MULTIMODAL *TRANSPORT 1*

Our learning objectives

- Single Contract
  - entire journey is covered by one contract, simplifying the logistics and legal aspects for the shipper.
- Efficiency
  - By combining different modes of transport, multimodal transport can optimize routes, reduce transit times, and lower costs.
- Flexibility
  - for greater flexibility in choosing the most efficient and cost-effective routes and modes of transport.
- Reduced Handling
  - Goods are typically transported in a single loading unit (like a container), which reduces the need for handling and the risk of damage.
- Environmental Benefits
  - Multimodal transport can help reduce the environmental impact by optimizing the use of different transport modes, such as using rail or sea for long distances and trucks for shorter distances

Programme

At stake

I- Multimodal intermodal definitions & transshipments

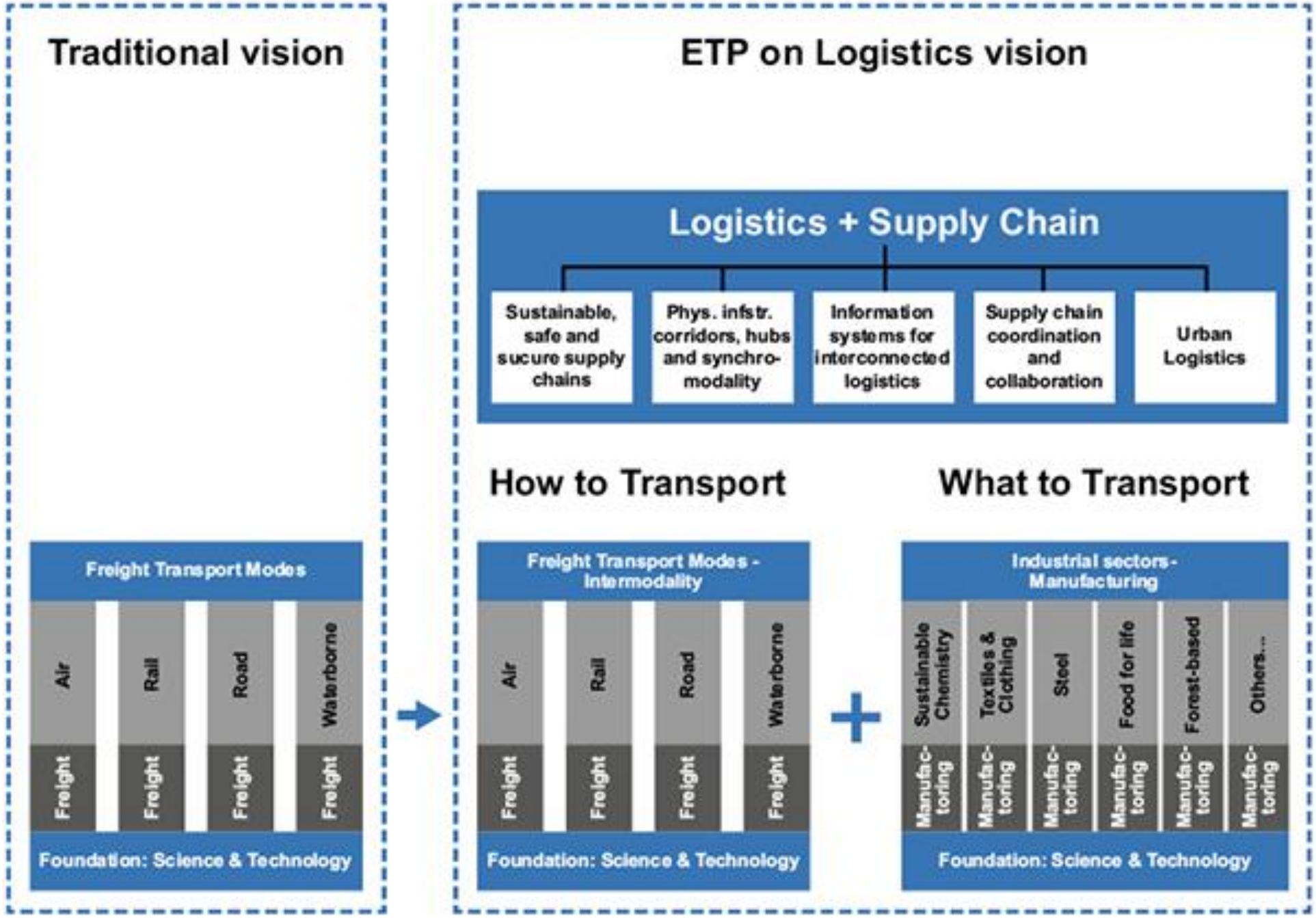
II- World flows

III- Intercontinental distances

IV- Continental distances

V- The multimodal Transport Operator

IV- Information and regulation


Traditional vision
Freight Transport Modes
Air
Rail
Road
Waterborne
Freight
Freight
Freight
Freight
Foundation: Science & Technology
ETP on Logistics vision
Logistics + Supply Chain
Sustainable, safe and sucure supply chains
Phys. infstr. corridors, hubs and synchro-modality
Information systems for interconnected logistics
Supply chain coordination and collaboration
Urban Logistics
How to Transport
What to Transport
Freight Transport Modes - Intermodality
Air
Rail
Road
Waterborne
Freight
Freight
Freight
Freight
Foundation: Science & Technology
Industrial sectors - Manufacturing
Sustainable Chemistry
Textiles & Clothing
Steel
Food for life
Forest-based
Others...
Manufac-turing
Manufac-turing
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Manufac-turing
Manufac-turing
Foundation: Science & Technology

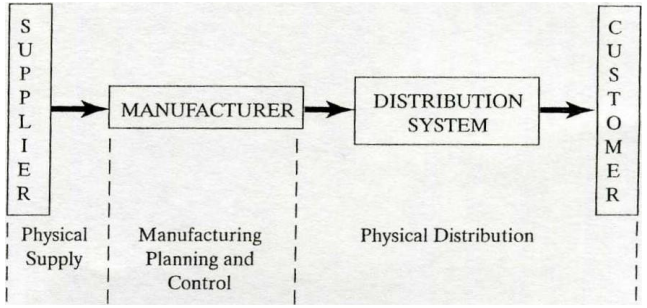
Performance characteristics

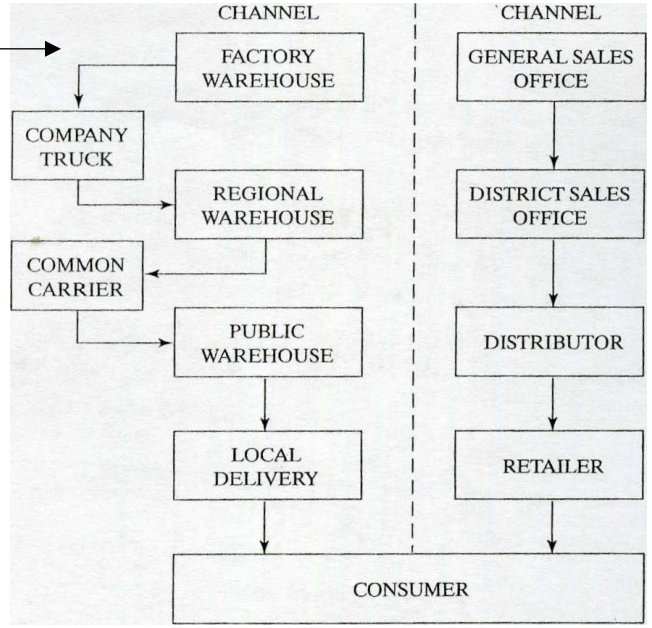
Mode of transportation	Cost 1=highest (b)	Average delivery time (c) 1=fastest	Delivery time ,variability Absolute 1= least	Percent (d) 1=least	Loss and damage 1 = least
Rail	3	3	4	3	5
Truck	2	2	3	2	4
Water	5	5	5	4	2
Pipe	4	4	2	1	1
Air	1	1	1	5	3

b column per ton/mile
c door to door speed
d ratio of absolute variation in delivery time to delivery time

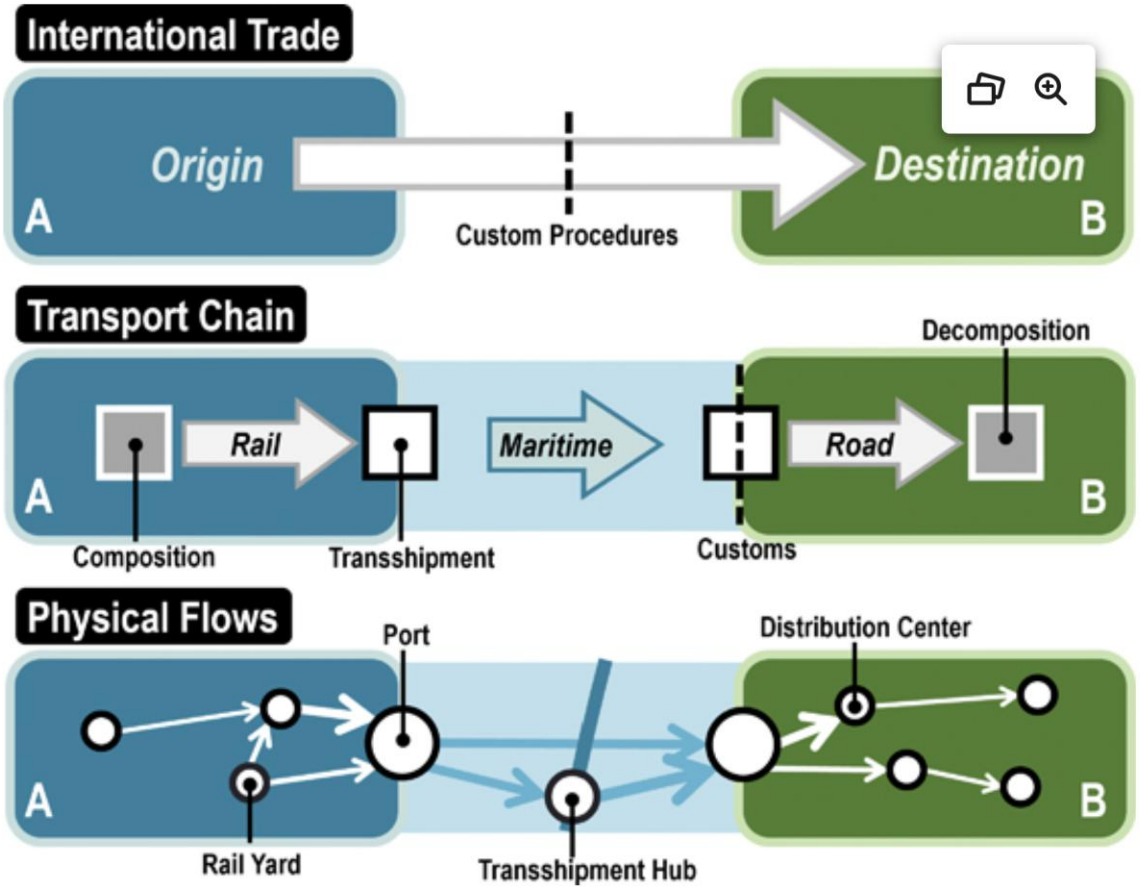
Presentation

- Multimodal transport & Physical distribution
  - Physical supply
  - Distribution
    - Fragmented
    - Than concentration
  - **Channels of distribution**
    - Transaction channel of distribution centers separated from factories
    - Distribution channel as a display function of models
    - Identification of logistics problems
      - Deciding the location, size and time
    - **Multimodal approach needed**
      - To the channels of distribution
      - The types of markets
        - Geography, orders, goods
          - Weight, density, fragility, perishability …
      - **And** type of transportation as available





International Transportation



Direct derived demand and undirect

- Freight transportation
  - movements of raw materials
    - parts
    - finished products on modes such as trucks, rail, or containerships
    - transportation is directly the outcome of production and consumption functions.
- Undirect
  - fuel consumption from transportation activities must be supplied by an energy production system requiring
    - movements from extraction zones, to refineries and storage facilities and to places of consumption.
  - Warehousing
    - moving cargo directly from where it is produced to where it is consumed is virtually impossible.
- Induced transport demand
  - Additional road capacity results in
    - mode shifts
    - route shifts
    - redistribution of trips
    - generation of new trips
    - land use changes that create new and longer trips

Footprint

Transportation infrastructures = consumers of space

- the right of way (e.g. roads and rail lines)
- terminals

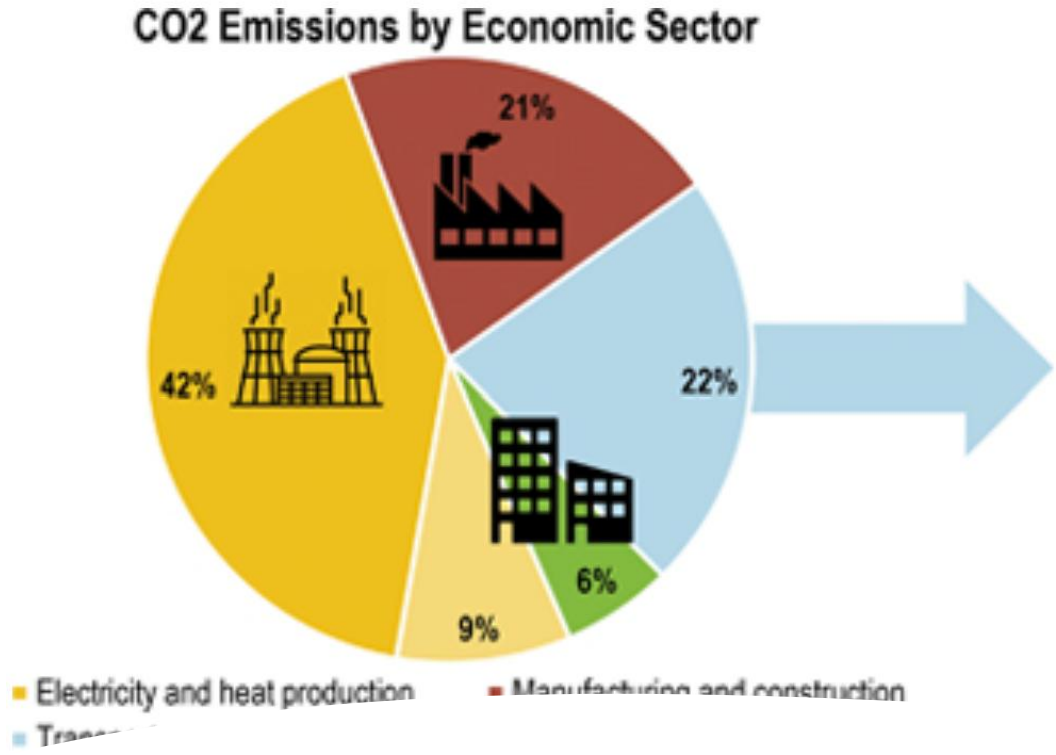
The more extensive a transport system and the higher the mobility level, the more extensive its footprint

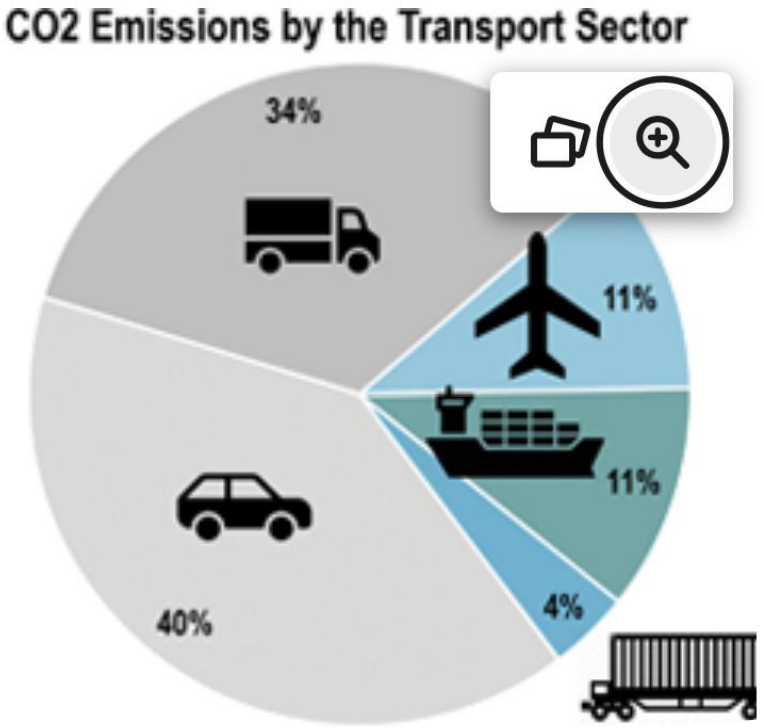
- For instance, roads and parking spaces can consume up to 50% of the land in highly motorized cities.
- Globalization = setting of massive terminal facilities such as container ports, airports, and distribution centers.
- space consumed by
  - road infrastructure is mostly linked with local and regional activities
  - rail, port, and airport terminals is linked with activities taking place at a larger scale.

