The Geography of Transport Systems

The spatial organization of transportation and mobility

8.3 – Urban Mobility

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> Urban mobility involves three broad categories of collective, individual, and freight transportation. While the mobility of passengers is the outcome of individual decisions based on different rationales, freight mobility is decided in tandem between the cargo owners and transportation service providers.

1. Urban Mobility and its Evolution

Urban areas are the most complex settings in which the mobility of passengers and freight is taking place. Typical urban attributes such as density, diverse economic, cultural, political, and social functions, and land scarcity, jointly generate

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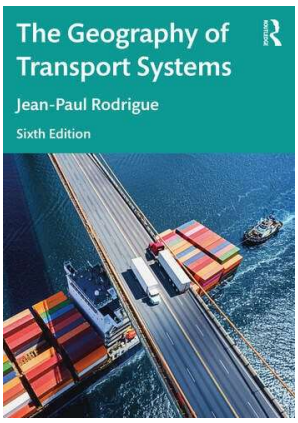

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mobility demands and constraints. In several instances, the mobility of passengers and freight is complementary as they may be using separate routes. Still, both are competing for the usage of scarce land and transport infrastructures:

- **Collective transportation (public transit)**. The purpose of collective transportation is to provide publicly accessible mobility over specific parts of a city. The systems are usually owned and operated by an agency, and access is open to all as long as a fare is paid; the reason why they are called public transit. The efficiency of public transit systems is based upon transporting large numbers of people and achieving economies of scale. It mainly includes tramways, buses, trains, subways, and ferries.
- **Individual transportation**. Includes any mode where mobility results from a personal choice and means, such as the automobile, walking, cycling, or motorcycling. Most people walk to satisfy their basic mobility, but this number varies according to the urban context. Some forms of individual mobility could be favored, while others could be impaired. For instance, walking accounts for 88% of all movements within Tokyo's central area, while this figure is only 3% for Los Angeles. The density and design of the former are more accommodating to the mobility of pedestrians than the latter.
- **Freight transportation**. Since cities are dominant centers of production and consumption, urban activities are

Jean-Paul Rodrigue (2020), New York: Routledge, 456 pages. ISBN 978-0-367-36463-2

doi.org/10.4324/9780429346323

Sixth Edition available April 2024

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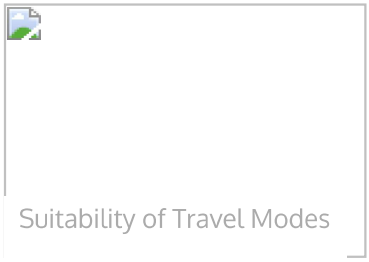
accompanied by large freight movements. These movements are characterized mainly by delivery trucks moving between industries, distribution centers, warehouses, and retail activities, including major terminals such as ports, railyards, distribution centers, and airports. The growth of e-commerce has been associated with increased home deliveries of parcels. The mobility of freight within cities is part of an emerging field related to city logistics.

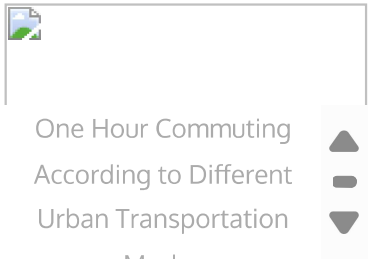
Rapid urban development occurring across much of the globe increased the mobility of passengers and freight within urban areas in absolute and relative terms. There are more urban movements and also more movements per urban resident. Urban mobility also tends to involve longer distances, but evidence suggests that **commuting times have remained relatively similar** over the last hundred years; approximately 1 to 1.2 hours per day is spent on average commuting. This means that commuting has gradually shifted to faster transport modes, and consequently, greater distances could be traveled using the same amount of time. This underlines the convergence among mobility, the deployment of transport infrastructure, and the diffusion of transportation modes.

Each form of urban mobility, be it walking, the automobile, or urban transit, has a level of suitability to fill mobility needs. Different transport technologies and infrastructures have been implemented, resulting in a wide variety of

urban transport systems around the world. In developed economies, there have been four general eras of urban development, each associated with a different form of urban mobility, with a fifth phase unfolding.



