CHAPTER 8

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• Transportation and Urban Form
• Transportation and Land Use
• Urban Mobility
• Urban Transport Challenges
Transportation and Urban Form
## Urban Hierarchy

<table>
<thead>
<tr>
<th><strong>Hamlet</strong></th>
<th>Small collection of homes: population 10-100</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Village</strong></td>
<td>Rural in character. Population less than 10,000.</td>
</tr>
<tr>
<td><strong>Urban area</strong></td>
<td>Defined by land use? E.g. 75% built up; by function?</td>
</tr>
<tr>
<td><strong>Town</strong></td>
<td>Larger than a village but smaller than a city. With town charter. Less than 100,000 population.</td>
</tr>
<tr>
<td><strong>City</strong></td>
<td>Legal status in some countries. Over 100,000?</td>
</tr>
<tr>
<td><strong>Conurbation</strong></td>
<td>Urban area incorporating adjacent centres e.g. former free-standing towns and villages. After Geddes 1915</td>
</tr>
<tr>
<td><strong>Metropolis</strong></td>
<td>Large urban agglomeration, usually over 1 million</td>
</tr>
<tr>
<td><strong>Megacity</strong></td>
<td>Urban metropolis over 10 million</td>
</tr>
<tr>
<td><strong>Megalopolis</strong></td>
<td>Chain of adjacent metropolitan areas.</td>
</tr>
<tr>
<td><strong>World or global city</strong></td>
<td>A global centre for finance, culture, political influence.</td>
</tr>
<tr>
<td><strong>Eperopolis</strong></td>
<td>‘Continental city’.</td>
</tr>
</tbody>
</table>
Perspectives about the Urban Spatial Structure: From Dichotomy to Continuum
World's Largest Cities, 1850

- London
- Beijing
- Paris
- Guangzhou
- Istanbul
- Hangzhou
- New York
- Mumbai
- Tokyo
- Saint Petersburg
- Suzhou
- Berlin
- Calcutta
- Naples
- Liverpool
- Vienna
- Philadelphia
- Glasgow
- Moscow
- Manchester
- Liverpool
- Vienna
- Philadelphia
- Berlin
- Calcutta
- Manchester
- Moscow
- Glasgow

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World’s Largest Cities, 1900

- London
- New York
- Paris
- Berlin
- Chicago
- Vienna
- Tokyo
- Calcutta (Kolkata)
- Moscow
- Birmingham
- Philadelphia
- Manchester
- St. Petersburg
- Boston
- Glasgow
- Liverpool
- Xian
- Liverpool
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tokyo</td>
<td>Tokyo</td>
<td>Tokyo</td>
<td>Tokyo</td>
<td>Moscow</td>
<td>Moscow</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>Los Angeles</td>
<td>Los Angeles</td>
<td>Osaka</td>
<td>Osaka</td>
<td>Osaka</td>
</tr>
<tr>
<td>Developing countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Shanghai</td>
<td>Shanghai</td>
<td>Shanghai</td>
<td>Mexico City</td>
<td>Mexico City</td>
</tr>
<tr>
<td></td>
<td>Mexico City</td>
<td>Mexico City</td>
<td>Mexico City</td>
<td>Sao Paulo</td>
<td>Sao Paulo</td>
</tr>
<tr>
<td></td>
<td>Buenos Aires</td>
<td>Shanghai</td>
<td>Shanghai</td>
<td>Shangai</td>
<td>Shangai</td>
</tr>
<tr>
<td></td>
<td>Beijing</td>
<td>Calcutta</td>
<td>Calcutta</td>
<td>Calcutta</td>
<td>Calcutta</td>
</tr>
<tr>
<td></td>
<td>Sao Paulo</td>
<td>Buenos Aires</td>
<td>Buenos Aires</td>
<td>Bombay</td>
<td>Bombay</td>
</tr>
<tr>
<td></td>
<td>Rio De Janeiro</td>
<td>Beijing</td>
<td>Beijing</td>
<td>Seoul</td>
<td>Seoul</td>
</tr>
<tr>
<td></td>
<td>Tianjin</td>
<td>Rio De Janeiro</td>
<td>Tianjin</td>
<td>Calcutta</td>
<td>Calcutta</td>
</tr>
<tr>
<td></td>
<td>Jakarta</td>
<td>Jakarta</td>
<td>Jakarta</td>
<td>Jakarta</td>
<td>Jakarta</td>
</tr>
<tr>
<td></td>
<td>Cairo</td>
<td>Cairo</td>
<td>Cairo</td>
<td>Riyadh</td>
<td>Riyadh</td>
</tr>
<tr>
<td></td>
<td>Delhi</td>
<td>Delhi</td>
<td>Delhi</td>
<td>Delhi</td>
<td>Delhi</td>
</tr>
<tr>
<td></td>
<td>Manila</td>
<td>Manila</td>
<td>Manila</td>
<td>Manila</td>
<td>Manila</td>
</tr>
</tbody>
</table>
World’s Largest Cities, 2015