Energy

- Price level and volatility
- Technological and technical changes
- Environmental externalities

- Vehicle manufacture, maintenance and disposal (a ship to 2 years)
- Vehicle operation
- Infrastructure, construction and maintenance
- Management of transport operations
- Energy production and trade



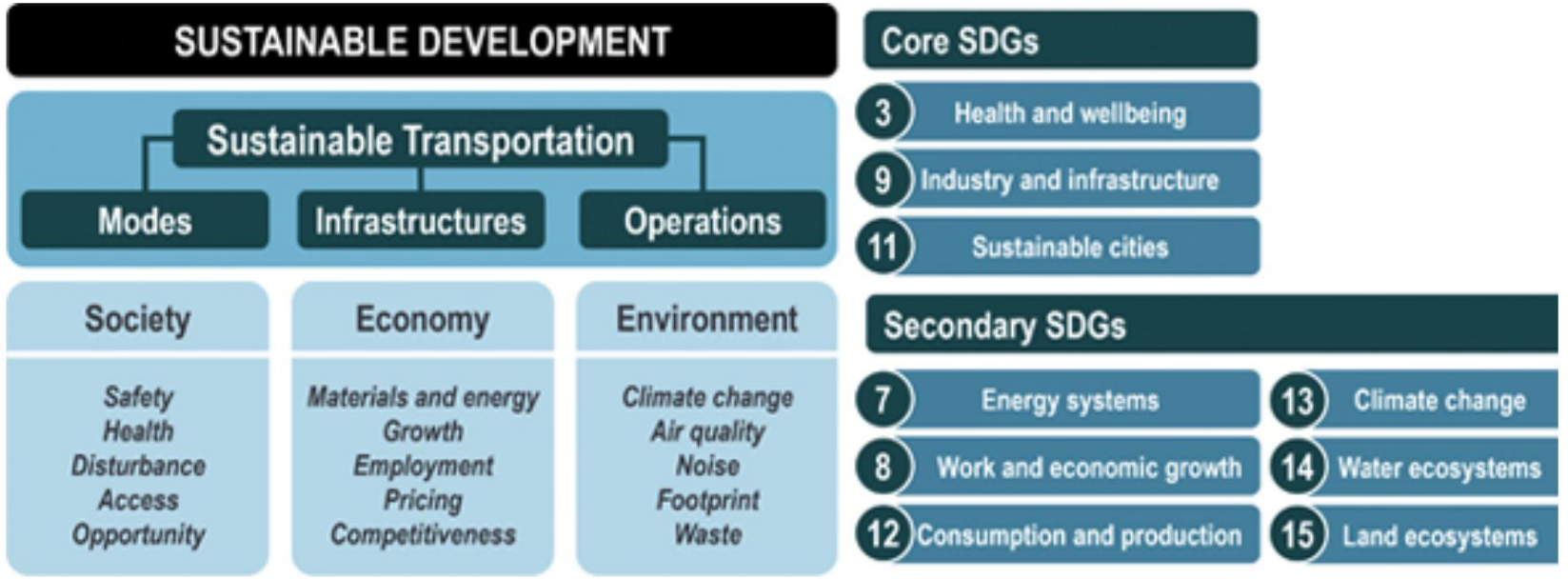


Energy and Cost

- Biofuels
- Natural gas
- Hydrogen and ammonia
- Electricity
- Hybrid vehicles

Energy & transport

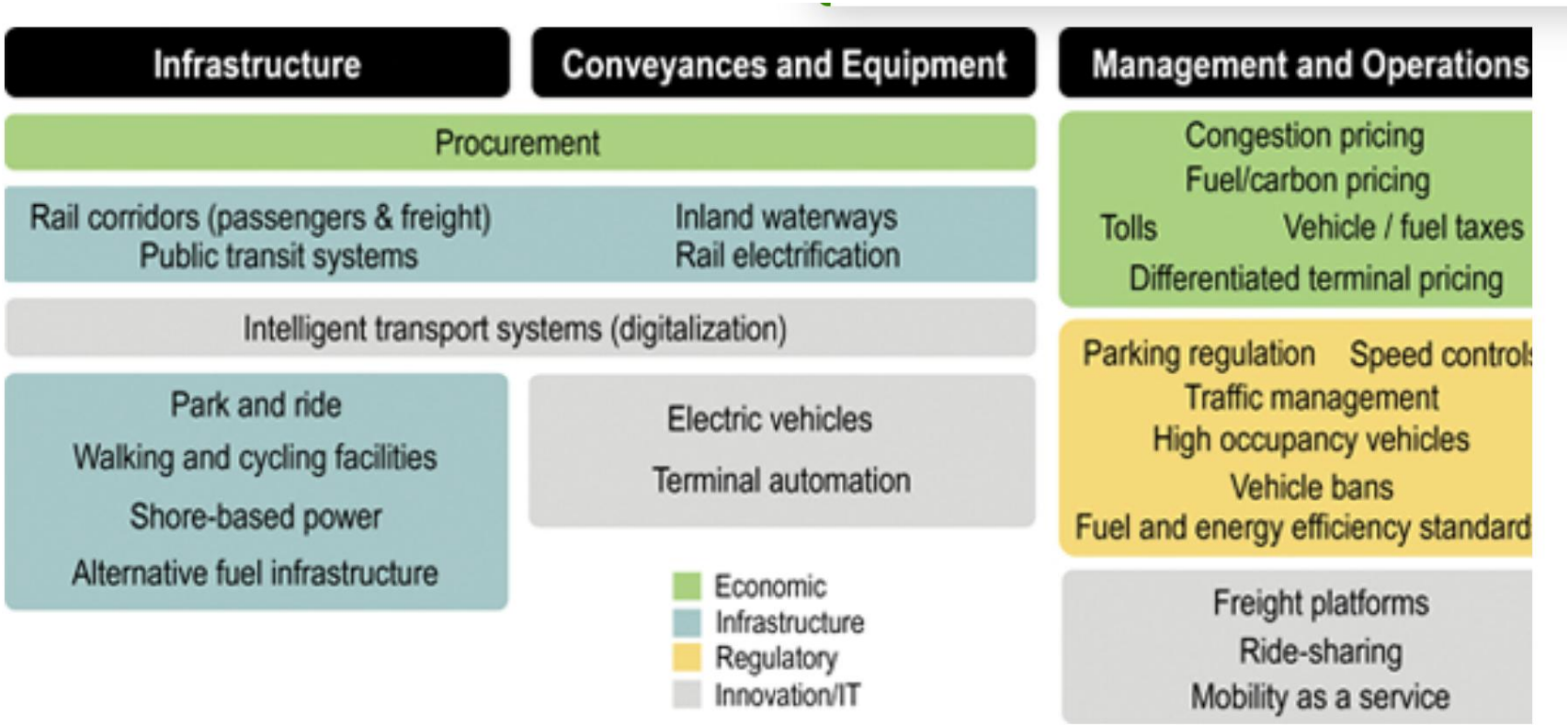
- Sustainable development goals
- (3) Health and well-being. Ensuring transportation safety and the provision of opportunities through improved mobility.
- (9) Industry and infrastructures. Supply chains and the mobility of passengers and freight.
- (11) Sustainable cities. Urban mobility and logistics



Energy & transport

- Issues
  - Mitigation
    - improvement of productivity and efficiency of existing modes, terminals, and managerial approaches so that environmental externalities are reduced
    - short to medium-term strategies.
  - Adaptation
    - change in the level of use and the market share of respective modes to reflect better long-term trends
      - higher energy prices
      - improved information technologies
      - stricter environmental regulations.

Energy & decarbonization



Transport and sustainability

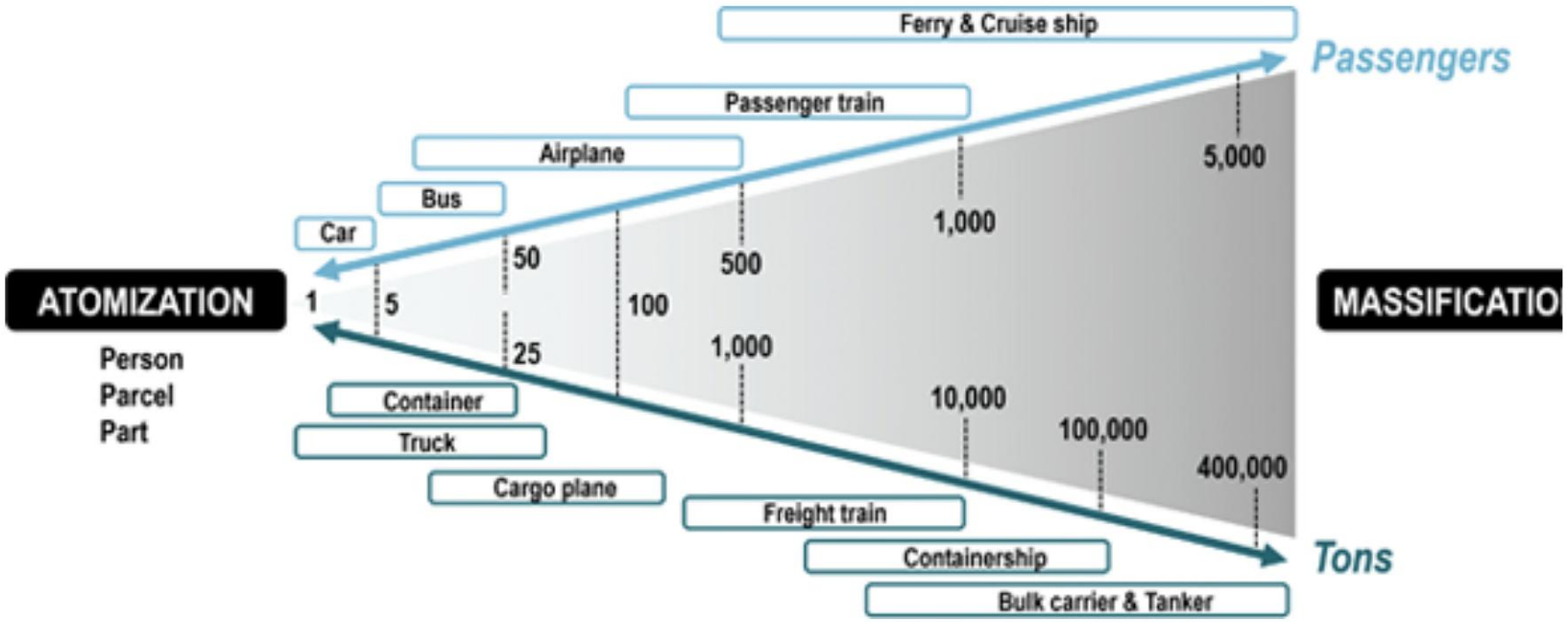
- Transport and atmospheric pollution
  - most developing economies still have limited capabilities for enforcing environmental standards
  - trend is toward greater control over emissions, which will affect modes and their respective competitiveness, particularly if a mode is subject to a greater degree of legislation than another

- Transport and water quality
  - Significant progress has been made in a number of areas, such as ballast water, waste, and oil spills.
  - dredging, where environmental constraints are placing a growing financial burden on ports seeking to deepen channels to keep pace with the growth of vessel size

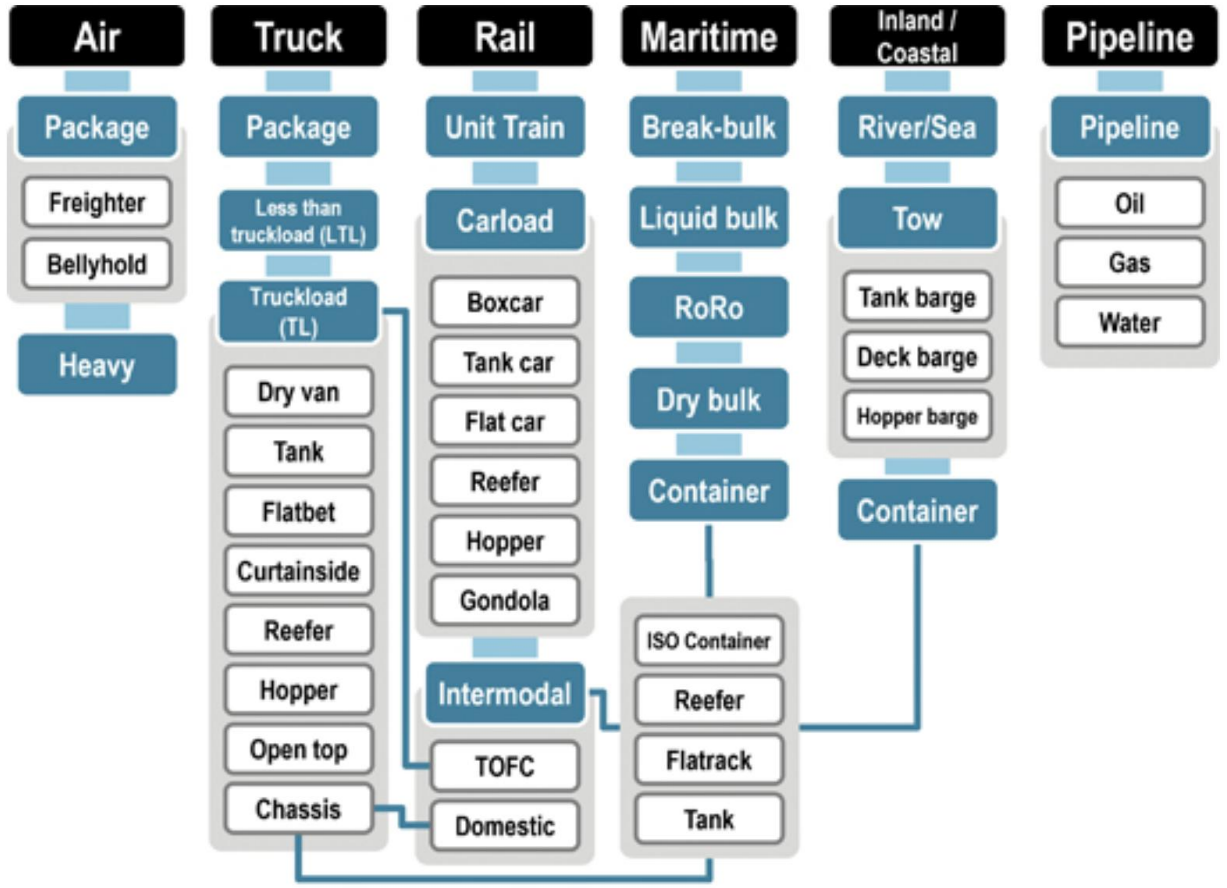
- Transport footprint
  - enormous pressure on new infrastructures
  - likely have an impact on how transport infrastructure is designed

- Transport and climate change
  - Transport activities, particularly vehicles, account for 24% of CO2 emissions worldwide
  - regulatory pressures to improve their environmental performance regarding the greenhouse gases
  - Severe weather occurrences disrupt transport systems
  - The prospects of sea level rises are particularly challenging for coastal transport systems

First and last segment



Modes


Air
Package
Freighter
Bellyhold
Heavy
Truck
Package
Less than truckload (LTL)
Truckload (TL)
Dry van
Tank
Flatbet
Curtainside
Reefer
Hopper
Open top
Chassis
Rail
Unit Train
Carload
Boxcar
Tank car
Flat car
Reefer
Hopper
Gondola
Intermodal
TOFC
Domestic
Maritime
Break-bulk
Liquid bulk
RoRo
Dry bulk
Container
ISO Container
Reefer
Flatrack
Tank
Inland / Coastal
River/Sea
Tow
Tank barge
Deck barge
Hopper barge
Container
Pipeline
Pipeline
Oil
Gas
Water

- **Activities in distribution systems**
  - **Transportation**
    - The single highest cost of distribution
  - **Distribution inventory**
    - The second most important
  - Warehouses (distribution centers)
  - Materials handling : capital cost
  - **Protective packaging**
    - Contained, protected and identified
    - Fitting into transportation
  - Order processing and communication
    - Time element

Example
Transport rail cost $200
Transit time 10 days
Low value product
Inventory cost 10$ a day
Rail will be cheaper
Moved by air $1,000

- **Total cost concept**
  - Cost tradeoff
    - Transportation and carrying inventory
  - Interface
    - Supply/production/Distribution
  - Production
    - Cost of interrupting production
    - Availability of transportation
      - Raw material example and location

Transportation

- **Modes to be connected**
  - Road, rail, air, water, pipeline
- Cost of carriage
  - Basic physical elements
    - Ways, terminals, vehicles
  - Fixed and variable cost
    - Purchase of the truck
    - Fuel, maintenance, ? driver's wage ?
- **Terminals**
  - Connections performance
  - Maintenance, owned by carriers or publicly owned
- Vehicles
  - All modes
    - Except pipelines

Intermodality

- Intermodality
  - **Recent reduction of transport cost … or not**
    - Containerization
    - Internationalization of standards
    - Rapid dissemination of information
    - Cure for land congestion but …

    Information technology
    - Crossdocking
      - Immediately dispatched
      - Depends on IT tools
    - Warehouse management system
    - Vendor managed inventory system VMI

A record-breaking 44 container ships are stuck off the coast of California

Congestion

when the demand for mobility exceeds the capacity of the transport system.

when random but predictable events bring about a temporary service disruption, such as an accident or a natural hazard, such as flooding

- increasing capacity engenders a hidden, induced demand

Technology

The commercial diffusion of Global Positioning Systems (GPS)

- identification and routing of vehicles
- better utilization of these assets.

