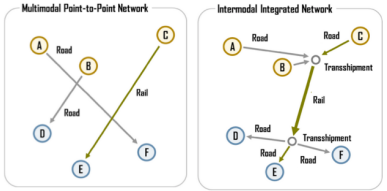
- Each transportation mode has key **operational** and commercial advantages and **properties**
- Can **compete** or **complement** each other in terms of cost, speed, accessibility, frequency, safety, comfort, etc.
- Cost is one of the most important considerations in modal choice and actual competition between the modes depends on
  - Distance travelled
  - Quantity of the shipment
  - Value of the goods
- For passenger services, rail has difficulty in meeting the competition of road transport over short distances and aircraft for longer trips
- For freight, rail and shipping have suffered from competition from road and air modes for high value shipments
- Intense competition over the last thirty years has seen **road** and **air** modes capture an **important market share** of the high revenue-generating goods. **Road transport clearly dominates.**

Intermodal Transportation

3 Primary reasons for Intermodal Transports:

1. Economies of scale
2. Frequency
3. Interchange (optional)

Multimodal vs. Intermodal



(R) Intermodal- using one or more transportation method and involves interchanging to reach the destination

- Offers cost savings but also costly delays

(L) Multimodal- the use of one transportation method and there is no interchange

Containerization

Container= driver of intermodal transportation
TEU= Twenty equivalent unit (most common)
FEU= Forty equivalent unit (less common)
Why bigger containers?

- Reduce loading and unloading time
- More capacity

Why not use bigger containers?

- Road restrictions

Advantages of Containerization

- **Standard transport product**
  - Follow ISO standards
- **Flexibility of usage**
- **Management**
- **Economies of scale**
  - Reduce transport costs, before 5% to 10% of retail price
- **Speed (Biggest advantage)**
- **Warehousing**
- **Security**

Challenges of Containerization

- **Site constraints**
- **Infrastructure costs**
- **Stacking**
- **Thefts and losses**
- **Empty travel**
- **Illicit trade**

Main Advantages of Joint Operations

- **High capital costs**
  - Spread across diverse revenue stream
- **Maintenance costs**
  - Spread over a wider base
- Same modes or traction can be used for **both freight and passengers**

Disadvantages of Joint Operations

- **Location of demand (origin and destination are far apart)**
  - Passenger= highly populated area
  - Freight= industrial area
- **Frequency of demand**
  - Passengers need high frequency service
  - Freight tends to be somewhat less critical
- **Timing of service**
  - Peaks during the day
  - Evenly spread throughout the day
- **Traffic balance**
  - Tend to be in equilibrium
- **Reliability**
  - Passenger= delays not acceptable, harder to manage
- **Sharing routes**
  - Favours passenger traffic, often given priority
- **Different Operational Speed**
- **Security Screening**
  - Different procedures for freight and passenger

Transport Terminals

- Terminal defined as any facility where passengers and freight are assembled or dispersed

3 Major Attributes of Terminals

1. **Location**
   a. To serve large concentration of pop. or industrial activities
2. **Accessibility**
   a. Accessibility to other terminals
3. **Infrastructure**
   a. A utilization rate of 75 to 80% is considered optimal

Passenger Terminals

2 important components

1. Design
2. Scheduling of arrivals/departures

Passenger Terminals: Airports

- Most complex of terminals functionally
- Passengers may spend hours in transit, check-in, security checks, baggage pick up and customs
- To measure activity at airports a common indicator is the **# of passengers handled** as well as
- **# of aircraft movement**, a figure that must be used with some caution because it pays no regard to the capacity of planes

Freight Terminals

- Terminals are differentiated functionally both by the mode involved and the commodities transferred and can be distinguished between
- **Bulk (large quantities that are unpackaged)**
  - Liquid bulk (easier to handle)
  - Dry Bulk
- **General Cargo (goods in many shapes, dimension and weights)**
  - Machinery, processed material and parts
  - General cargo has more labour than dry bulk and dry bulk has more labour than liquid bulk
- **Containers (standard units that are vital to terminal operations)**

Measurement of Freight Traffic

- Standard measures of weight and value are difficult to compare and combine
- Because bulk cargo carry more weight, terminals that specialize in these cargo will record higher throughputs measured in tons then those not specializing
- Problem with measurements involving weight or volume become difficult when different types of freight is handled because one is adding together goods that are unequal
- Common measure of productivity is measured by the # of lifts per hour
- Bremen Rule (survey of the labour costs)
  - 1 ton of general cargo = 3 tons of dry bulk and 12 tons of liquid bulk