Population (2015)
- 1 to 2 million
- 2 to 4 million
- 4 to 8 million
- 8 to 16 million
- More than 16 million
<table>
<thead>
<tr>
<th>Function</th>
<th>Main Mode</th>
<th>Nexus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trade</strong></td>
<td>Water transport.</td>
<td>Port terminals.</td>
</tr>
<tr>
<td></td>
<td>Railways</td>
<td>Heavy industries.</td>
</tr>
<tr>
<td>Production and Distribution</td>
<td>Highways</td>
<td>Rail terminals and railyards.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manufacturing clusters.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Distribution clusters.</td>
</tr>
<tr>
<td><strong>Mobility and Accessibility</strong></td>
<td>Highways</td>
<td>Central stations.</td>
</tr>
<tr>
<td></td>
<td>Transit</td>
<td>Shopping districts.</td>
</tr>
<tr>
<td><strong>Transactions</strong></td>
<td>Telecommunications</td>
<td>Financial / management districts.</td>
</tr>
<tr>
<td></td>
<td>Air transport</td>
<td></td>
</tr>
</tbody>
</table>
Cities and Connectivity

**Production and Distribution**
- Port districts.
- Heavy industries.
- Railyards.
- Manufacturing clusters.
- Distribution clusters.

**Mobility and Accessibility**
- Central / transit stations.
- Shopping districts.
- Airport districts.

**Transactions**
- Financial / management districts.

---

![Diagram of cities and connectivity](image-url)
Exhibit 1.4 Most influential urban forms from the early 20th century

The most influential urban forms have been:

- The garden city, circa 1900 (UK): small, self-contained satellite towns, detached dwellings, large plots of land, low density, separation of incompatible land uses, radial road networks and pedestrian curving routes.
- Greenbelts, circa 1900 (UK): large buffers of open space surrounding a town or city to prevent it from expanding outward and to separate it from new satellite towns (garden cities or new towns) beyond the belt.
- The neighborhood unit, 1920s (US): low-density, outer expansions of open space, focused on community facilities, minimizing conflict between cars and pedestrians by confining arterial routes to the periphery and encouraging through-traffic; assumption that this layout will create several communities.
- Radburn layout, 1928 (US): closely related to garden cities, this layout is characterized by cul-de-sacs and superblocks free of traffic; cars and pedestrians are separated from each other; public facilities and shops are located on pedestrian networks and embedded in open space.
- Urban modernism: new urban developments following Le Corbusier's ideas of tower-blocks "housing in open space and connected by parks.
- Urban renewal (1930s onwards): "slum" clearance and rehousing projects following Radburn or neighborhood unit layouts, and urban modernism.
- Road hierarchies, 1963 (UK): adopted by the 1963 report by Colin Buchanan (traffic in towns). Provides a rational for urban traffic management and the problems of traffic congestion by creating a hierarchy of roads with different functions. At the lowest level, the hierarchy an environmental cell (or residential area) carries only local traffic on "local distributor". At higher levels, district and primary distributors (freeways) carry passing and long-distance traffic. The assumption is that every household will eventually own a car and all urban movement will be car based. These ideas fitted well with urban modernism and the two strands became closely intertwined.
- New towns, (1946-1965) UK: a regional response to a perception of problems of growth in major cities (de-concentration), but also seen as a tool of development in lagging regions.
- Suburbs, 1920s onwards: unconfined and extensive areas of residential development on the urban periphery, single-family units, low densities and large plots of land, structured around car movement systems, serviced with community facilities and shopping malls. Assumes very high levels of car ownership and affluence.