Automatic Identification Systems (AIS)

- standard on all ships, allowing the monitoring of their location, direction, and velocity.

standardization provided by the Internet in terms of communication protocols

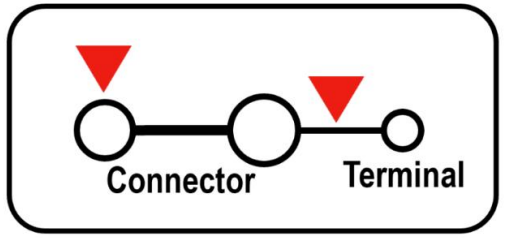
- establish interfaces with a large customer base, which permitted new forms of retailing
- E-commerce

Intermodality

- **E-commerce**
  - and Big Data : G.P.S., W.M.S….
  - Resulting in a strong competition among networks
  - To reconfigure traditional transport patterns
  - Reducing transaction costs …
  - Could affect number, size and location of physical points of sale such as … shops
- **Logistics and global production networks**
  - Complying with customer requirements
  - A detailed understanding of inefficiencies
    - Improvements through value stream mapping
  - 3PL firms carry out logistics functions
    - Instead of first and second party
    - Major freight forwarders
  - Self reinforcing fashion and decline in transport cost …

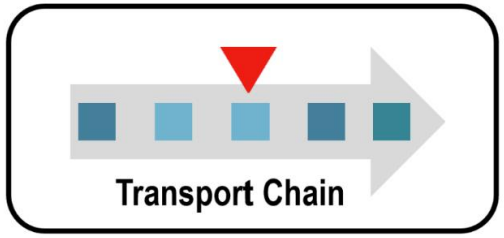
Bottlenecks identification

Infrastructure Bottlenecks



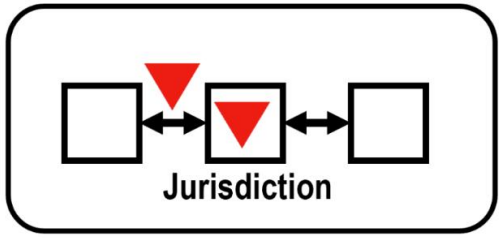
- Lack of terminal or connector capacity.
- Availability of conveyances.
- Natural or anthropogenic disruptions.
- Lack of investment and maintenance.

Operational Bottlenecks



- Lack of logistical services.
- Lack of logistical performance (cost, time and reliability).
- Lack of labor flexibility.
- Lack of qualified labor.

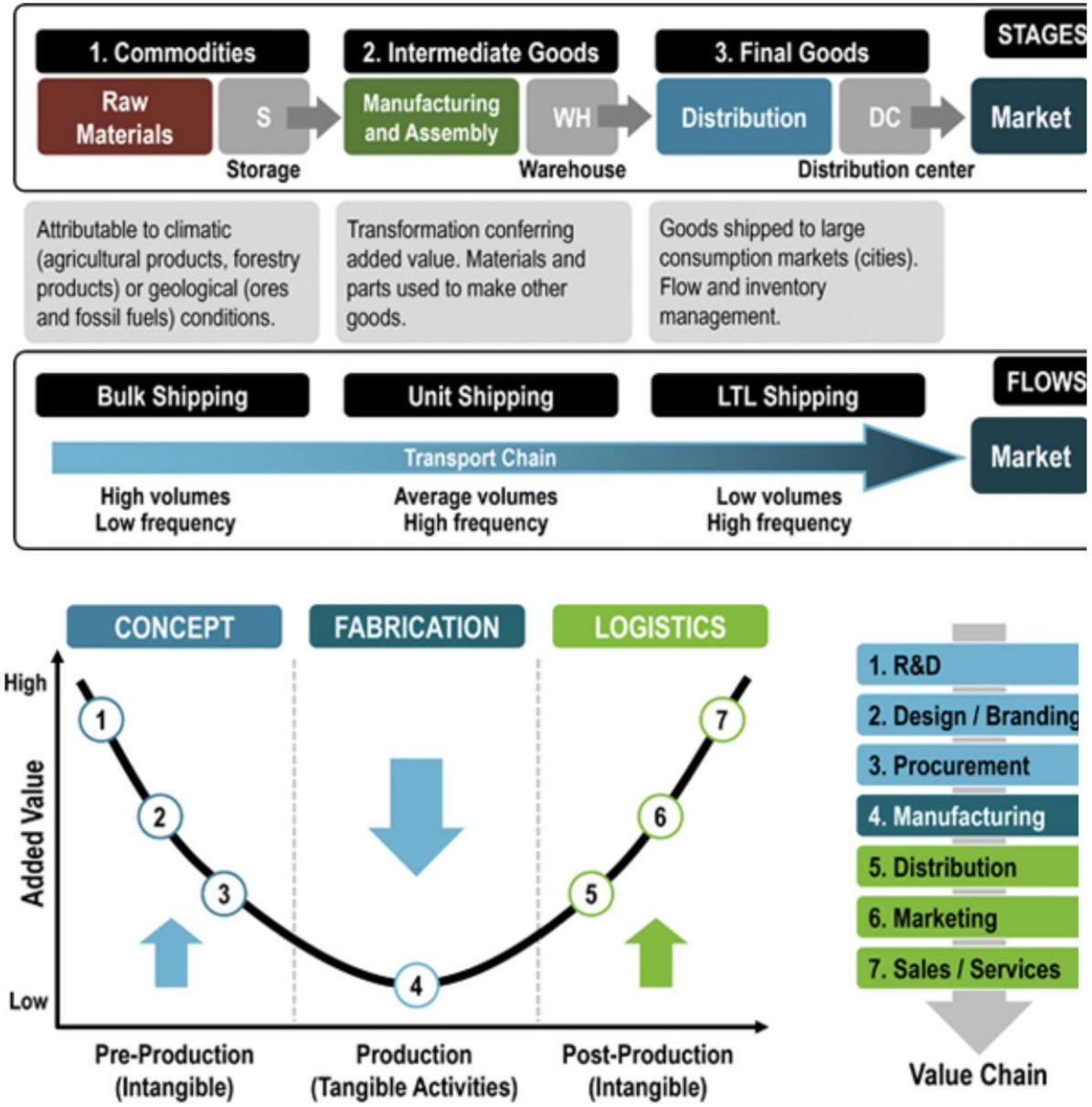
Regulatory Bottlenecks



- Customs clearance delays.
- Cabotage restrictions.
- Competition and fiscal policies.
- Lack of clear mandate and jurisdiction.
- Lack of coordination and cooperation.

VALUE CHAIN

- a series of nodes, linked by various types of transactions, such as sales and intra firm transfers.
- First stage : bulk and low frequency
- Second stage : manufacturing : containers
- Third stage : distribution : L.T.L.



Transport and logistics multinationals

Carriers	Terminal Operators	Logistics Service Providers
		
• Transport passengers or freight. • Own or lease their equipment. • Contracts or spot rates.	• Transship passengers or freight. • Own or lease (concessions) terminals. • Contracts or spot rates.	• Offer services such transport, warehousing and supply chain management. • Arrange transport chains with thei own assets or through third partie (carriers and terminal operators). • Contracts or spot rates.
• Maritime shipping (Maersk). • Air carriers (Emirates). • Rail carriers (BNSF).	• Container terminals (HPH). • Airports (Vantage Airport Group). • Rail (Rail Management Services).	• Freight forwarders / Third Party Logistics (DHL). • Logistics real estate (Prologis).

SUM UP

- Why is Multimodal transport key to global flows
- Why sustainable to coming years

After this main picture,
let's go further …
Multimodal transport is a critical solution but what's ABOUT multimodal transport

1- common characteristics

2- multimodal transport

3- intermodalism

4- combined transport

5- terminal and cargo handling equipment

1- Common characteristics

- **By at least two different modes of transport**
  - Multimodal transport
  - Intermodal transfer and transportation
  - Intermodal freight transportation
  - A single freight bill
    - *CEMT*

Single contract of carriage

- Through freight rate – liability storage – handling

Maritime access and use

- A network – all types of transportation
- Access
- Geography
- Economies of scale
  - Per unit cost – consolidation and break bulk
  - Infrastructure factor

2- multimodal transport

- Carriage of goods
- Containerised and non containerised transport
- General cargo
- Bulk cargo
- Neo bulk

• Several Contracts of Carriage (traditional concept)

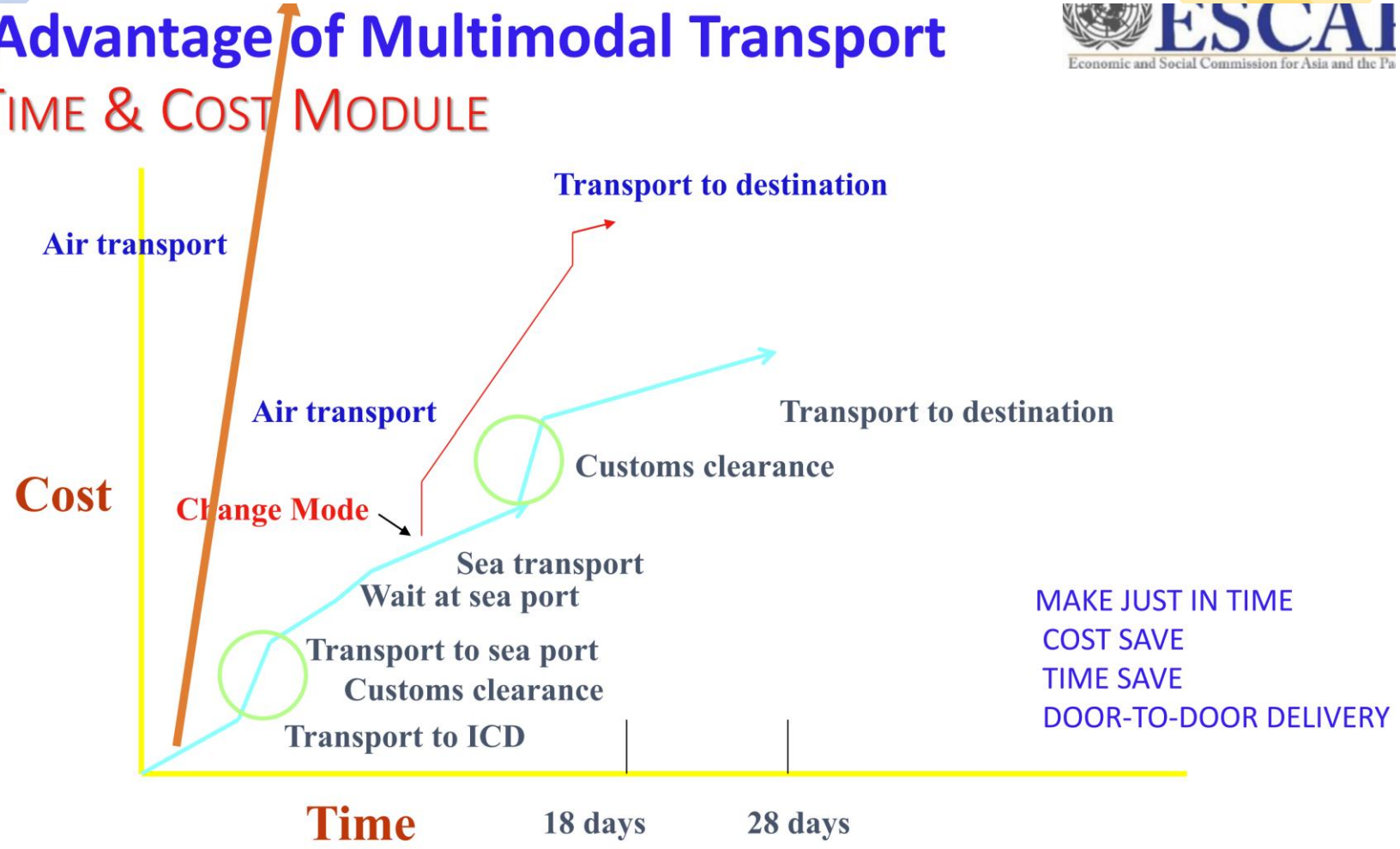
• Single Contract of Carriage but liability of carrier is based on each leg of transport at latter stage.

Advantages

- Reduction in the costs and time for coordination and operation of logistics.
- Increased monitoring of shipments from stage to stage.
- There is only one company in charge of meeting the shipment deadline; therefore, there is better control on management and less risk of merchandise theft or loss while responsibility lies on just one entity.
- Scheduling routes, costs, staff, and logistics becomes easier.
- The FBL document has preference to enter and go through customs

Advantage of Multimodal Transport

TIME & COST MODULE



MAKE JUST IN TIME
COST SAVE
TIME SAVE
DOOR-TO-DOOR DELIVERY

Disadvantages

- The merchandise may encounter legal and operational limitations when international standards are applied.
- For safety reasons, inspections in terminals are frequent, which limits operations

3- Intermodalism

Development of cellular containerships and relevant ports

Quick turn around

Increased productivity – efficient cost – effective transport network

Integration

- The same loading unit – eliminating to unpack and repack
- Containerised movement of cargo
  - Quicker transfer of cargo
  - Heavy capital investments

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3-

Transport and handling cost
- storage

Utilization of vehicles and facilities
- infrastructures

Paper work and time

Prevention from loss

Driver-accompanied / unaccompanied

ISO containers
- Rail or road

Short sea - deep sea and barge

Advantages

- Increased ability to negotiate terms per stage or stretch of the route.
- Each supplier is responsible for its service.
- Possibility to choose carriers and take advantage of the best rates for each stage or stretch of the route.
- Fewer inspections because containers are sealed in advance.
- Because everything is loaded in the same container, the time it takes for loading and unloading is lower.
- Increased flexibility and special handling of loading and unloading in different ports.
- Cheaper insurance premiums.
- Consistent Capacity and service such as Rail and truck
- Quality Service because choice of selection

Disadvantages

- Slower because cost reduction is prioritized.
- Less reliability because there are several suppliers answering for their own services.
- Tracking all the suppliers and coordinating solutions to delays with them.
- More expenditures due to the need to coordinate several contracts with different suppliers.
- The infrastructure that makes intermodal transportation easier for example, cranes for containers, is scarce and more expensive.
- Additional packaging costs to mitigate damage when moving merchandise

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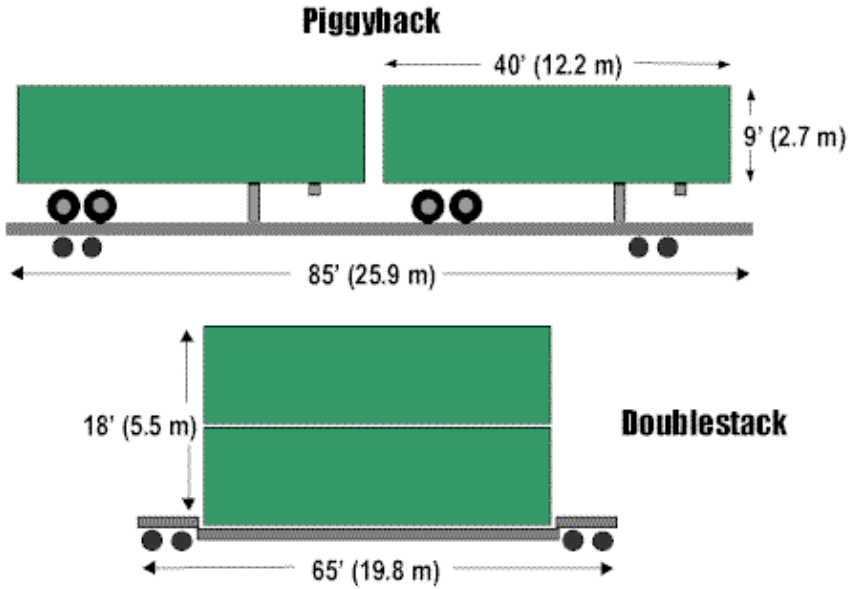
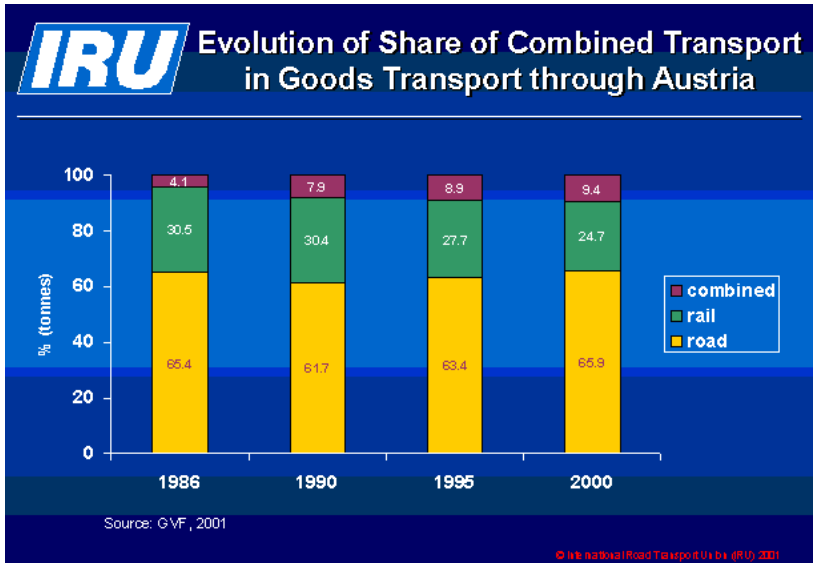
Intermodalism & container