Suitability of Travel Modes



One Hour Commuting According to Different Urban Transportation

a. The Walking-Horsecar Era (1800s – 1890s)

Even during the Industrial Revolution, the dominant means of getting around was on foot. Walking cities were typically less than 5 kilometers in diameter, making it possible to walk from the downtown to the city edge in about 30 minutes. Land use was mixed, and density was high (e.g. 100 to 200 people per hectare). The city was compact and more-or-less concentric depending on the local landscape. Still, the industrial revolution brought additional populations through rural to urban migrations, improved construction techniques allowing for higher densities and new forms and employment locations. The development of the first public transit systems in the form of omnibus service extended the diameter of the city but did not change the overall urban structure.

The railroad facilitated the first real change in urban morphology. New developments, often called trackside suburbs, emerged as small nodes physically separated from the city itself and one another. The nodes coincided with the location of rail stations and stretched out a considerable distance from the city center, usually up to a half-hour train ride. Within the city proper, rail lines were also laid down, and horsecars introduced mass transit. The realm of urban mobility was expanded.

b. The Electric Streetcar or Transit Era (1890s – 1920s)

The invention of the electric traction motor created a revolution in urban travel. The first electric trolley line opened in the late 19th century, and the technology was quickly adopted in other cities. The operating speed of the electric trolley was three times faster than that of horse-drawn vehicles and did not generate waste on the streets. The streetcar city was able to spread outward 20 to 30 kilometers along the streetcar lines, creating an irregular, star-shaped pattern. Urban fringes became areas of rapid residential development, with trolley corridors as commercial strips that would come to characterize commercial areas of the era. The city core was further entrenched as a mixed-use, high-density zone, gradually losing its residential function. Land use patterns reflected social stratification where outer suburban areas were typically middle class,

while the working class concentrated around the central city.

As street congestion increased in the first half of the 20th century due to the diffusion of the automobile, the efficiency of streetcar systems deteriorated as cars infringed on their right of way. Further, many cities had ordinances that prevented fare increases, implying that many streetcar systems became unprofitable, leading to a lack of maintenance and investment in additional services. These factors contributed to the demise of many streetcar systems in the later part of the 20th century.

c. The Automobile Era (1930s – 1950s)

The automobile was introduced in European and North American cities in the 1890s, but only the wealthy could afford this innovation. So no impacts on urban land use and mobility were initially observed. From the 1920s, ownership rates increased dramatically, with lower prices made possible by assembly-line production techniques. As automobiles became more common, land development patterns changed. Developers were attracted to green-field areas located between the suburban rail corridors, and the public was attracted to these single-use zones, thus avoiding many inconveniences associated with the city, mainly pollution, noise, crowding, and lack of space. Still, this phase usually represented the peak share of public transit in urban mobility as suburban

developments did not yet account for a large share of the urban landscape, and cities were still high-density and transit-dependent.

d. The Freeway Era (1950s – 2010s)

In the second half of the 20th century, the massive diffusion of the automobile, as well as the construction of highway networks, had substantial impacts on urban mobility. Highways were built to connect the central business district to outlying areas, and, in many cases, complete or partial ring roads were built. The personal mobility offered by the automobile represented a paradigm shift in terms of lifestyle, consumption patterns, and residential locations. The automobile considerably reduced the friction distance, leading to **urban sprawl**. The emergence of the suburb created a new landscape in which public transit did not fit well, with few services being offered to these new residential areas. Transit ridership fell, and transit companies ran into financial difficulties. Eventually, transit services throughout North America and Europe became subsidized, publicly-owned enterprises. Some tramway systems were being dismantled, and the surviving transit lines were separated from road circulation, namely subway systems.