Transportation, Urban Form and Spatial Structure

- Transportation
- Infrastructures
- Modes
- Users

Spatial imprint

Urban Form

Spatial interaction

Urban Spatial Structure
Types of Urban Spatial Structures

Centralized

Clustered (A)  Dispersed (B)

Decentralized

Clustered (C)  Dispersed (D)
One Hour Commuting According to Different Urban Transportation Modes

- Walking
- Streetcar
- Cycling
- Automobile
- Automobile with freeways
Evolution of the Spatial Structure of a City

Core activities

Peripheral activities

Central activities

Central area

Major transport axis
Possible Urban Mobility Patterns

Organized

Monocentric

Polycentric

Disorganized

Primary flow

Secondary flow
City Street Network Orientation
I - Walking-horsecar era (1800-1890)
II - Streetcar era (1890-1920)
III - Automobile era (1920-1945)
IV - Highway era (1945-)

North America

Streetcar line

Europe

Highway
Built up area prior to introduction of mechanical transport
Development consequent on steam railways
Development consequent on tramways
Development consequent on motor buses
Development consequent on private car
Evolution of Urban Densities in North America and Europe

1 Prior to mechanized transport
2 Early forms of mechanized transport (tramways)
3 Diffusion of motor vehicles (buses, automobiles)
4 Suburbanization
Urban Transport Development Paths

Ownership of Passenger Modes

Public
- Main development paths
- Path divergence

Low
- Walking Cities
  - Non-Motorized Transport
  - Motorized Cities
  - Traffic Saturation
- Bus / Paratransit Cities
  - Bus Traffic Saturation
  - Transit Cities
- Complete Traffic Saturation
- Car Cities

High

Urban Mobility Level

Low
- Walking Cities
- Non-Motorized Transport
- Motorized Cities

High

B. Transit-Oriented

C. Hybrid Cities

A. Car Dependency

People per square km, 2012
- 700 to 1,500
- 1,500 to 3,000
- 3,000 to 6,000
- 6,000 to 12,000
- More than 12,000

Distribution of density

Mean: 7,583
Share of Housing Units Equipped with Air Conditioning by Region in the United States, 1980-2015
Density and Car Use in Selected Global Cities, 2000s
Type I - Completely Motorized Network
Type II - Weak Center

- Main Road
- Highway
- Transit line
- Activity center
Type III - Strong Center

Main Road
- Highway
- Transit line
- Activity center
Type IV - Traffic Limitation

Diagram showing the layout of Main Road, Highway, and Transit line around an Activity center.
Street Network Types

- Conventional Grid Pattern (c 1900)
- Curvilinear Loop Pattern & Beginning of Cul-de-Sacs (1930-1950)
- Conventional Cul-de-Sac Pattern (since 1950)

Arterial road  Local street
Scale and Urban Spatial Structure

Components of the spatial structure

- Streets
- Basic services
- Residences

- Main roads
- Employment zones
- Municipal services

- Highway and transit systems
- Major transport terminals (ports and airports)
The Rationale of a Ring Road

Spatial Structure

Avoiding the congested central area
Secondary Center
Structuring Suburban development

Accessibility

Before
A to B = 30

After
A to B = 20

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Suburban Development along a Highway Interchange
Transportation and Land Use
Types of Urban Expansion

- Existing build up
- Infilling
- Extension
- Linear development
- Sprawl
- Large-scale projects
Relationships between Land Uses

**Land Use**

- Core activities
- Central activities
- Peripheral activities
- Central area

**Relationships**

- **Commuting**
  - Home to work
- **Professional Movements**
  - Work to work
- **Personal Movements**
  - Shopping
  - Social interactions
- **Distribution**
  - Procurement
  - Commercial deliveries
  - Home deliveries

**Passengers**

**Freight**
The Transport / Land Use System

Infrastructures (Supply)
- Traffic assignment models
- Transport capacity

Friction of Distance (Impedance)
- Spatial interaction models
- Distance decay parameters
- Modal split