4-Combined transport

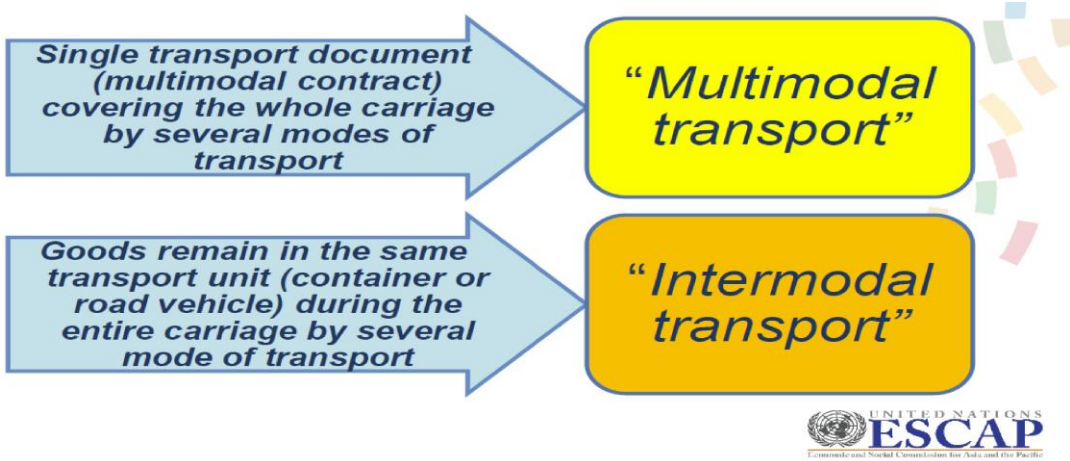




4-

- Definition
  - Intermodal transport units ITU
  - Remain in their original packaging
  - Roll on Roll off
  - Rolling road
  - Lift on lift off

SUM UP


Single transport document (multimodal contract) covering the whole carriage by several modes of transport
"Multimodal transport"
Goods remain in the same transport unit (container or road vehicle) during the entire carriage by several mode of transport
"Intermodal transport"
UNITED NATIONS
ESCAP

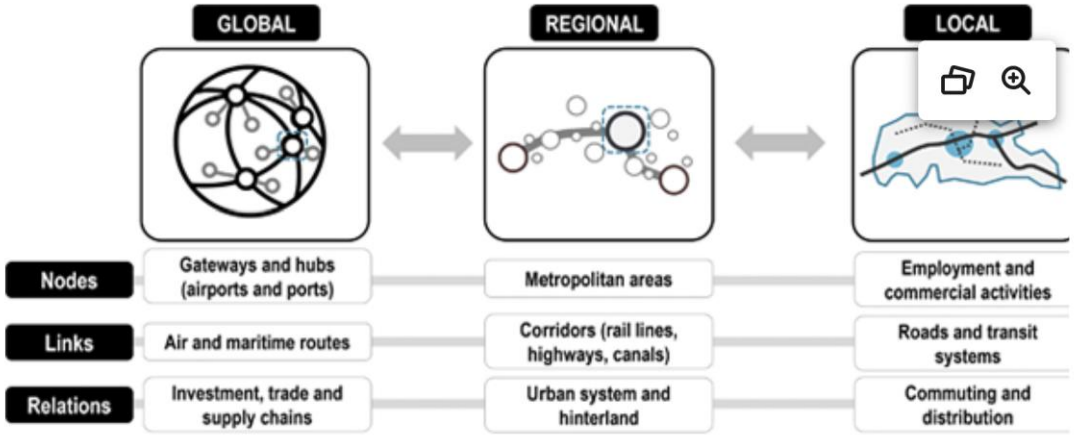
SUM UP

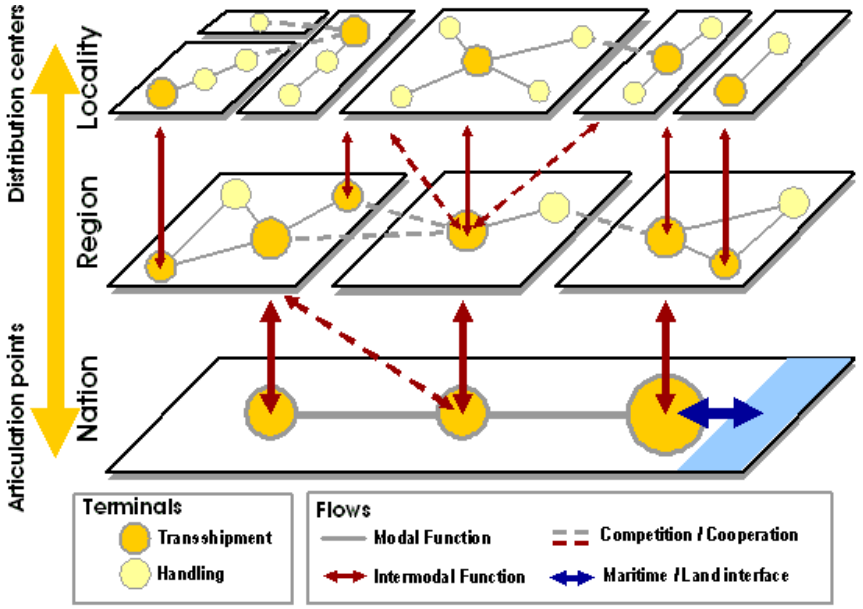
Definitions

- Multimodal
- Intermodal
- Combined

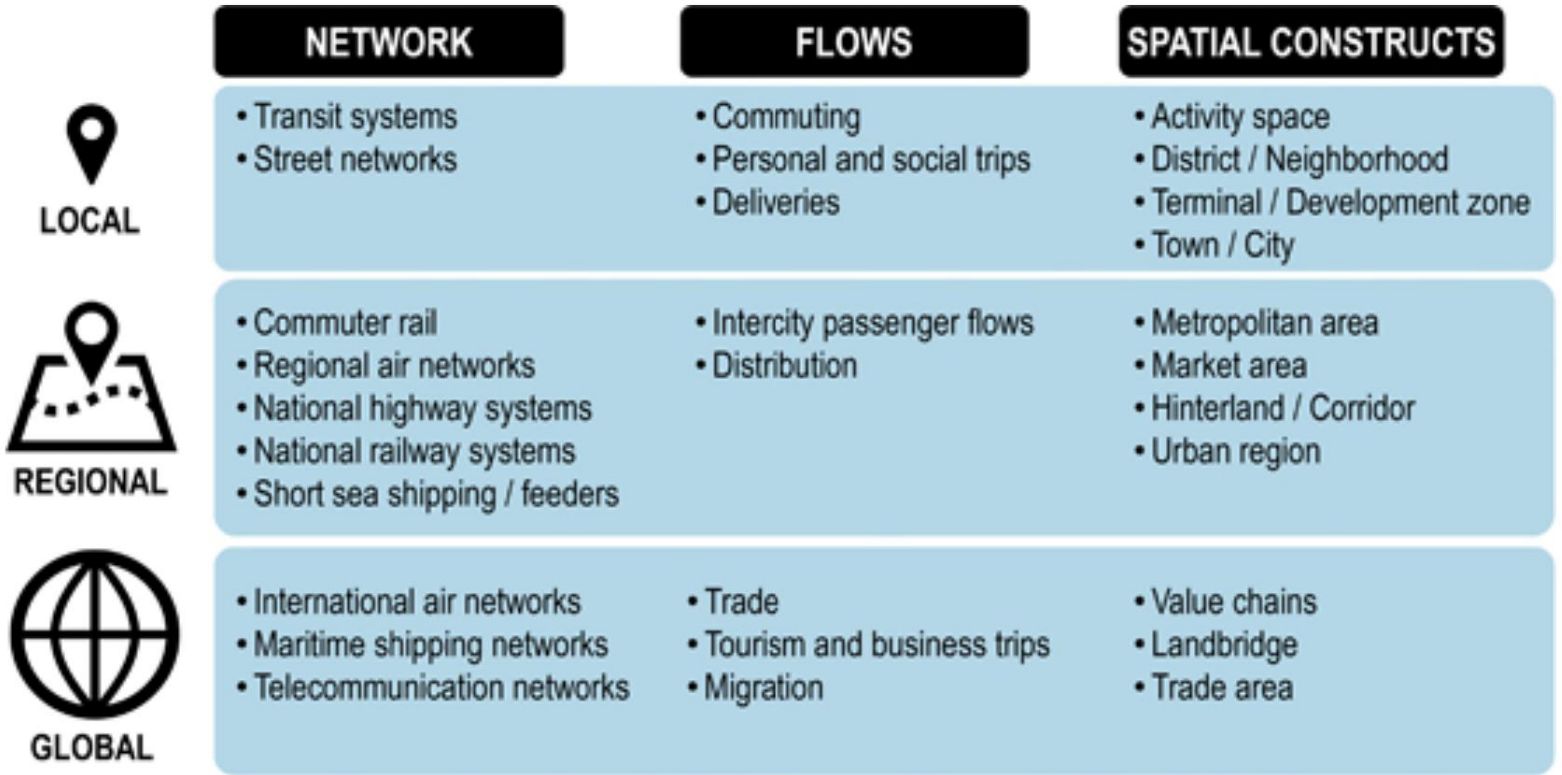
PREREQUISITE

5- Possible intermodal networks

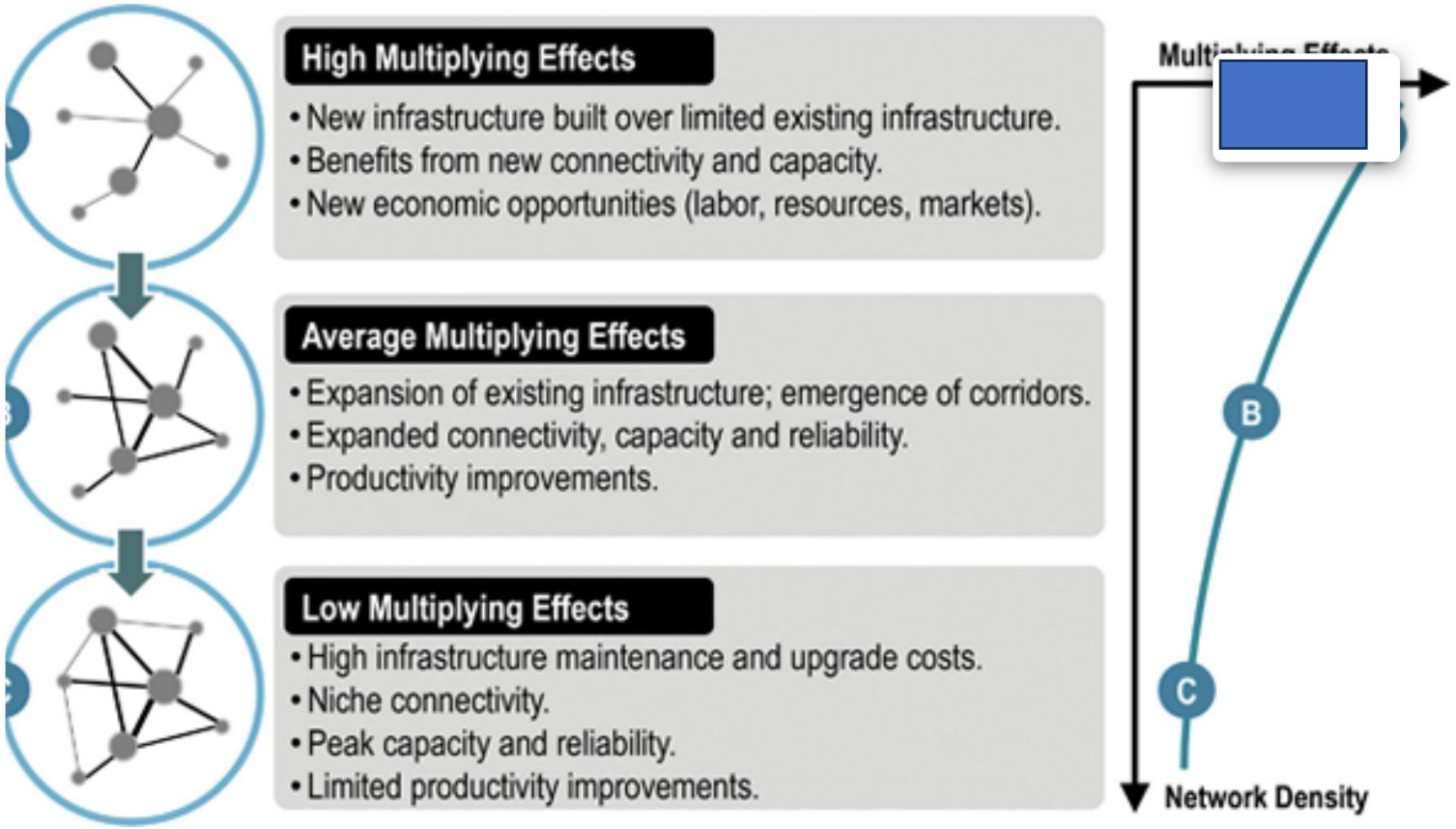




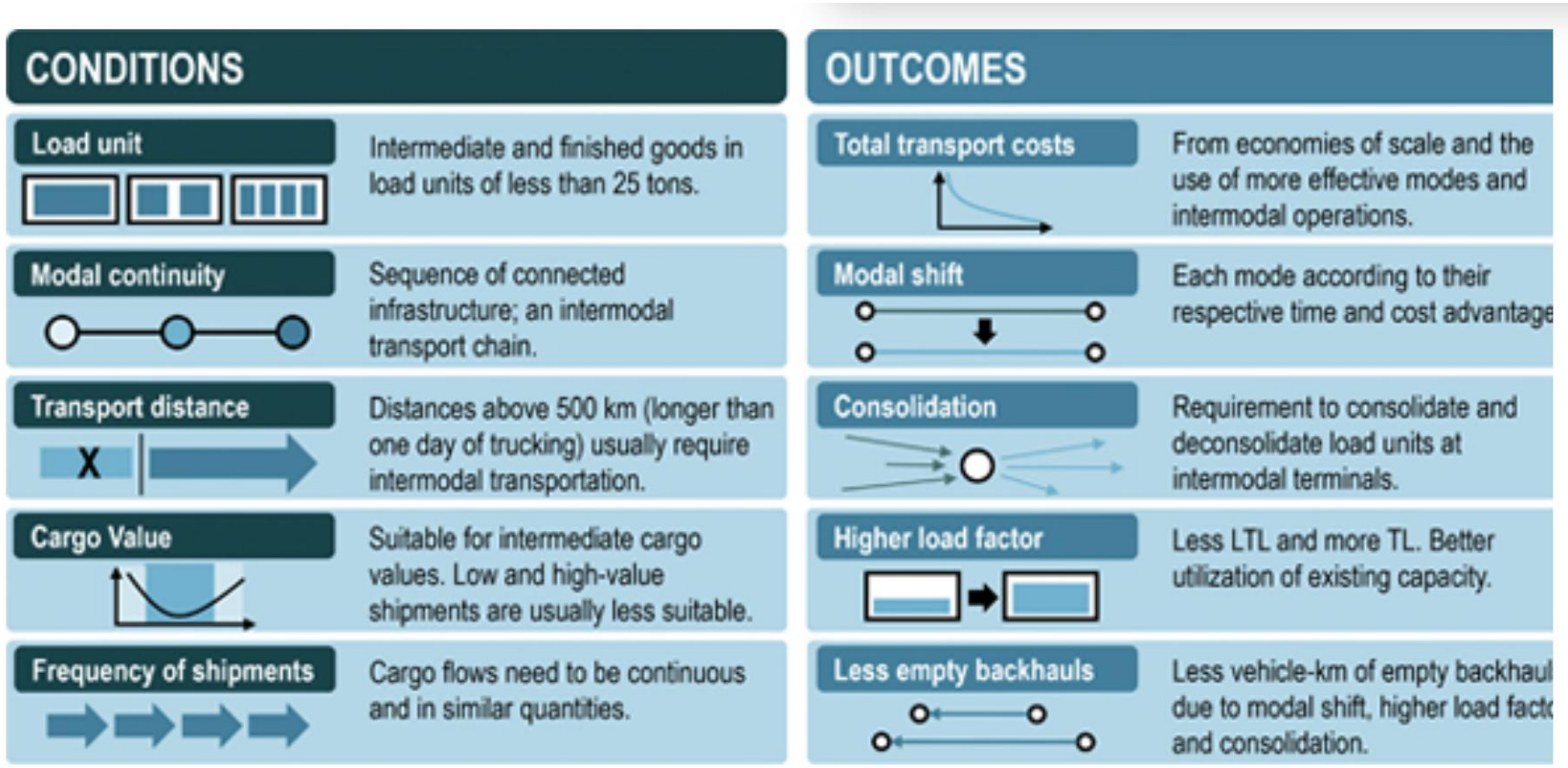
Scales


NETWORK
FLOWS
SPATIAL CONSTRUCTS
LOCAL
• Transit systems
• Street networks
• Commuting
• Personal and social trips
• Deliveries
• Activity space
• District / Neighborhood
• Terminal / Development zone
• Town / City
REGIONAL
• Commuter rail
• Regional air networks
• National highway systems
• National railway systems
• Short sea shipping / feeders
• Intercity passenger flows
• Distribution
• Metropolitan area
• Market area
• Hinterland / Corridor
• Urban region
GLOBAL
• International air networks
• Maritime shipping networks
• Telecommunication networks
• Trade
• Tourism and business trips
• Migration
• Value chains
• Landbridge
• Trade area