Truck Terminals

3 terminal types

1. **Pickup and Delivery Terminals**
   a. Serves local area, does milk runs
2. **Break-Bulk Terminals**
   a. Performs consolidation and dispersion
   b. Rarely have contact with customers
   c. Can do long or short hauls

3. **Relay Terminals**
   a. Freight never touched

Operating Ratio

OR= (operating expenses/ operating revenue) x 100

Ratios for LTL usually range between 93 and 96 and for TL are low to mid 80's

Airport Terminals

1. **Linear Orientation (allows several planes to board at once through jet bridges)**
   a. Recommended for low activity airports
2. **Islet (permits the stowage of several planes on a smaller terminal surface which is linked to the airport)**
   a. Best for high traffic airports
3. **Transporter (uses shuttles to and from the aircraft)**
   a. Prevalent in air cargo ops.

Transport Modes in International Trade

1. **Ports and Maritime Shipping**
   a. In terms of tonnage, maritime shipping handles about 90% of global trade
2. **Airports and Air Transport**
   a. air only carries 0.2% of total tonnage
   b. It is important in terms of total value is around 15% of the value of global trade

Value of Transportation Service

- Considers the impact of transportation costs and service on the demand for the product
- The impact of transportation costs on the demand for a product at a given location usually focuses on the landed cost of the product.
- The landed cost of the product includes the cost of the product at the source, the cost to transport the product to its destination, plus any ancillary expenses such as insurance or loading costs.
- If the landed cost of the product is lower than that of other sources, there is a demand for that product and also for the transportation of that product from its origin point
- Landed cost determines the extent of the market for business therefore the greater the distance the product is shipped, the higher the landed cost

Calculating Landed Cost (Example)

- Producer P has a production cost of $50 per unit and transportation cost of $0.60 per unit per mile. Producer S also has a production cost of $50 per unit

- The extent of the market between the two producers is the point at which their landed costs are equal:
  - Landed cost (P) =Landed cost (S) or LC(P)=LC(S)

1. 50 + X(0.6) = 50 + (200-X)(0.5)
2. 0.6X + 50 = -0.5X + 150
3. 0.6X + 50 + 0.5X = -0.5X + 150 + 0.5X (to cancel out 0.5X)
4. 1.1X + 50 = 150
5. 1.1X + 50 -50 = 150 -50 (to cancel out 50)
6. 1.1X / 1.1 = 100 / 1.1
7. X = 90.91 (landed cost)

Freight Transport Services within Supply Chain

1. **Management of Shipments**
   a. Refers to cargo transported by the owner, the manufacturer or by a third party
2. **Geographical Coverage**
   a. Implies a wide variety of scales
3. **Time Constraint**
   a. ranging from express (time is essential) to the lowest cost possible (time is secondary)
4. **Consignment Size**
   a. Depending on the product, consignment can be carried out in TL, LTL, General Cargo, Container load or parcel
5. **Cargo Type**
   a. Break-Bulk or Bulk cargo require different vehicles, vessels, transhipment and storage infrastructure
6. **Mode**
7. **Cold Chain**

Evolution of Supply Chain Management

1. Integration – a fundamental restructuring of goods merchandising by established integrated supply chains with integrated freight transport demand (Supply+Demand driven)
2. Time Mitigation- transport is regarded as a tool for overcoming space, logistics is concerned with mitigating time
3. Specialization- achieved by shifts towards vertical integration like outsourcing and subcontracting

Benefit from Transport Improvements

1. Commodity Market- improving the firm's access to raw materials, parts and their respective customers
2. Labour Market- improvement in the access to labour and reduction in cost by improving commuting (regional scale) or the use of lower cost labour (global scale)

The Major Impacts of Transport on Economic factors

Factor	Pro/Con	Outcome
Geographic specialization	Comparative adv	+
Large scale production	Economies of scale	+
Increased competition	↑ mkt size ↑variety of goods	+ prod + cons
Increased land value	Adjacent/serviced land value Accessibility	+ -

Geographic Specialization

Evolution of transport systems impacts regional economies in terms of their level of specialization

1. **Self-Reliance**
   a. no efficient transport link between 2 regions; goods cannot be transferred in a cost effective manner; must satisfy their own needs
2. **Regional Trade**
   a. transport link between 2 regions, a specialization can take place; Comparative advantage between 2 products/region
3. **International Trade**
   a. Having access to a larger market and range of products through gateway