New light rail systems were introduced, which could generate ridership if large parking lots were provided at suburban stations. Commercial activities also began to suburbanize, creating

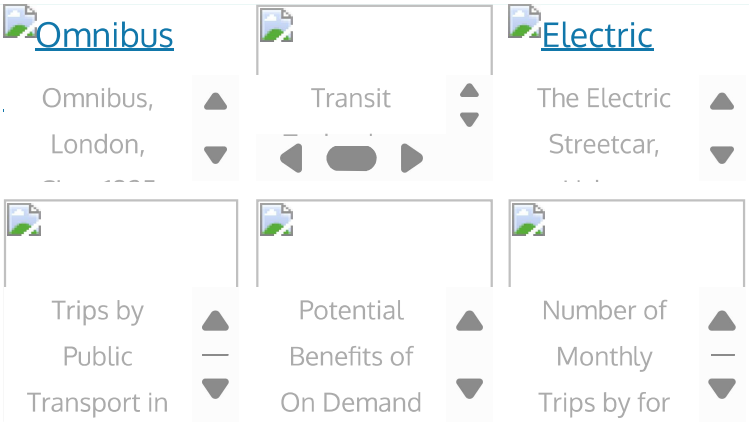
additional passenger and freight mobility systems that did not rely much on public transit. Within a short period, the automobile became the dominant mode of travel in all cities of North America and, from the 1970s, in a growing number of developed and developing economies. Since the 2000s, a similar process has occurred on a massive scale in China, creating motorized high-density cities. Wherever incomes rise, the growth of automobile use tends to increase accordingly. Motorization and the diffusion of personal mobility have been trends linked with the ongoing and substantial declines in the share of public transit in urban mobility in the second half of the 20th century.

e. The Integrated Mobility Era (2010s onward)

Throughout their evolution, urban transportation modes remained rather disconnected, particularly since they are owned and operated by separate entities such as transit agencies, automobile owners, or trucking companies with limited interaction. The diffusion of **information and communication technologies** is changing this relationship. Emerging urban mobility systems are gaining from a higher level of integration and collaboration, resulting in better asset utilization levels and the creation of new mobility markets. An early example concerns on-demand vehicle services pooling individual drivers and matching their mobility supply with the consumer demand through a platform

accessible through a mobile device. In several high-density markets, the outcome of this convenience was a surge in demand for for-hire vehicles. A further development concerns self-driving vehicles that could expand mobility options and better utilization of automobile assets.

This era is also associated with the diffusion of e-commerce and its associated home deliveries, underlining the issue of **city logistics** and last-mile freight distribution. Trucks and delivery vans have become more prevalent in urban mobility. Information technologies have also allowed the pooling of resources in the more conventional food delivery market, replacing business-specific deliveries with fleets of on-demand vehicles. An emerging form of urban mobility concerns **micromobility**, with early forms, such as the bicycle, being developed in the late 19th century and widely used by the early 20th century. In the early 21st century, a new array of electrically assisted conveyances and leasing/sharing systems became available, particularly electric bikes (e-bikes) and scooters. Such systems can be effective in high-density areas and for short trips. However, e-bikes are at least five times more expensive than bicycles. Further, users are concerned about parking e-bikes in public areas and finding locations to recharge them. They are also effective for last-mile parcel deliveries and fast deliveries such as restaurant orders.



In many areas where urbanization is more recent, the above synthetic phases did not occur. Fast urban growth led to a scramble to provide transport infrastructure inadequately, leading to rather chaotic conditions supporting urban mobility. Enduring congestion tends to characterize cities in developing economies.

2. A Taxonomy of Urban Mobilities

Mobility is linked to specific urban activities and land use, with each type involving generating and attracting an array of movements. This complex relationship is linked to factors such as recurrence, income, urban form, density, level of development, and technology. Urban mobility is either **obligatory** when linked to scheduled activities (such as home-to-work trips) or **voluntary** when those generating it are free to decide on the scheduling (such as leisure) and even the mode. The most common types of urban mobility include:

- **Pendulum movements**. These are obligatory movements involving commuting between

locations of residence and workplaces. They are highly cyclical since they are predictable and recurring, most of the time on a daily basis, thus the term pendulum. The **historical stability** of these movements allowed the planning of transportation infrastructure and services.