Return on infrastructures



Connections mode



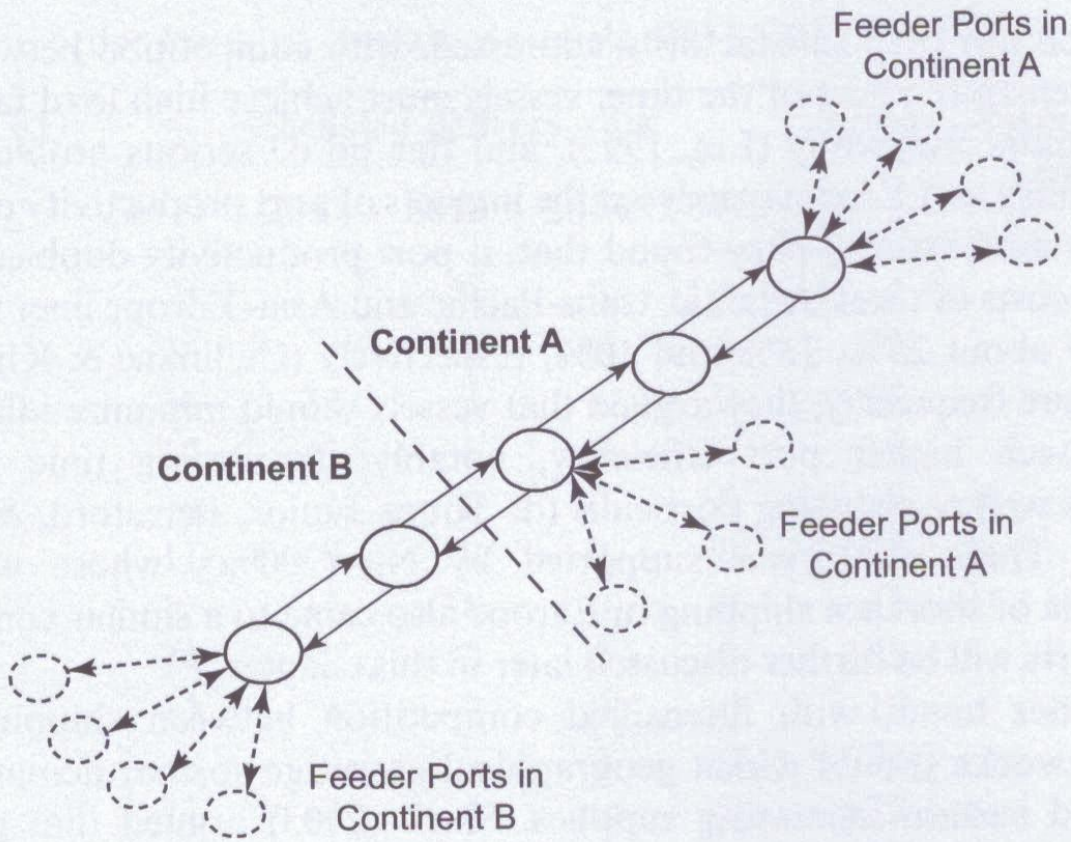
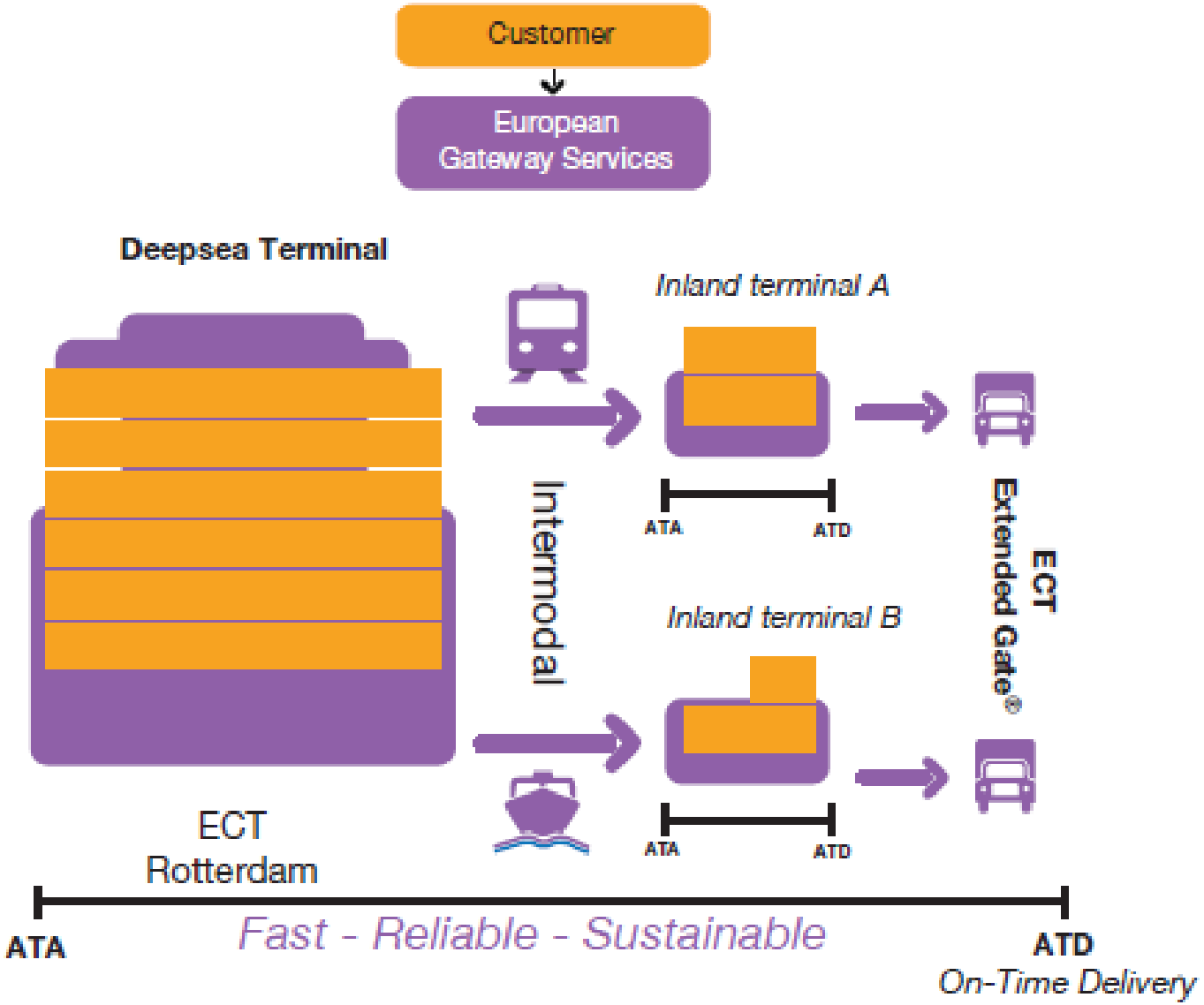
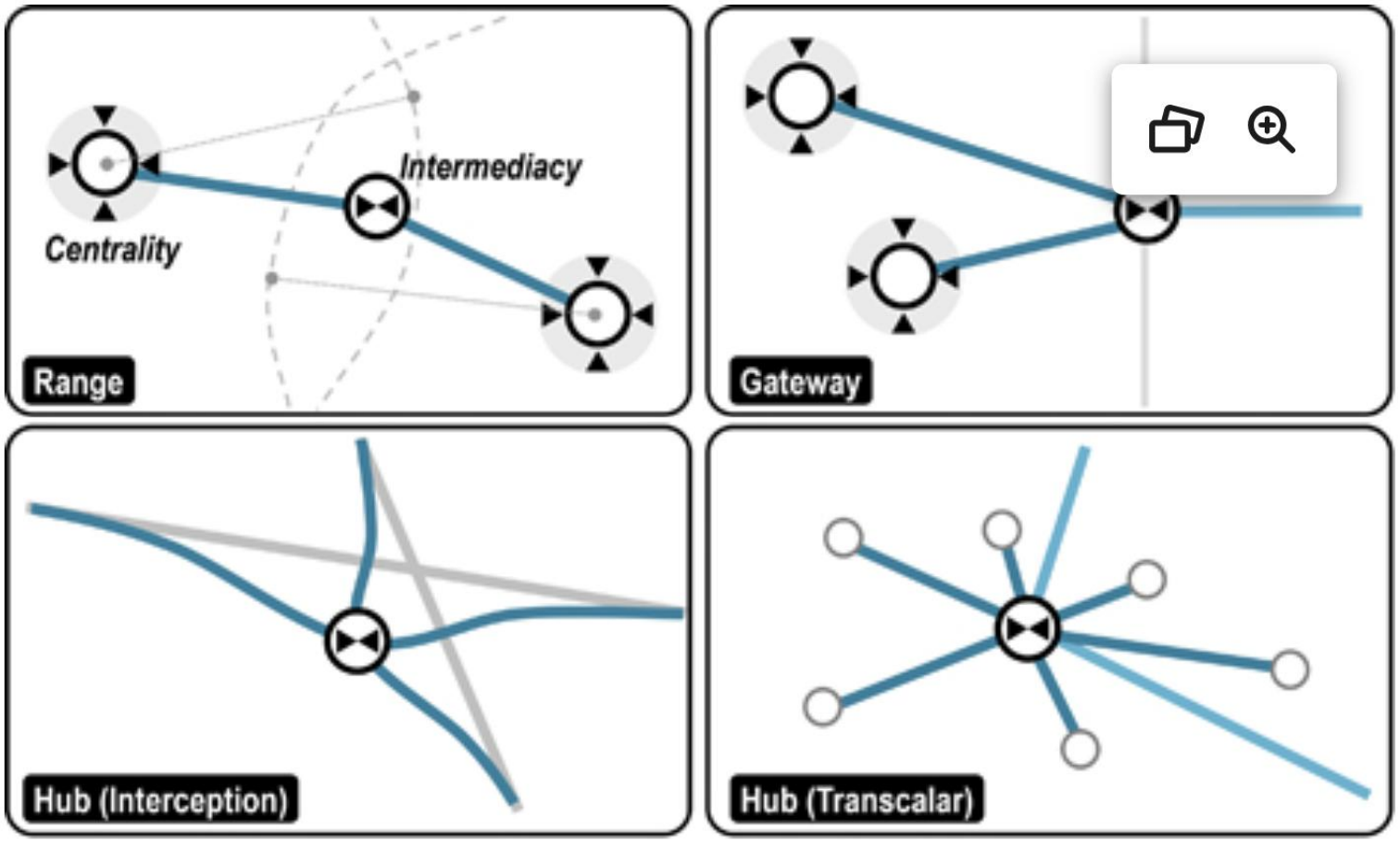


Figure 2.1: A diagram illustrating the trunk-and-feeder system in container liner shipping


Customer
European Gateway Services
Deepsea Terminal
Inland terminal A
Inland terminal B
Intermodal
ATA
ATD
ATA
ATD
ECT Extended Gate®
ECT Rotterdam
ATA
Fast - Reliable - Sustainable
ATD
On-Time Delivery

5- Liner production systems



5-Liner production systems

High transport demand spread over the whole year

Additional stops, in the vicinity of the two end points

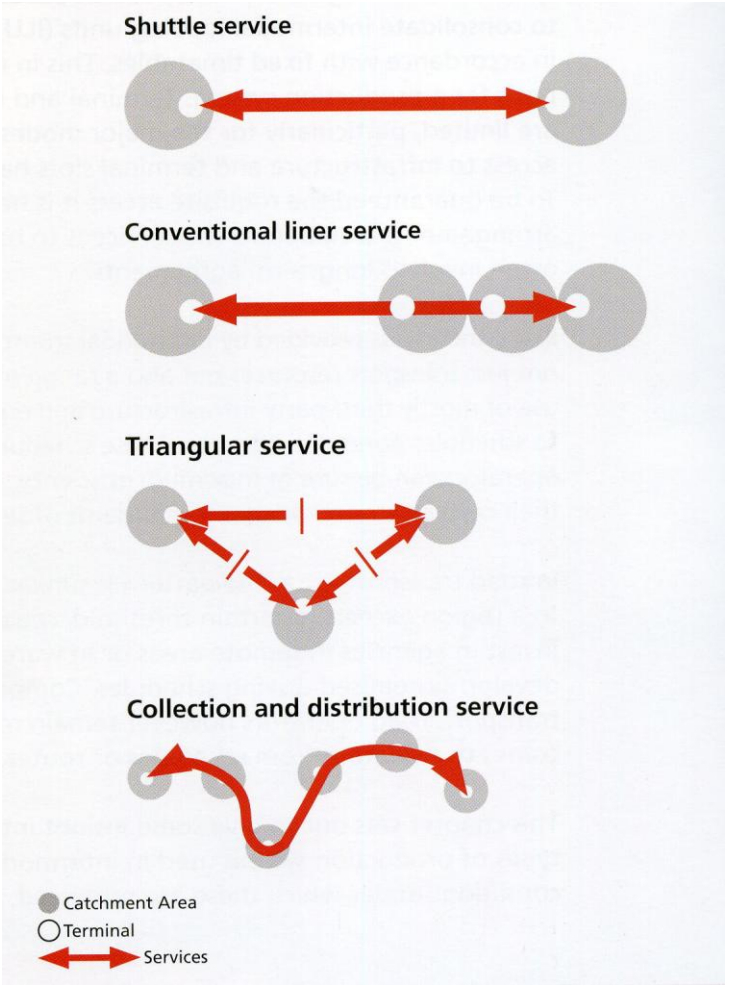
- Additional cargo
  - increases revenue

Additional stop costs time

- Extra call may add to
  - the trip distance

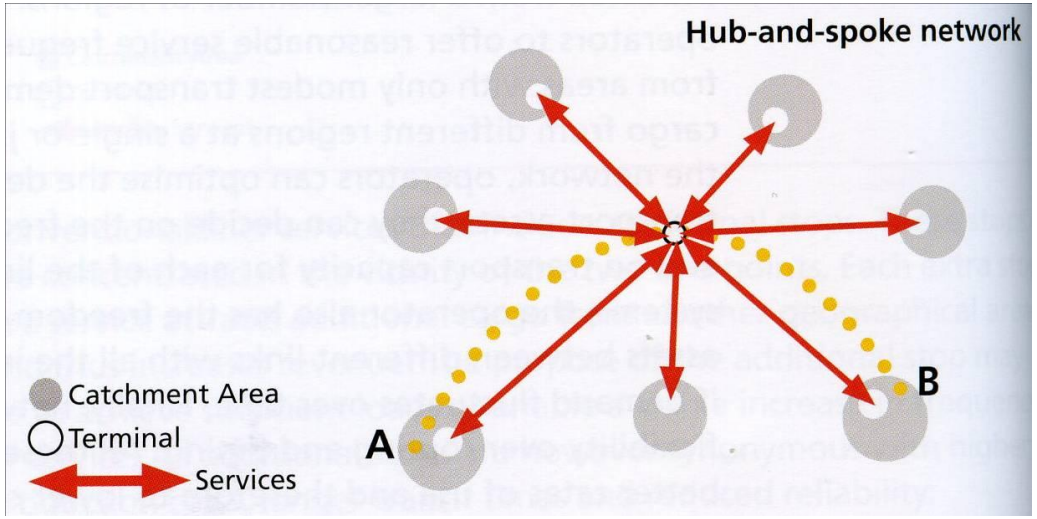
Triangular services

- Short sea shipping
- Regional distribution

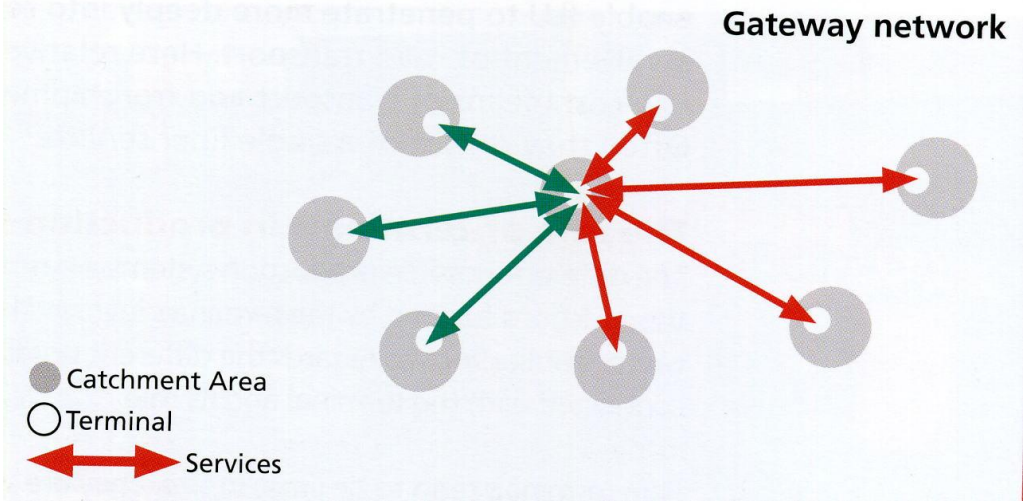


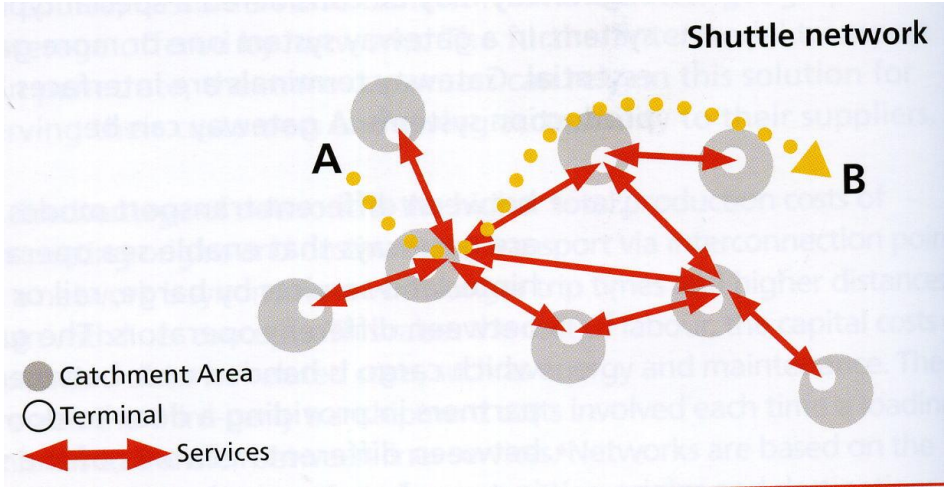
5- Network production systems

Interconnection points
- A larger number of regions
- Deployment of transport assets
- Better geographical coverage