Socioeconomic Impacts

1. **Mobility Gaps-** people's mobility and transport demands depend on their socioeconomic situation; higher income = higher mobility
2. **Cost Differences** – locations with low levels of accessibility tend to have higher costs resulting in higher transport costs
3. **Congestion-** increase use of transport system result in usage above design capacity
4. **Accidents-** more traffic= higher chance of accidents
5. **Environmental Consequences-** air quality, noise
6. **Water quality-** accidental and nominal runoffs

Distance and Cost

Distance is commonly the most basic condition affecting transport costs

4 Main Categories

1. No Effects of Distance- these activities generally have a fixed cost which is not related to distance but often to a service zone
   a. Telephone calls, Postal Fees, Public Transit Fares
2. Linear Effects of Distance- transport cost are increasing proportionally to distance. Fuel consumption
3. Non-Linear Effects of Distance- freight distribution costs are growing in a non-linear fashion with distance from terminal because of empty back hauls. Affects trucks the most
4. Intermodal Transport Chain- combination of line haul and terminal costs where transhipment cost at terminal increase the friction of distance as efforts must be spent at loading or unloading when passing from one mode to another

Outsourcing

Transportation is another activity that is widely outsources to external experts Companies like:

- **COSCO (China Ocean Shipping Company)**
- **Deutsche Post (owner of Exel and DHL)**
- **FedEx**
- **Maersk, and UPS** provide a wide variety of transportation services

These third party logistics service providers are experts in the management and flow of freight.

Types of 3PL Providers

3PL's promote themselves as integrated service providers with a comprehensive range of logistical capabilities

- Most have their origins and greatest level of expertise in a specific logistics activity

1. **Transportation based-** trace their origins to freight movement via truck, rail , air and other modes of transportation
   a. They not only move freight but advise on cost reduction and develop logistics solutions
2. **Distribution Based-** originated from the contract warehousing business and have expanded into a broader range of logistics services
   a. Involved in inventory management, warehousing
   b. Biggest advantage is flexibility
   c. Range from single facility operators to global organizations with strategically located operations centers
3. **Forwarder Based-** brokers and agents that primarily facilitate the flow of good on behalf of customers
   a. Do not own equipment, they arrange transportation services for LTL, air cargo and ocean freight
   b. Engaged in the support of international freight movement: booking cargo space, prep and process doc.
4. **Financial Based-** helps customers with monetary issues and financial flows in the supply chain
   a. Role include freight rating, freight payment, freight bill auditing and accounting services
5. **Information Based-** digitized many activities that were done by hand before or required licensed software
   a. Provided online freight brokerage services as well as freight planning, routing and scheduling
   b. Offer companies access to mgmt systems
   c. Provide tools and online capabilities for the coordination, optimization and control of transportation and logistics activities

Asset-Based vs. Non-Asset Based

- Asset-based providers - 3PL's with tangible equipment and facilities
- Non-asset based providers - 3PL's that leverage the resources of other companies

Asset-Based Providers

- Typically has its own labour force to perform the customers work and management team to oversee the daily operations
- Internal resources allow the 3PL to leverage internal strengths and infrastructures to provide direct, immediate solutions
- Known companies
  - DHL, FedEX, UPS, Saddle Creek
- Customers choose to work with asset based providers because
  - Readily available capacity
  - Permanent employees
  - Direct control of freight
  - Prefer to work with a single 3PL who will take responsibility for the outsourced activity and assume accountability if problems occur
  - Customers can also maintain greater visibility of outsourced activities and inventory
- Primary concern with asset based providers is bias toward their internal resources

Non-Asset based Providers

- Acts as a service integrator and is not restricted to using any particular warehouse or transportation company in providing services to its customers
- Offer expertise in negotiating contracts with transportation companies and distribution centers in an effort to achieve the best combination of price and service for their customers
- Consulting Firms like
  - Accenture, Capgemini, CSC Consulting, and software firms
- **Customers view non-asset based providers as being more flexible than their asset based counterparts**
  - Can be unbiased in their decision making as they are not limited to an internal infrastructure of assets
- **Concerns with non-asset based providers**
  - Do not have significant internal capacity
  - Problem during economic expansion when transportation equipment availability is squeezed

Major Users

- **Leading the use of 3PL services are**
  - Technology, Automotive, Retailing industries (GM, Procter & Gamble, Walmart, Ford and PepsiCo)
- **Concerns**
  - Unrealized service-level commitments
  - Lack of continuous improvements
  - Cost reductions not realized