- **Professional movements**. These are movements linked to professional, work-based activities such as meetings, repair, maintenance, and customer services, dominantly taking place during work hours.
- **Personal movements**. These are voluntary movements linked to the location of commercial activities, which include shopping and recreation.
- **Touristic movements**. These are important for cities having historical and recreational features. They involve interactions between landmarks and amenities such as hotels and restaurants and tend to be seasonal or occur at specific moments during the day. Major sports events are important generators of urban movements during their occurrence.
- **Distribution movements**. These are concerned with freight distribution to satisfy consumption and manufacturing requirements. They are mostly linked to transport terminals, distribution centers, and retail outlets. However, the growth of online transactions involves more freight movements being carried to residential areas through home deliveries.

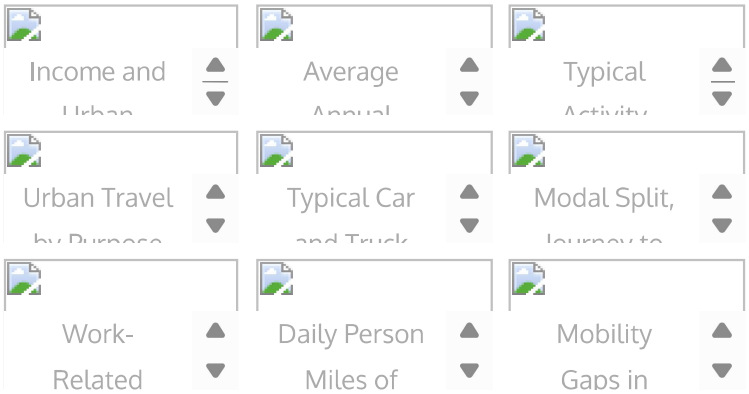
The consideration of urban mobility, both for passengers and freight, involves the consideration of the factors behind their generation, the modes and routes used, and their destination:

- **Trip generation**. On average, an urban resident undertakes between 3 and 4 daily trips. Mobility in an urban area is usually done to satisfy a purpose such as employment, leisure, or access to goods and services. The **activity space** of an individual is an important trip generation factor since it indicates the travel that needs to be undertaken. Temporal variations in the number of trips by purpose are observed on a daily and weekly basis, with commuting as the most prevalent pattern. Similar temporal variations are observed for freight mobility, with most of this mobility occurring in the morning when goods are delivered to retail outlets. This often leads to conflicts with the mobility of passengers since vehicles share the same road infrastructure, including parking space, which is the object of capacity constraints in urban areas.
- **Modal split**. This implies using a series of transportation modes for urban trips, which is the outcome of a **modal choice**. This choice depends on factors such as cost, technology, availability, preference, travel time (distance), and income. Therefore, walking, cycling, public transit, the automobile, or even teleworking, will be used either as a choice or as a constraint (lack of choice). For instance,

locations within five minutes of walking are readily accessible to pedestrians. There is thus a wide variety of modal split across metropolitan areas. Urban freight distribution can also use a variety of modes, but the van and the truck tend to dominate as they allow maximum accessibility to urban locations.

- **Trip assignment (routing)**. It involves which routes will be used for trips within the city. Passenger trips usually have stable routing. For instance, a commuter driving a car usually has a fixed route between the residence and the place of work. This route may be modified if congestion or another activity (such as shopping) is linked with that trip, a practice often known as **trip chaining**. The routing of freight distribution is dependent on the types of deliveries involved. Direct deliveries are the norm for large retail outlets, while vehicles will accommodate flexible routing for smaller stores and parcel deliveries. Several factors influence trip assignment, the most crucial being transport costs, time, and congestion levels. The diffusion of information technologies, particularly global positioning systems, allows each vehicle to select a path minimizing distance or time in a dynamically evolving situation. The benefits of such technologies tend not to be fully acknowledged as large-scale routing optimization of individual vehicles significantly reduces total travel time and energy consumption.
- **Trip destination**. Changes in the spatial distribution of economic activities in urban

areas have caused important modifications to trip destinations, notably those related to work. Activity-based considerations are essential since each economic activity tends to be associated with a level of trip attraction. Retail, public administration, entertainment, and restoration are the activities that attract the most movements per person employed. For freight movements, manufacturing, transport terminals, and retail are the activities attracting the most movements. The **central city** used to be a major destination for trips, particularly passengers, but its share has substantially declined in most areas, and **suburbs** now account for the bulk of urban trips.