Interfaces between production systems
- Transport modes
- Operators
- Both





5- shuttle network

- Hub and Spoke
  - Large in size
  - Not necessarily linked to the close region
- Difference with gateway terminals
- Regional terminals

- **PORT CONGESTION**
- Optimization measures
    - Multi-pick lifting
    - Truck appointment system
        - Synchronised time slot
    - Extending gate opening hours
    - Electronic document transmission
        - Customs as well as payment documents
        - Seaway bill example
    - High speed gates
        - Optical character recognition
    - Automated yard marshalling
        - Rotterdam


SCHELDE
SAFTINGENDOK
PSA - HNN
DEURGANCKDOK
ANTWERP GATEWAY

Table 7.2 Key figures for selected container ports

Characteristic	Port of Singapore[a]	Port of Shenzen[b]	Port of Hamburg[c]	Port of Los Angeles[d]	Port of Klaipeda[e]	Port of Riga[f]
# terminals	7	4	4	8	2	2
# berths[g]	57	58	25	31	6	2
quay length	17.350 m	17.505 m	7.570 m	9.336 m	1.908 m	645 m
# STS cranes	212	175	80	72	9[h]	7[i]
terminal area	700 ha	792 ha	440 ha	684 ha	54 ha	125 ha
mio TEU (2014)[j]	33,87	24,03	9,73	8,33	0,49	0,39
Transhipment share	85% (2013)[k]	50% (2013)[k]	36% (2015)[l]	<10% (to date)[m]	<10% (to date)[m]	<10% (to date)[m]

a PSA Singapore, 2016.
b Zheng and Park, 2016.
c Hamburg Port Authority, 2016.
d Port of Los Angeles, Container, https://www.portoflosangeles.org/, 2016.
e Drungilas, 2015.
f Freeport of Riga Authority, 2009.
g Berth length: about 300m
h Thereof 4 mobile cranes.
i Thereof 1 mobile crane.
j World Shipping Council, Top 50 world container ports, http://www.worldshipping.org/about-the-industry/global-trade/top-50-world-container-ports, 2016.
k Marine Information Service, 2015.
l Hafen Hamburg Marketing, 2016.
m Rodrigue, J.P., The geography of transport systems: Levels of transshipment incidence, https://people.hofstra.edu/geotrans/eng/ch4en/conc4en/transshipment_incidence.html, 2016.

Key figures for selected container ports

Ship To Shore STS

Yard operations

- Reefer container requirement
- Containers with hazardous goods
- Empty containers stacking
- Landside operations
- Terminal types
  - Pure transhipment terminal
  - Combined transhipment and gateway terminal
  - Pure gateway terminal
  - Trans terminal

Container terminal classification and KPIs

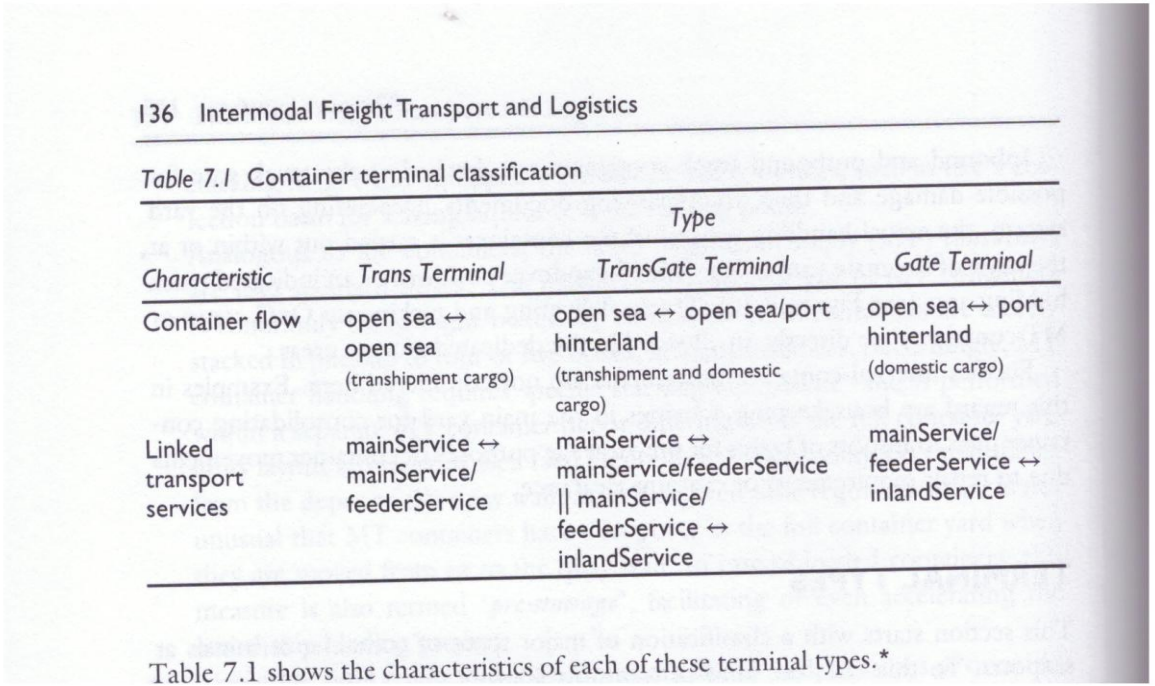


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Table 7.1 Container terminal classification

Characteristic	*Type*		
	Trans Terminal	*TransGate Terminal*	*Gate Terminal*
Container flow	open sea ↔ open sea (transhipment cargo)	open sea ↔ open sea/port hinterland (transhipment and domestic cargo)	open sea ↔ port hinterland (domestic cargo)
Linked transport services	mainService ↔ mainService/ feederService	mainService ↔ mainService/feederService || mainService/ feederService ↔ inlandService	mainService/ feederService ↔ inlandService

Table 7.1 shows the characteristics of each of these terminal types.*

Available Port Data	Yield	Available Port Metrics	
Always		**Land Use**	
Channel & Berth Depth		TEU/Gross Acre	Gross/Net CY Acres
Berth Length		TEU Slots/CY Acre (Density)	Net/Gross Ratio
Berths		TEU Slots/Gross Acre	CY Utilization
Cranes & Types		TEU/Slot (Turns)	Moves/Container
Gross Acres		TEU/CY Acre	Avg. Dwell Time
Port TEU		**Crane Use**	
Avg. Vessel TEU		Number of Cranes	Avg./Max Moves per hour
Vessel Calls		TEU/Crane	TEU/Available Crane Hour
Sometimes		Vessel Calls/Crane	TEU/Working Crane Hour
Avg. Crane Moves/hr		Crane Utilization	TEU/Man-Hour
CY & Rail Acres		**Berth Use**	
TEU Slots		Number of Berths	Max Vessel DWT and TEU
Estimated		Length of Berths	TEU/Vessel TEU
Max Vessel TEU		Depth of Berth & Channel	Vessel TEU/Max Vessel TEU
Confidential		TEU/Berth	Berth Utilization - TEU
Costs		Vessels/Berth	Berth Utilization - Vessels
Man-hours		**Balance & Tradeoffs**	
Vessel Turn Time		Cranes/Berth	Net Acres/Berth
Rates		Gross Acres/Berth	Cost/TEU
Avg. Dwell Time		CY Acres/Berth	Man-Hours/TEU
Working Crane Hours		CY Acres/Crane	Man-Hours/Vessel

1 acre = 0.40 ha

- PORT CONGESTION
- Optimization measures
  - Hinterland traffic diversion
  - Congestion pricing
  - Off-dock container yards
  - Fast rail shuttles
  - Expanded rail connections

Examples ….

Appendix A: Survey Country Reviews on Congestion

Table 4.A.1: Synthesis of survey country reviews on congestion.

Port	Measurement and data used	Current state of congestion	Expected development of congestion	Policy plans
Miami	No structural measurement	Problem landside: gate, location close to city	Increasing	Major port redevelopment, new gate system
Antwerp	Time registration for every vessel	Sometimes congestion, especially at terminals	Situation will improve: new quays, better rail, inland navigation and trucking system	Barge Traffic Services, new rail system, trucking assignment
Gdynia	No structural measurement	No congestion, at least not on maritime side	Worsening if no measures	Better hinterland connections
London	Every vessel is registered by the Port Authority	No structural congestion on maritime side	Probable worsening in hinterland	No structural plans
Rotterdam	No vessel registration	Only congestion on hinterland side	Pessimistic	No new infrastructure plans
Humber	Time measurement for every vessel	No congestion	No immediate worsening	No plans needed at this stage
Hamburg	No measurement	Congestion occurs, but not quantified	No worsening	No plans available
Long Beach	Some measurement, not structural	Road and rail increasingly congested, terminals equally congested	As traffic increases, problems may worsen	No immediate plans
Felixstowe	Shipping companies do measurements	No congestion	No worsening expected	No plans
Barcelona	Measurement of time that goods spend in port	Some inland congestion	No worsening expected	Discussion groups, no plans yet
Kotka	Data are collected for ships and at terminal	No real congestion	No worsening expected	No plans

SUM UP

- What are transport production systems ?
- What are nodes ?
- What has multimodal transport to manage ?

6- terminal and cargo handling equipment

Inter port competition has intensified

Less fidelity of shipping lines

Example of New York and Maersk 570 m $

Efficient infrastructures

- Coopetition and regional port governance
- Busan and Rotterdam

Le Havre Hamburg ranges 130 ports more than 120 million ctrs,

The Pearl River Delta

Acronyms by sea to locate delivery

Carriers, be careful !

Free In	Free In FI : on board ship/ port of departure
Free in	Free in Stowed FIS : on board ship port of departure stowed
Free out	Free out FO : on board ship, port of destination
Free In	Free In / Liner Out FILO : on board ship port of loading (regular lines)
Board	Liner In / Free Out LIFO : on board ship port of arrival (regular lines)
Free In and Out	Free In and Out FIO : on board ship port of departure, on board ship port of arrival, stowed
Free In	Free In Out Stowed FIOS : On board port of departure, on board port of arrival , stowed
Free in	Free in Out Trimmed FIOT : idem FIO, marchandises en vrac nivelées

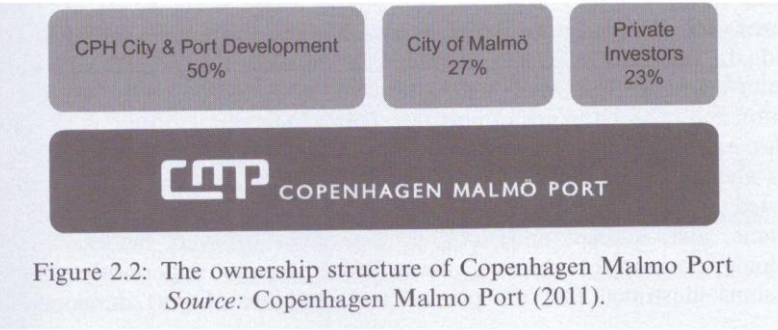


Figure 2.2: The ownership structure of Copenhagen Malmo Port
Source: Copenhagen Malmo Port (2011).

Synchronization between ports is needed :
Container transhipment traffic
+ 32% in Europe
+ 25% in Far East
+ 51% South East Asia
+ 31% Latin America
+ 33% in Africa

6- terminal and cargo handling equipment

- Some definitions
  - Terminal
    - Transshipment and storage of ITU's
    - Any location where either originate, terminate or are handled in the transportation process.
    - Central and intermediate locations in the mobility of freight.
    - require specific facilities and equipment to accommodate the traffic they handle.
    - A utilization rate of 75–80% of design = to be optimal, above this level, congestion starts to rise
  - Hub
    - Central distribution point

6- terminal and cargo handling equipment

- Efficient infrastructural facilities
  - Crane
  - Gantry crane
  - Straddle carrier
    - Rubber tired overhead lifting vehicle
  - Reach stacker
  - Spreader
    - Adjustable fitting for containers
- Bulk cargo transfer
- Containerized cargo transfer
  - Including pipelines to tank containers

Inland port

- Railroads
- Water access
- road

6-

- Inland container depots

  also called dry ports
- A kind of warehouse area
  - To relieve congestion at the ports
  - To extend continuous movement of containers
  - Handling containers
  - Special containers
  - Receipt and delivery
    - Weighing, inspection of seals and damages, container information control
    - Consolidation and distribution
  - Depot function
  - Maintenance and repair
  - Customs clearance activities at inland terminals and not at port location
  - Under bond
  - Physical distribution services

- Dry port
  - An ICD with large logistics area

- Container freight stations
  - Stuffing / destuffing service
  - Consolidation points
  - Customs formalities
  - Customs service
  - LCL cargo / FCL shipments
  - CFS to ICD

6-

Conventional

Small terminal surface

Direct transshipment possible

Limited mechanization and automation

Improvisation in terminal operations

Container

Large terminal surface

Indirect transshipment (modal separation in time and space)

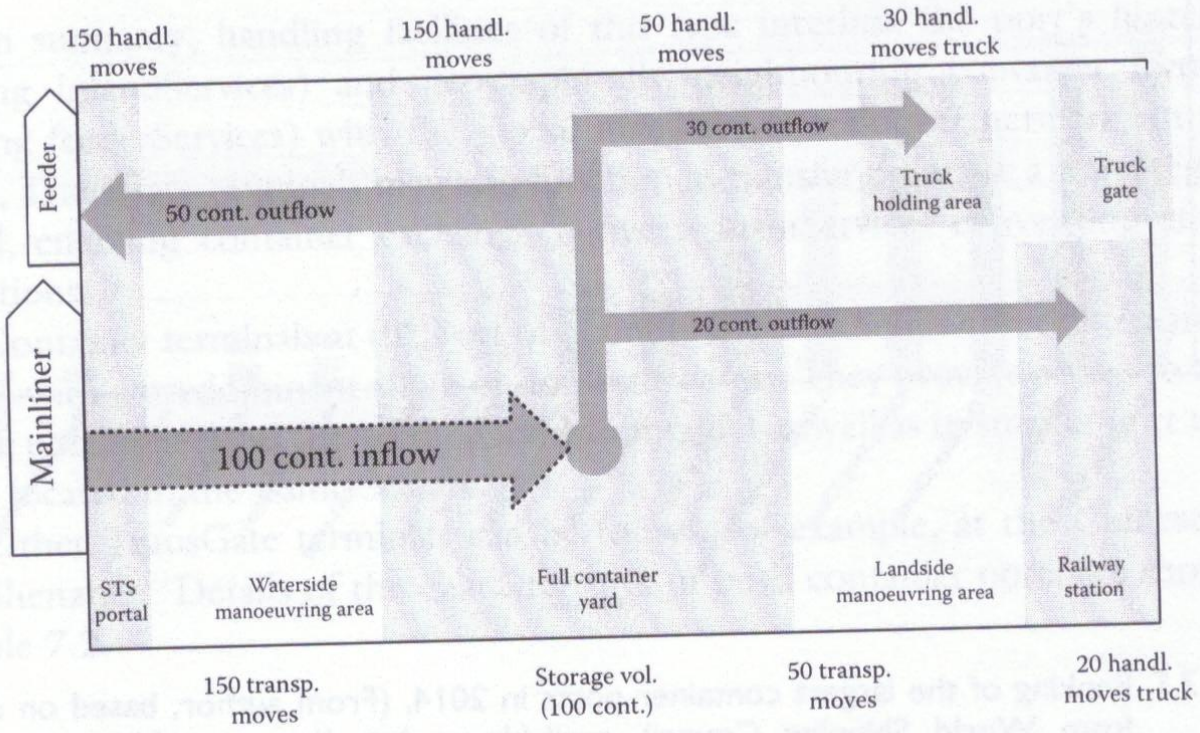
Advanced mechanization and automation

Organization and planning

6-

- Terminal characteristics
  - Intermodal interchange
    - Road rail / road barge
  - Location
    - Small package industry
    - Access
      - Airports as well as Ports
  - Productivity
    - Port hinterland operations
      - Adequate terminal access for various modes
      - Meet scheduling
      - Level of throughput and…
      - Of course, profitability

Terminal flows



Shares of derivative outflows: 50% feeder transhipment, 30% truck, 20% rail

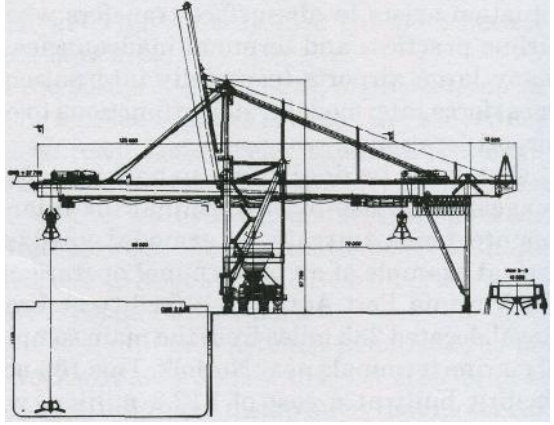
Figure 7.6 Original main service inflow of 100 containers and resulting derivative outf with associated logistical requirements (example).