Spatial Accumulation (Demand)
- Economic base theory
- Location theory
- Traffic generation and attraction models

Transport System
Spatial Interactions
Land Use
Von Thunen's Regional Land Use Model

Isolated State

- Central city
- Navigable river
- Market gardening and milk production
- Firewood and lumber production
- Crop farming without fallow
- Crop framing, fallow and pasture
- Three-field system
- Livestock farming

Modified Conditions

Sub-center
Inference of Von Thunen’s Model to the Continental United States

Assumptions
1. New York City the only market
2. Crops ranked by rent paying ability
3. No terrain or climatic variation

Assumptions
1. New York City the only market
2. Crops ranked by rent paying ability
3. No terrain variation
4. Climatic variation considered
Sector and Nuclei Urban Land Use Models

1 CBD
2 Wholesale and light manufacturing
3 Lower-class residential
4 Middle-class residential
5 Upper-class residential
6 Heavy manufacturing
7 Sub business district
8 Residential suburb
9 Industrial suburb
The Hybrid Land Use Model: Transportation and the Formation of Urban Landscapes

- Pre-Industrial (Concentric)
  - Walking
  - Horsecar

- Streetcar (Sector)

- Bicycle (Concentric)

- Automobile (Concentric)

- Highway (Concentric and Nodal)

- Centers
- CBD
- Railways
- Suburb Towns
- Roads
- Main roads
- Highways
- Suburb
- New suburb
Basic Land Economics

![Diagram of supply and demand for land](Diagram)

- **Price**
  - P1
  - P2
  - P3

- **Quantity of Land**
  - Q1
  - Q2
  - Q3

**Supply**
- Towards downtown (less land, higher price)

**Demand**
- Towards the periphery (more land, lower price)
Land Rent and Land Use

1. Bid rent curves
   - A. Retailing
   - B. Industry/commercial
   - C. Apartments
   - D. Single houses

2. Overlay of bid rent curves
   - City limits

3. Land use
Land Rent Theory and Rent Curve

Model
Rent = 1/S

S = πD^2
S = 3.14
S = 75.40
S = 235.62

Rural
Market gardening & dairying
Firewood & timber
Extensive farming
Animal farming

Urban
CBD
Commerce & industry
High density residential
Low density residential
Contemporary Modifications of the Land Rent Theory

A. Conventional CBD
B. Commercial / industry / warehousing
C. High to medium density residential
D. Sub center
E. Suburbia
Cellular Automata Land Use Dynamics

![Cellular Automata Land Use Dynamics](image)

- **t=0**: Initial state
- **t=1**: State after one time step
- **t=2**: State after two time steps
- **t=3**: State after three time steps

- Urban land use
- Non-urban land use
- Protected land use
- Highway
Basic Urban Dynamics

Transport Investments
- Terminals
- Infrastructures
- Modes

Accessibility
- Passengers
- Freight
- Information

Economic Impacts
- Economic growth
- Agglomeration / clustering
- Productivity
- Employment
- Investment

Feedback
Dynamics of Urban Change

Components

Transport Network
Freight Transport
Commuting
Employment
Population
Workplaces
Housing
Land Use

Pace of Change

Very Slow
Very Fast
Fast
Slow
Very Slow
## Suitability of Travel Modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Limitations</th>
<th>Most Appropriate Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>Requires physical ability. Limitation distance and carrying capacity. Difficult or unsafe in some areas.</td>
<td>Short trips by physically able people.</td>
</tr>
<tr>
<td>Bicycle</td>
<td>Requires bicycle and physical ability. Limited distance and carrying capacity.</td>
<td>Short to medium length trips by physically able people on suitable routes.</td>
</tr>
<tr>
<td>Taxi</td>
<td>Relatively high cost per mile.</td>
<td>Infrequent trips over short and medium distance.</td>
</tr>
<tr>
<td>Fixed Route Transit</td>
<td>Destinations and times limited.</td>
<td>Short to medium distance trips along busy corridors.</td>
</tr>
<tr>
<td>Paratransit</td>
<td>High cost and limited service.</td>
<td>Travel for disabled people.</td>
</tr>
<tr>
<td>Auto driver</td>
<td>Requires driving ability and automobile. High fixed costs.</td>
<td>Travel by people who can drive and afford an automobile.</td>
</tr>
<tr>
<td>Ridesharing</td>
<td>Requires cooperative automobile driver. Consumes driver’s time for deviations.</td>
<td>Trips that the driver would take anyway (commuting).</td>
</tr>
<tr>
<td>Vehicle Rentals</td>
<td>Requires convenient and affordable vehicle rentals services.</td>
<td>Occasional use by drivers who do not own an automobile.</td>
</tr>
<tr>
<td>Motorcycle</td>
<td>Requires riding ability and motorcycle. Average fixed costs.</td>
<td>Travel by people who can ride and afford a motorcycle.</td>
</tr>
<tr>
<td>Telecommuting</td>
<td>Requires IT equipment and skills.</td>
<td>Alternative to some types of trips.</td>
</tr>
</tbody>
</table>
Space Required per Passenger on Road Transport Modes