Mobility is also a social issue. The share of the automobile in urban trips varies in relation to location, social status, income, quality of public transit, and parking availability. Mass transit is often affordable, but several social groups, such as students, the elderly, and the poor, are a **captive market**. There are important variations in mobility according to age, income, gender, and disability, with policies aiming at promoting the accessibility and mobility of groups perceived as disadvantaged. The gender gap in

mobility is the outcome of socio-economic differences, as access to individual transportation is dominantly a matter of income. Within households, differences in role and income are related to the respective activity range and mobility of its members. Consequently, in some instances, modal choice is more of a **modal constraint linked to economic opportunities.**

Central locations generally have the most urban mobility options because private and public transport facilities are present. However, this does not mean mobility is easier since central areas are congested. In locations outside the central core, a share of the population not having access to the automobile faces a level of isolation or at least more limited access to amenities and employment opportunities. Limited public transit and high automobile ownership costs have created a group of spatially constrained (mobility-deprived) people. In a context where mobility is car-dependent, there is a strong incentive to own an automobile irrespective of income level.

3. Urban Transit

Transit is almost exclusively an urban transportation mode, particularly in large urban agglomerations. The urban environment is particularly suitable for transit because it provides conditions fundamental to its efficiency, namely **high density** and significant

short distance mobility demands. Since transit is a **shared service**, it potentially benefits from economies of agglomeration related to high densities and economies of scale related to high mobility demands. One key advantage of public transit is the higher the demand, the more effective public transit services can be offered. Lower densities are linked with lower demand and a greater likelihood of public transit systems operating at a loss and requiring subsidies. Most public transit systems are not financially sound and must be **subsidized**, even if several of their core segments are profitable.

Transit systems are comprised of many types of services, each suitable to a **specific market and spatial context**. Different modes provide complementary services within the transit system and, in some cases, between the transit system and other transport systems.

- **Bus transit**. One of the most common forms of urban transit includes vehicles of various sizes (from small vans to articulated buses) offering seating and standing capacity along scheduled routes and services. They usually share roadways with other modes and are susceptible to congestion. Bus rapid transit systems offer a permanent or temporary right of way and have the advantage of unencumbered circulation. However, this footprint can come at the expense of other uses.
- **Rail transit**. Vehicles of fixed guideways usually have their right of way. Light rail

systems are composed of streetcars that can share the right of way, particularly in central areas. Heavy rail systems are commonly called subways or metro since many operate underground. Another type of rail transit concerns commuter rail systems, usually servicing central business districts and peripheral areas along specific rail corridors.

- **Taxi systems**. Usually, private for-hire vehicles such as automobiles, jitneys, or rickshaws offer point-to-point services. Recent technological developments have enabled car-sharing services and expanded the availability of on-demand transit.
- **Alternative transit**. Refer to transit systems developed to cope with specific conditions (or niche markets) using alternative modes. Ferries are the most common form of alternative transit as they serve cities with waterways separating different urban districts. Funiculars are also prevalent in locations with steep inclines and enough traffic to justify construction. Aerial lifts are also used in some settings to connect locations that are difficult to access.

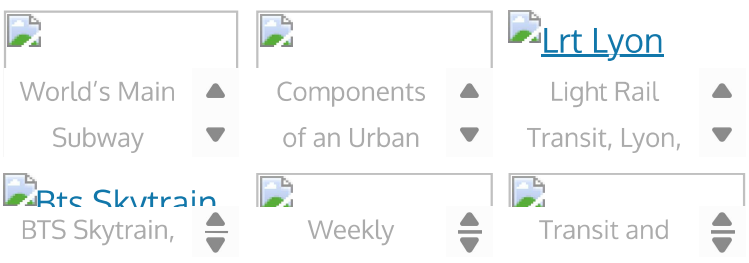
Contemporary transit systems tend to be **publicly owned**, implying that many decisions related to their development and operation are politically motivated. This is a sharp contrast to what took place in the past, as most transit systems were private and profit-driven initiatives. With the fast diffusion of the automobile in the 1950s, many transit companies faced financial difficulties, and the

quality of their service declined; in a declining market, there were limited incentives to invest. Gradually, they were purchased by public interests and incorporated into large agencies, mainly to continue providing mobility. As such, public transit often serves more as a social function of public service and a tool of social equity than having an economic role. Transit has become dependent on government subsidies, with little competition permitted as wages and fares are regulated. As a result, they tend to be disconnected from market forces, and subsidies are required to keep a level of service. With suburbanization, transit systems tend to have even fewer relationships with economic activities and the latest dynamism of cities.