6-

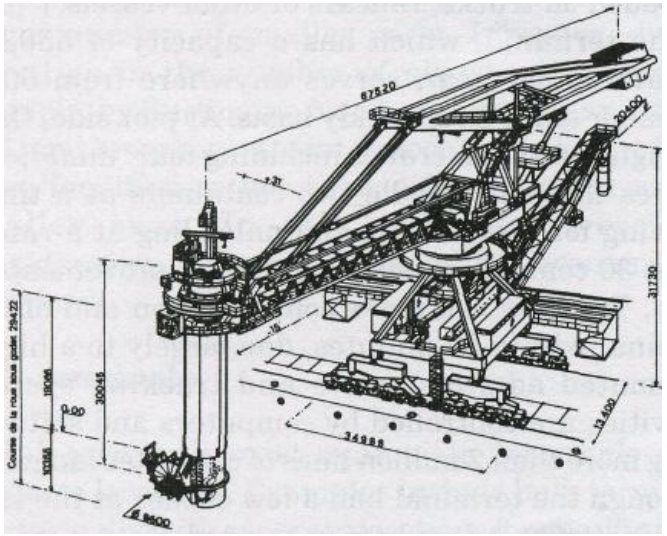
- **Terminal characteristics**
  - Density of terminal placement
    - Greater density, smaller terminals
    - Large ocean terminals
    - Successful small package services
    - Sub-terminals
    - Direct vessel rail
      - Front Royal 235 miles from New-York
    - Advance marine terminals
      - HK terminal
      - Rotterdam Delta terminal

6-

- **Cargo transfer**
  - Skilled staff and container equipment
  - All necessary documents
  - Maintain a status report
  - Preplan all loading / Unloading
  - Maintain security and … supervision
- **Intermodal** equipment for bulk freight transfer at ports
  - Continous vs discontinous bulk movement
  - Types of sea port bulk handling equipment
  - Environmental and political concerns



Grab bucket



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• Container ports and equipment

- LCL infrastructure
- Computation of moves
- Cranes
  - Shore based
  - Rail mounted
  - Ahinged boom crane
- Spreaders and frames
- Straddle carriers
  - Bigger ships need biggercranes
- Stacking cranes
- Container handlers

Spreader

Straddle carrier

• Forklift trucks

Figure 2.9 Forklift handling an empty container. (From Michael Coghlan on Flickr. 'Handling a Container' is copyright (c) 2011 Michael Coghlan and made available under a Creative Commons Attribution-NoDerivs 2.0 Generic License.)

Comparative tasks

Trans terminal inbound to outbound feeder
Trans gate terminal : feeder to mainliner hub

Each of them is separated

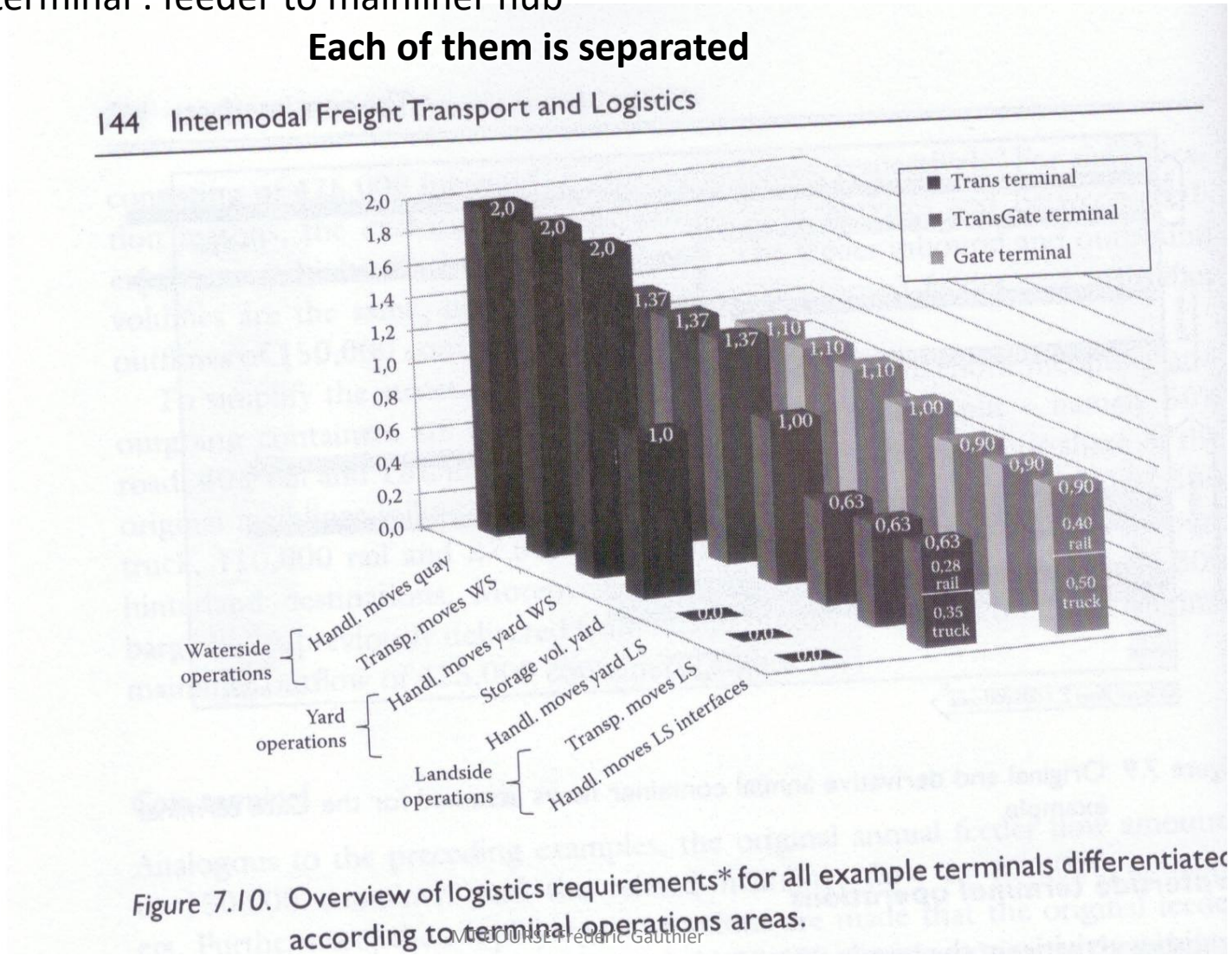


Figure 7.10. Overview of logistics requirements* for all example terminals differentiated according to terminal operations areas.

Land Intermodal terminal design example

- Location
- Marshalling
- Slopes and tracks availability
- Electrification of tracks and terminals
- Signalling systems connected to the terminal
- Paving
- Truck entry and exit capacity
- Lighting (security)
- Local road network
- Security
- A yard for wagons and containers
- Sufficient length

STRADDLE CRANE

- **Not transferred directly from a ship to a railcar**
  - Rail intermodal terminal
  - Inland intermodal facilities
  - Straddle cranes
  - Smaller intermodal facilities : side loaders – oversized forklifts

Figure 2.10 Reach stacker loading a container onto a train. (From Rickard Bergqvist and Jason Monios.)

Table 6.1 World Bank toolkit

No.	Section
1	Introduction and basic conditions
2	Handover
3	Project control and finance
4	Extension works
5	Operations
6	Fees
7	Legal and insurance
8	Hand back
9	Legal and insurance
10	Performance
11	Legal and insurance

Source: Adapted from Monios, J., Bergqvist, R., *Research in Transportation Business & Management* (*RTBM*), 14 (March). 1–3, 2015.

Terminal costs

Loading and unloading ships at an intermodal container terminal, we can manage, *average waiting time*

- Utilization of the system is less than 100%
  - no ship has to wait
  - **U = p/m * a** where p is the **number of hours** needed to load/unload a ship,
    - **a** is number of hours that pass between arriving to be loaded/unloaded
    - **m** number of **container cranes**
  - U < 100 %
- But **existing variability** following a given probability distribution to be predicted with
  - Tq = p/m * (u (exp squareroot(2*m+1))-1) /(1-u) * (((CV*a exp2) +(CVp exp2))/2)
  - Cva and CVp represent the coefficients of variation of the probability distribution used to model variation in the processing and inter- arrival time.

$$T_q = \frac{p}{m} * \frac{u^{\sqrt{(2*(m+1))}-1}}{1-u} * \frac{CV_a^2 + CV_p^2}{2}$$

Figure 2.11 Rubber-tyred gantry crane. (From Rickard Bergqvist and Jason Monios.)

Intermodal life cycle

Length	Planning, funding and development 3 to 10 years	Finding an operator 1 to 2 years	Operations and governance More than 10 years	Extension strategy More than 15 years
Main stake holders	Public infrastructures (authorities) Terminal operators Large shippers Ports Rail operators	Public infrastructure Terminal operator Terminal owner	Public infrastructure Terminal operator Terminal owner Rail operator	Public infrastructure Terminal operator
Main activities	Planning and design Funding construction	Business design Ownership model Contract development	Responding to changes in technology and demand	Renewed concessions Potential changes in ownership Potential expansion
Main influences Relevant policy and regulatory issues	Market demand Location of competitors Avaibility of innovation and technology Interface between transport administration and infrastructure owner Government policy	Public policy Market structure to terminals and rail operations Interface Rail regulations	Market structure (rapid change) Competition and technology Interface Rail regulations Government policy	Declining demand Changes in distribution strategies Competition Demand for land Gobernment policu (modal shift, economice development) Incentives

Figure 2.15 AGVs in operation at a port container terminal. (From © Henrik Jesser BY 3.0] via Wikimedia Commons.)

6-

- Container ports and equipment
  - Side loaders
  - Yard hostels
  - Ocean land intermodal transfer point
  - Container chassis
  - Chassis flippers
  - Container handling standards

Side loader

Container chassis

- Equipment for intermodal transfer of breakbulk sea freight
  - Breakbulk cranes
  - Breakbulk forklift trucks
  - Winches and slings
- Equipment for intermodal transfer of RO/RO sea freight
  - Ro/ro forklift trucks

Breakbulk crane

Winches & slings

SUM UP

Discussion

- Compare for and against
  - Bulk
  - Container
- What key indicator we look for

	Ro-Ro operations	Lo-Lo operations
Number of TEU carried in 7x24 hours	2800	2100
Round trip time	84h	108h
Time in port per round trip	12h	36h
Transport time stack to stack	42-48h	54-72h
Transport cost stack-to-stack per unit (20 /40ft)	209 / 338	338 / 399

- Improvement in port performance
  - Ports and opening hours
  - Terminals
    - Indicators ISO
    - Global 40 €per TEU
    - Value example
      - PSA Singapore purchased 20% of Hutchinson port Hong-Kong 4.4 billions $
  - World leading ports by productivity

Rank	Port	Volume 2018 (Million TEU)	Volume 2017 (Million TEU)	Volume 2016 (Million TEU)	Volume 2015 (Million TEU)	Volume 2014 (Million TEU)	Website
1	Shanghai, China	42.01	40.23	37.13	36.54	35.29	English Chinese
2	Singapore	36.60	33.67	30.90	30.92	33.87	English
3	Shenzhen, China	27.74	25.21	23.97	24.20	24.03	Chinese
4	Ningbo-Zhoushan, China	26.35	24.61	21.60	20.63	19.45	English Chinese
5	Guangzhou Harbor, China	21.87	20.37	18.85	17.22	16.16	English Chinese
6	Busan, South Korea	21.66	20.49	19.85	19.45	18.65	English Korean Chinese Japanese
7	Hong Kong, S.A.R, China	19.60	20.76	19.81	20.07	22.23	English Chinese
8	Qingdao, China	18.26	18.30	18.01	17.47	16.62	English Chinese
9	Tianjin, China	16.00	15.07	14.49	14.11	14.05	English China
10	Jebel Ali, Dubai, United Arab Emirates	14.95	15.37	15.73	15.60	15.25	English Arabic
11	Rotterdam, The Netherlands	14.51	13.73	12.38	12.23	12.30	English Dutch Deutsch Chinese

Main gateways

- Gateway regions are groupings of gateways that are organized along a major corridor.
  - The Yangtze River Delta (Shanghai, Ningbo, Nanjing) is the most important gateway region, with a combined index of 8.9% of the world's containerized and air cargo freight
  - the Pearl River Delta (Hong Kong, Shenzhen, and Guangzhou) (8.6%)
  - the Strait of Malacca (Singapore, 6.7%)
  - the Rhine/Scheldt Delta for Western Europe (Antwerp, Rotterdam, 3.5%)
  - Southern California (Los Angeles area, 1.4%) for the American West Coast.
- Air
  - air cargo carries a high share in gateways such as Dubai, Seoul, and Bangkok

Classification

Port	Country	Container Volume (TEU)	Remarks
Port of Shanghai	China	47.0 million	Largest container port in the world
Port of Singapore	Singapore	37.2 million	Known for its efficiency
Port of Rotterdam	Netherlands	14.8 million	Largest port in Europe
Port of Hamburg	Germany	8.7 million	Investments in green technologies
Port of Los Angeles	United States	9.2 million	Largest port in the United States

2023 figures

Rank	Port	Country	Container Volume (TEU)
1	Port of Shanghai	China	47.0 million
2	Port of Singapore	Singapore	37.2 million
3	Port of Ningbo-Zhoushan	China	35.3 million
4	Port of Shenzhen	China	26.9 million
5	Port of Qingdao	China	26.4 million
6	Port of Busan	South Korea	22.8 million
7	Port of Tianjin	China	21.8 million
8	Port of Guangzhou	China	20.8 million
9	Port of Los Angeles/Long Beach	United States	16.6 million
10	Port of Jebel Ali	United Arab Emirates	14.5 million

Porter's 'Diamond' Model Applied to the Analysis of Container Port Competitiveness

Determinant:	Components:	Important for container ports to create and sustain competitiveness by:
Factor conditions	• Factor Endowment • Factor Hierarchy	- Availability of skilled, specialised, competent and motivated human resources - Favourable maritime access - Strategic geographical location - Stable climate - High quality port infrastructure - Good transportation network to access hinterland - Modern communications infrastructure - Available and accessible sources of financial capital - Available and abundant stock of scientific, technical and market knowledge - Active participation in factor-creation - Advanced and specialised factors
Demand conditions (e.g. of local hinterland)	• Demand Composition • Demand Size and Growth Pattern • Demand Internationalisation	- Quality of demand important for perceiving, interpreting and responding to user needs - Segment structure of demand shapes the attention and priorities of terminal operator - Sophisticated and demanding users provide window to future user needs - Size of demand important especially for cases involving substantial R&D, scale economies, uncertainty and technological requirements - Presence of a number of independent users foster faster rate of innovation - Rapid demand growth encourages investment in new products and facilities - Early saturation of demand increases pressure to innovate and upgrade - Inculcate domestic user needs into foreign users to internationalise demand base - Mobile or multinational local users can provide loyal customer base
Related and supporting industries	• Supplier industries • Related industries	- Presence of internationally competitive supplier industries - Presence of internationally competitive related industries
Firm strategy, structure and rivalry	• Strategy and structure of firm • Goals • Domestic rivalry • New business formation	- Management practices and mode of organisation must concur with national circumstances - Succeed when goals and motivation stimulate unusual commitment and effort - Status of national priority and/or prestige attracts outstanding talent and resources - Importance of sustained commitment - Successful operators compete intensely for home market and pressure each other to improve and innovate - New business formation feeds the process of innovation
Chance	• Events beyond ability of firm and government to influence	- Capitalise on opportunities created from discontinuities that shift competitive advantage
Role of government	• National, regional and local	- Potential impact from government policies - Opportunity to work together with government to reinforce competitive advantage

Source: Adapted from Porter (1990: 69-130).