Square Meter per Passenger

- Highway Driving
- Arterial Driving
- Cycling
- Walking
- Public Transport

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Transit and Urban Land Use Impacts

Transit Use
- High
- Average
- Low

Land Use Impacts
- Accessibility
- Convergence
- Integration
## Types of Urban Movements

<table>
<thead>
<tr>
<th>Movement Type</th>
<th>Pattern</th>
<th>Dominant Time</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pendular</td>
<td>Structured</td>
<td>Morning and afternoon</td>
<td>Localized (employment)</td>
</tr>
<tr>
<td>Professional</td>
<td>Varied</td>
<td>Workdays</td>
<td>Localized</td>
</tr>
<tr>
<td>Personal</td>
<td>Structured</td>
<td>Evening</td>
<td>Varied with some foci</td>
</tr>
<tr>
<td>Touristic</td>
<td>Seasonal</td>
<td>Day</td>
<td>Highly localized</td>
</tr>
<tr>
<td>Distribution</td>
<td>Structured</td>
<td>Nighttime / Early morning</td>
<td>Localized</td>
</tr>
</tbody>
</table>
Income and Urban Transport Demand

- Business
- Social
- Shopping
- Work

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Main Purposes of Passenger Trips in the United States, 2001

- Work: 34%
- Shopping: 13%
- School: 13%
- Business (Work): 5%
- Business (Personal): 8%
- Recreational: 1%
- Medical: 3%
- Social: 11%
- Other: 12%

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Main Purposes of Transit Trips in the United States, 2007

- Work: 59%
- School: 11%
- Social: 7%
- Shopping: 9%
- Medical: 3%
- Personal/Other: 11%
Typical Activity Space of an Urban Working Adult
Mobility Gaps in Urban Areas

- Employment center
- Car-based mobility
- Transit-based mobility
- Mobile individual
- Mobility constrained individual
Work-Related Mobility in the United States

Central City

Suburbia

Exurbia

- 35% Suburb > Suburb
- 25% Central city > Central city
- 25% Suburb > Central city
- 5% Central city > Suburb
- 5% Central city > Exurbia
- 2% Exurbia > Suburb
- 2% Exurbia > Central city
- 1% Suburb > Exurbia

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Percentage of Workers Using Public Transportation, Selected Urban Areas, 2000

- Washington
- San Francisco
- Philadelphia
- New York
- Los Angeles
- Dallas-Fort Worth
- Chicago

- Central City
- Metropolitan Area

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Urban Mobility Index, 2017

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Urban Transport Challenges
Land Area Consumed by the Car in Selected Countries, 1999

<table>
<thead>
<tr>
<th>Country</th>
<th>Land Area per Capita (sqr. meters)</th>
<th>% of total land area used by the car</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>268</td>
<td>0.59%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>72</td>
<td>1.76%</td>
</tr>
<tr>
<td>Germany</td>
<td>91</td>
<td>2.15%</td>
</tr>
<tr>
<td>France</td>
<td>173</td>
<td>1.87%</td>
</tr>
<tr>
<td>Japan</td>
<td>104</td>
<td>3.51%</td>
</tr>
<tr>
<td>Mexico</td>
<td>87</td>
<td>0.45%</td>
</tr>
<tr>
<td>Canada</td>
<td>734</td>
<td>0.25%</td>
</tr>
<tr>
<td>United States</td>
<td>573</td>
<td>1.74%</td>
</tr>
</tbody>
</table>
Central Business District Monthly Parking Rate, 2011