Reasons for and against 3PL use

REASONS FOR

- Opportunity for cost reductions
- Productivity improvement opportunities
- Ability to focus on core competencies
- Opportunity to improve customer service
- Expansion to unfamiliar markets

REASONS AGAINST

- Logistics is a core competency of company (logistics is too important to consider outsourcing)
- Cost reductions not experienced
- Control over outsourced function would diminish
- Issues related to security of shipments

Establishing and Managing 3PL Relationship

1. Perform Strategic Assessment
2. Decision to Form Relationship
3. Evaluate Alternatives
4. Select Partners
5. Structure Operating Model
6. Implementation and Continuous Improvement

- Ultimate goal is to develop productive relationships and create outstanding customer service and cost-efficient operations

Market Structure Models

1. **Pure competition-** large # of sellers
   a) All sellers and buyers are of such a small size that no one can influence prices or supply.
   b) There is a homogeneous product or service.
   c) There are no barriers to entry.
2. **Monopolistic Market-** with only one seller of a product or service
   a) single seller is able to set the price for the service offered and should adjust the price to its advantage b) to remain in this position the single seller must be able to restrict entry
3. **Oligopolistic Market-** competition between a few large sellers of a relatively homogeneous (substitutable) product
   a) Oligopoly is characterized by mutual interdependence among the various sellers.
   b) The individual seller is aware that in changing price, output, sales promotion activities, or the quality of the product, the competitors' moves must be taken into account
4. **Monopolistic Competition** – many small sellers and some differentiation of products
   a) # of sellers is great enough and the largest seller is small enough that no one seller controls a significant portion of the market.
   b) Any seller can lower price to increase sales volume without necessarily eliciting a retaliatory reaction from competitors

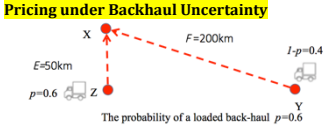
Establishing the Pricing Objective

1. **Market Skimming Pricing-** 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.
2. **Penetration Pricing-** This can lead to a sales-based pricing objective, which can be an effective strategy because

a. High price can be charged until competition starts to enter.
b. A high price portrays a high-quality service.

3. **Market Share Pricing-** used in an industry whose revenues are stagnant or declining
4. **Survival-Based Pricing-** aimed at increasing cash flow through the use of low prices.
5. **Social Responsibility Pricing-** objective forgoes sales and profits and puts the welfare of society and customers first

Pricing under Backhaul Uncertainty



The probability of a loaded back-haul $p=0.6$

The revenue $(r\times200)+0.6\times(r\times180)=308r$

The cost of moving loads $(c\times200)+0.6\times(c\times180)=308c=308$

Traveling empty to city (x) from city (y): $(0.4)(c\times200)=80c=80$

Traveling empty to city (x) from city (z): $(0.6)(c\times50)=30c=30$

Profit: $308r-418 \rightarrow 308r-418>0$, then $r>\$1.36$

Value of Service Pricing

Defined as third degree price discrimination

- 3 necessary conditions must exist before a seller can practice third degree price discrimination:

1. The seller must be able to separate buyers into groups or submarkets according to their different elasticity's 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.

Differential Pricing Methods

- Segregating the buyers into distinct groups

1. By commodity (e.g., such as coal versus computers)
2. By time (e.g., seasonal discounts or premium rates)
3. By individual person
4. By place

Policy and Planning

The following definitions are used here:

1. **Transport policy-** deals with the development of a set of constructs and propositions that are established to achieve particular objectives relating to social, economic and environmental development, and the functioning and performance of the transport system.
2. **Transport planning-** deals with the preparation and implementation of actions designed to address specific problems

- Governments are most involved in policy process, they either own or manage many components of the transport system
- The public sector usually provides transport infrastructure and the regulatory framework, while the private sector assumes the operations of many modes.
- A major distinction between planning and policy is that the latter has a much stronger relation with legislation.
- Policies are frequently, though not exclusively, incorporated into laws and other legal instruments that serve as a framework for developing planning interventions.
- Planning does not necessarily involve legislative action, and is more focused on the means of achieving a particular goal

Policy Instruments

1. **Public ownership-** direct control by the state
2. **Subsidies** - important instrument for policy goals
3. **Regulatory control-** represents a means of influencing the shape of transportation
4. **R&D-** governments are major promoters in transportation
5. **Labour regulations-** pertaining to conditions of employment, training, and certification
6. **Safety & operating standards-** speed limits