Endowment = dotation

Annualized Slot capacity

$$T^{k}_{xt} = 2G^{k}_{xt}F^{k}_{xt}\frac{\sum_{h=1}^{n} V^{kh}_{xt}}{n} = 2G^{k}_{xt}F^{k}_{xt}W^{k}_{xt} \quad \ldots (7.1)$$

where: T denotes ASC, which is measured in TEUs, that called at port *X* for a particular service *k* for time period *t*;

G number of calls made at port *X* for the whole service loop;

F frequency of call in a year;

V_h capacity of vessel *h* for *n* vessels employed; and

W average capacity of vessels employed for $W^{k}_{xt} = \frac{\sum_{h=1}^{n} V^{kh}_{xt}}{n}$.

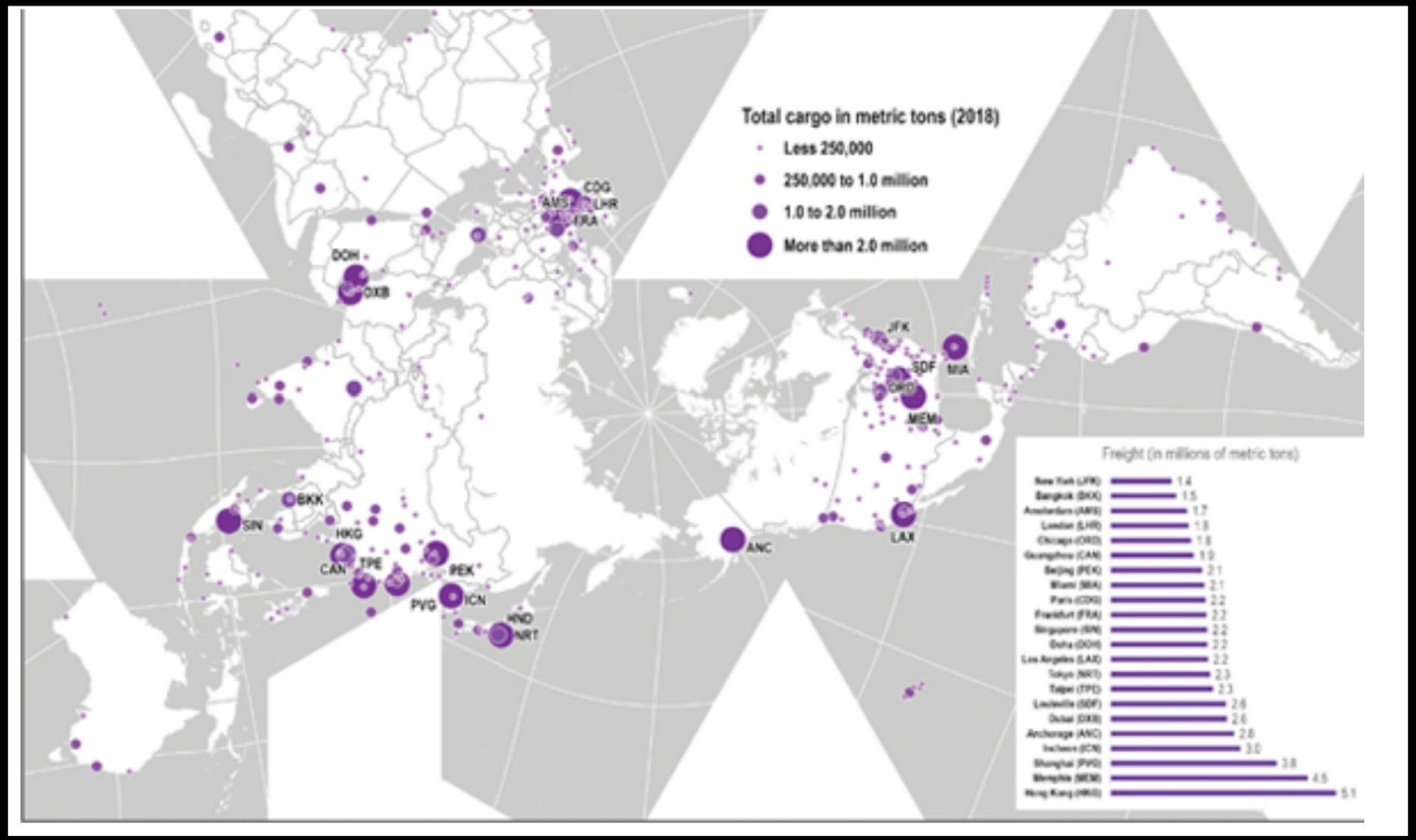
ASC example

- Service AES2 of the CHKY alliance
  - Port of rotation
    - Hamburg-Le Havre-Singapore-Hong Kong-Kobe-Nagoya-Tokyo-Shenzhen-Hong Kong-Singapore-Port Said-Rotterdam-Felixstowe-Hamburg
  - Regions connected to : NW Europe, SE Asia, East Asia and Near East
  - Trade routes connected to : Europe – Far East
  - Service partner : COSCO, Hanjin, K Line, Yangming
  - Service frequency : weekly
  - Vessels employed : 8 (by K Line)
  - Total vessel capacity employed : 44,780 TEUs
  - 1x5500 TEU, 5x5600 TEU and 2x5640 TEU

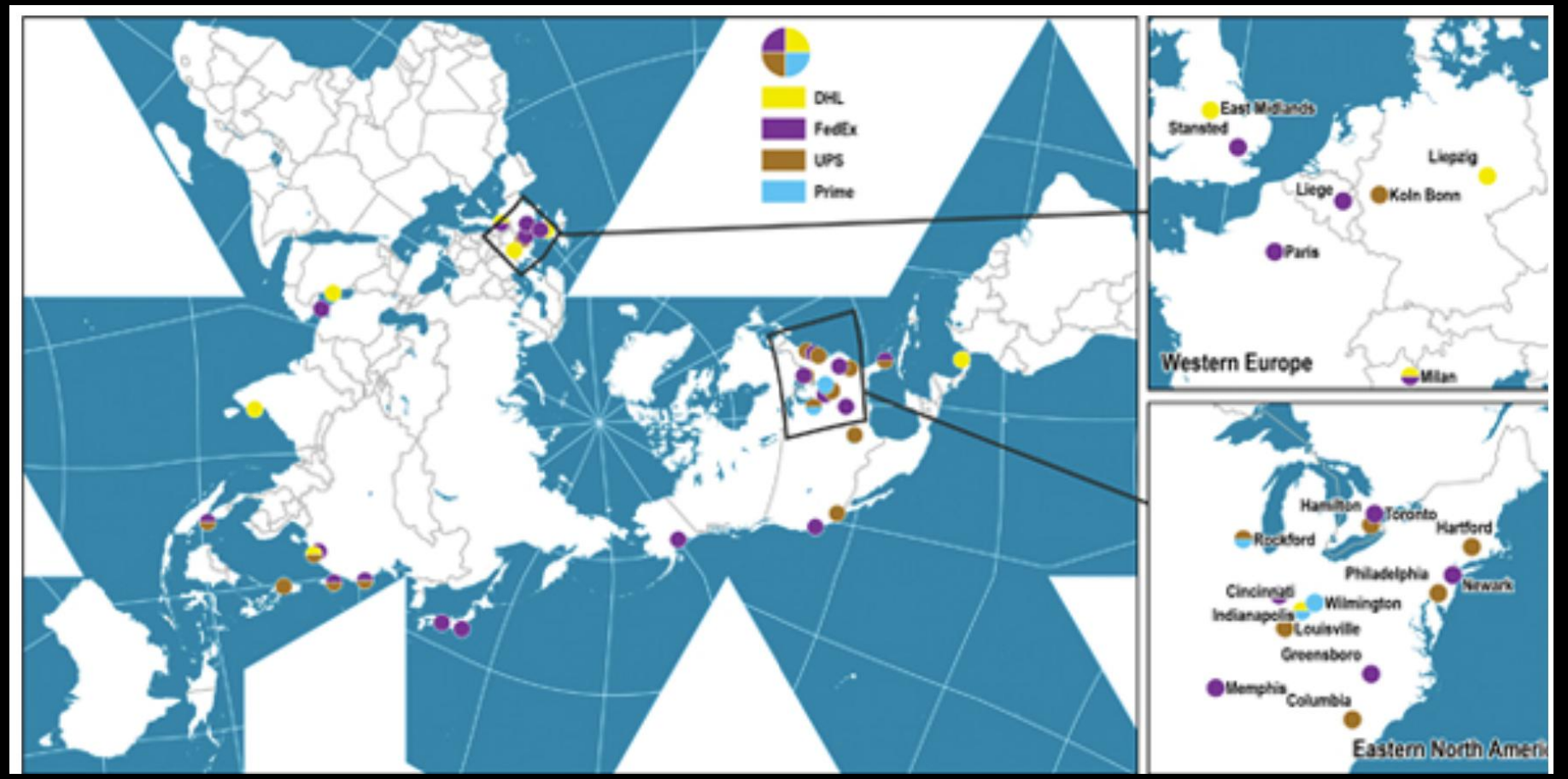
- Other modes
  - RoRo forklift trucks
    - Very short mast
  - Inland transport development
    - Russian federation
      - More than 200 millions tons
    - Yangtze river
      - More than 1billion tonnes
    - Wuhan more than 300 000t 1000 kms from Shangai
    - Railway transport

6-

- EU
- Russia
- USA
  - More than 3 billion tonnekm
- Corridors
  - Asia / Europe mainly China

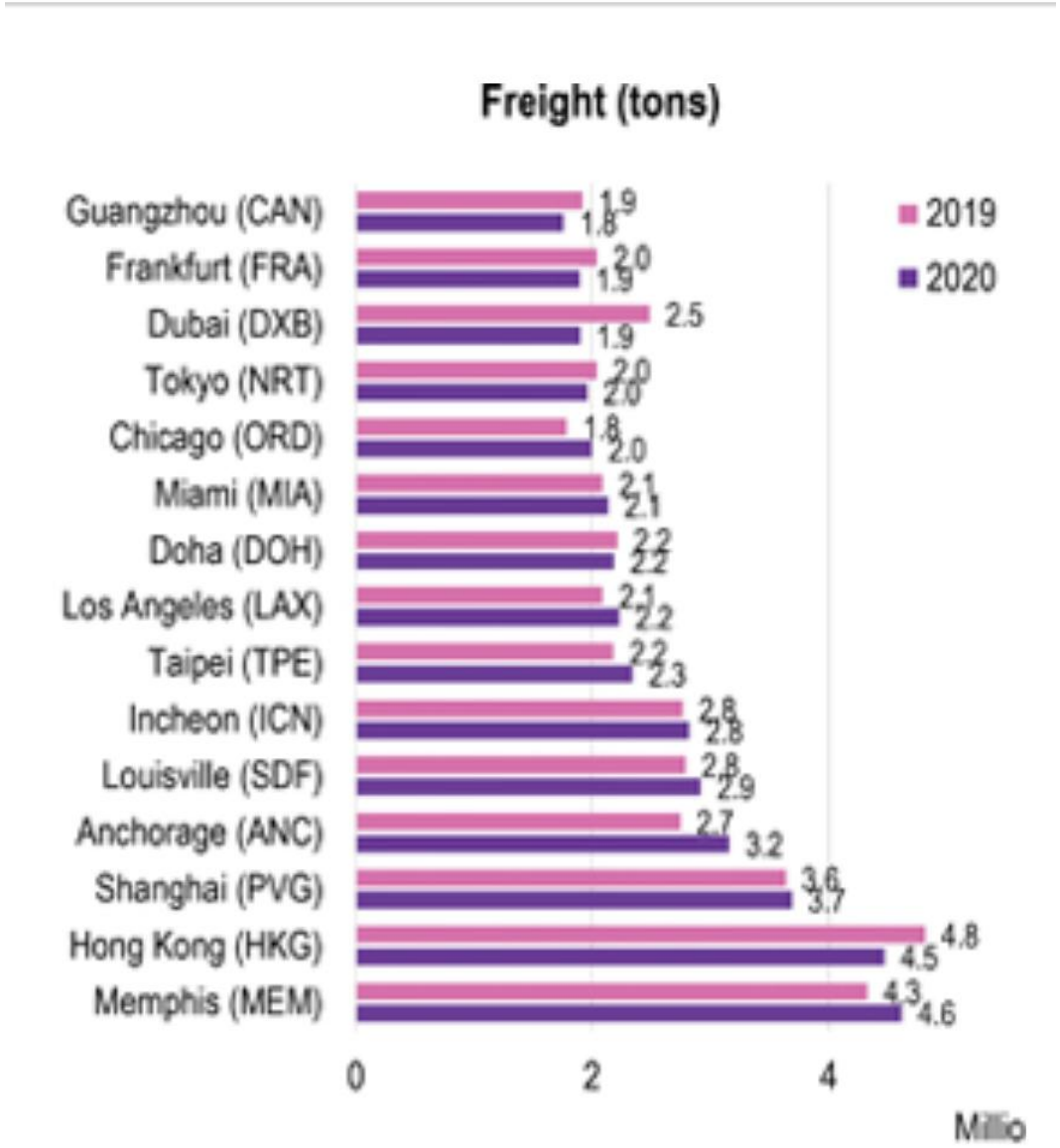


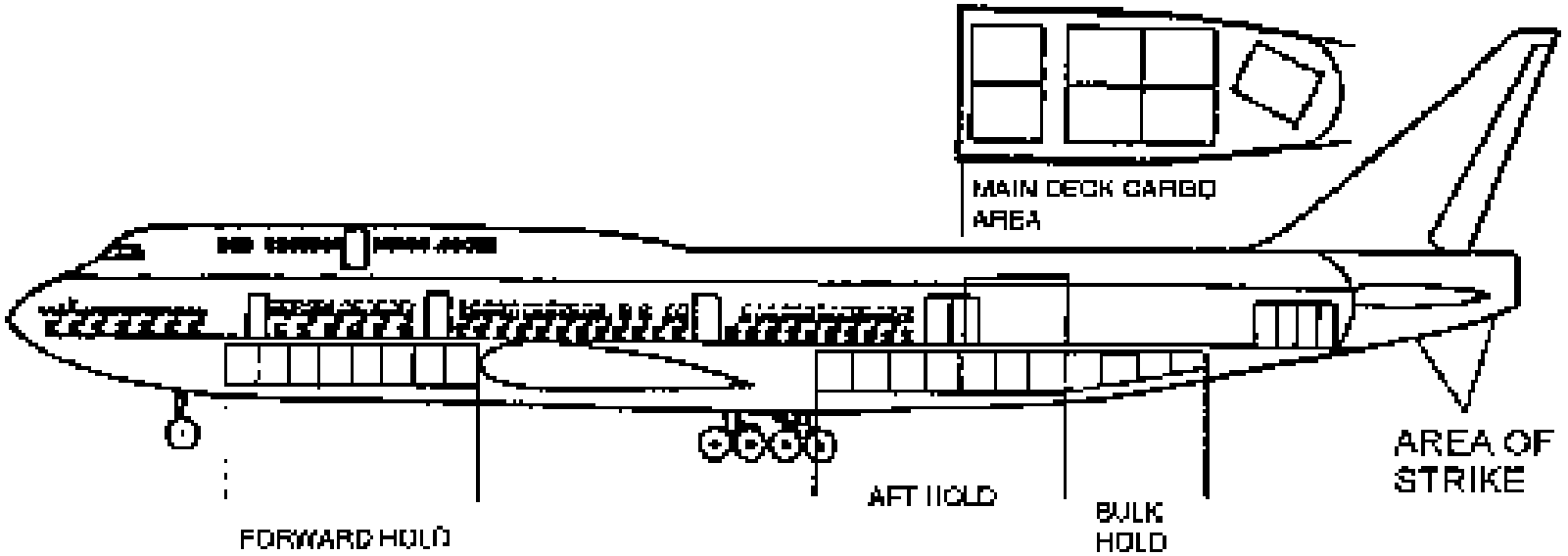
Airport terminals location



Major freight integrators

Freigth tons





6-

- Cargo handling at airports
  - Traditional airports
    - Primarly passenger traffic
  - Freight for domestic flights
    - Frequent schedules
  - Freight for international flights
    - Stored at gateways
    - Seasonal fluctations
  - Terminals and equipment
    - More storage space
    - Handling equipement

REMINDER

- Cargo handling at airports
  - International shipment
    - Tracking and clearing systems
    - Taking priority import freight ?
  - Classification of handling equipment
    - Combi airplane
    - Scissor lift platform …
    - Nose : mechanical loading
  - Intermodal air surface containers
  - Small package express equipment
    - Door to door
    - Upper segments
  - Intermodal airports and equipment
    - Strategically located
    - And traditional carriers

SUM UP

Discussion

- Port and airport performance key indicators
- Port and airport according to transport flows