- Boston: $438.00
- Calgary: $486.34
- Birmingham: $496.44
- Milan: $517.61
- New York: $541.00
- Stockholm: $546.41
- Copenhagen: $567.13
- Brisbane: $568.89
- Vienna: $575.12
- Amsterdam: $586.62
- Melbourne: $598.39
- Oslo: $612.15
- Sydney: $695.31
- Geneva: $704.70
- Perth: $717.43
- Rome: $718.90
- Tokyo: $744.00
- Hong Kong: $744.72
- Zurich: $822.15
- London: $1,083.59

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Geographical Paradoxes behind Urban Transport Problems

Level of Externality
Level of Specialization
Level of Agglomeration
Road Footprint

- Mono-functional
- Congestion
- Automobile dependency

North American Suburb
European City
Japanese City
Factors Contributing to the Growth of Driving in the United States

- Increase in population: 35%
- Increase in trip length: 17%
- Increase in number of trips: 18%
- Decrease in vehicle occupancy: 17%
- Switch to driving: 13%
Automobile Dependency, Space / Time Relationships and Modal Choice

Automobile Dependency

Car only

75%

50%

Transportation alternatives

Spatial Structure

A. High

B. Medium

C. Low

Mix

Worst case

Best case

High Density

Low

High Congestion

Low

Centralized

Dispersed

Optimal

Worst case

Best case

Worst case

Best case

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The Vicious Circle of Congestion

- Congestion
- Pressures to increase capacity
- New capacity
- Lower friction to mobility
- Urban sprawl incited
- Growth in length and number of movements
Parking Accumulation by Land Use by Time of the Day

- Residential
- Office
- Retail
- Restaurant

Percent of Peak Parking

6AM 7AM 8AM 9AM 10AM 11AM 12AM 1PM 2PM 3PM 4PM 5PM 6PM 7PM 8PM 9PM 10PM

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Major Sources of Recurring and Non-Recurring Congestion

Congestion in the United States (hours by Cause)

- Recurring Congestion: 40%
- Traffic Incidents: 25%
- Work Zones: 10%
- Weather: 5%
- Poor Signal Timing: 5%
- Other: 15%

Congestion in Germany (hours by Cause)

- Recurring Congestion: 34%
- Traffic Incidents: 32%
- Work Zones: 30%
- Other: 4%
Source of Revenue for Bus Operations, Europe, 2002

- UK: Subsidies 30% - Commercial revenue 70%
- Spain: Subsidies 40% - Commercial revenue 60%
- Germany: Subsidies 40% - Commercial revenue 60%
- Sweden: Subsidies 50% - Commercial revenue 50%
- Greece: Subsidies 60% - Commercial revenue 40%
- France: Subsidies 50% - Commercial revenue 50%
- Denmark: Subsidies 40% - Commercial revenue 60%
- Netherlands: Subsidies 60% - Commercial revenue 40%
- Italy: Subsidies 50% - Commercial revenue 50%
- Belgium: Subsidies 60% - Commercial revenue 40%
- Austria: Subsidies 70% - Commercial revenue 30%
Fare Recovery Ratio of Selected Public Transit Systems, United States, 2010

- Charlotte Area Transit System
- Bi-State Development Agency (St. Louis)
- Denver Regional Transportation District
- Metropolitan Atlanta Rapid Transit Authority
- Los Angeles County Metropolitan Transportation Authority
- Massachusetts Bay Transportation Authority (Boston)
- Washington Metropolitan Area Transit Authority
- New Jersey Transit Corporation
- Chicago Transit Authority
- MTA New York City Transit
- San Francisco Bay Area Rapid Transit District

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Transit Fare for the New York Subway, 1904-2015 (inflation adjusted)
Challenges of Urban Transit

- High to medium density transit city
- Low density suburb
- Sprawl
- Connectivity
- Travel patterns serviced by urban transit
- Travel patterns not serviced by urban transit