Government-owned public transit systems are facing **financial difficulties** for three main reasons. First, they are often designed to serve taxpayers, not necessarily potential customers. Because of the funding base, transit systems may be spread into neighborhoods that do not provide a significant customer base. The second is that transit unions were able to extract substantial advantages in terms of wages and social benefits, increasing labor costs. This makes public transit highly expensive to operate. The third concerns a technology fixation that incites investment in high-cost transit (e.g. light rail transit) while low-cost solutions (buses) would have been sufficient for many transit systems, particularly in lower-density areas.

Reliance on urban transit as a mode of urban transportation tends to be high in Asia, intermediate in Europe and Latin America, and low in North America. Since their inception in the early 19th century, comprehensive urban transit systems significantly impacted the urban form and spatial structure, but this influence is receding. Three major classes of cities can be found in terms of the relationships they have with their transit systems:

- **Adaptive cities**. Represent transit-oriented cities where urban form and land use developments are coordinated with transit developments. While a metro system adequately services central areas and is pedestrian-friendly, peripheral areas are oriented along transit rail lines.
- **Adaptive transit**. Represent cities where transit plays a marginal and residual role, and the automobile accounts for the dominant share of movements. The urban form is decentralized and of low density.
- **Hybrids**. Represent cities that have sought a balance between transit development and automobile dependency. While central areas have an adequate level of service, peripheral areas are automobile-oriented.



Accessibility along a Transit Line

Transit and Urban Land Use Impacts

Contemporary **land development tends to precede the introduction of urban transit services** instead of concurrent developments in earlier phases of urban growth. Thus, new services are established once the demand is deemed sufficient, often after being subject to public pressure. Transit authorities operate under a service warrant and usually run a recurring deficit as services become more expensive. This has led to considerations aimed at higher transit integration in the urban planning process, particularly in cities where such a tradition is not well established.

From a transportation perspective, the potential benefits of better **integration between transit and local land uses** are reduced trip frequency and increased use of alternative modes of travel (i.e. walking, biking, and transit). Evidence often fails to support such expectations since the relative share of public transit ridership is declining across the board. There is usually a reciprocal relationship between automobile ownership and the use of public transit. Good accessibility to public transit is often associated with lower automobile use. In contrast, areas of high automobile use may impair the development of public transit systems since the automobile is already dominant. Exceptions tend to be cities having very high-density levels.

Community and land use design can have a significant influence on travel patterns. Local land use impacts can be categorized into three dimensions in terms of accessibility, the convergence of mobility, and the land use integration they provide. Land use initiatives are trying to be coordinated with other planning and policy initiatives to cope with automobile dependence. However, there is a **strong bias against transit** in the general population because of negative perceptions, especially in North America, but increasingly globally. As personal mobility symbolizes status and economic success, public transit users can be perceived as less successful segments of the population. This bias may undermine the image of transit use within the general population but can be subject to change with the evolution of social norms and values.

The COVID-19 pandemic had **complex impacts** on public transit systems. In the initial phase of the lockdowns in 2020, most transit systems experienced a decline in ridership in the range of 75%. The benefits of public transit, the massification of trips, **became a disadvantage** as users became concerned about the transmission risks during a public transit trip. Many transit systems, particularly in advanced economies, did not experience recovery to pre-pandemic levels. A factor is the growth of teleworking, which offered a substitution for transit trips, but a shift to car use is the most important. People actively using cars increased their car use, while active transit users also

increased their car use. As a fundamental support to urban mobility, public transit systems remain challenged by revenue generation, rising infrastructure costs, and the willingness of users to shift to other modes.

Related Topics

- 8.1 – Transportation and the Urban Form
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- 8.4 – Urban Transport Challenges
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- 2.4 – Information Technologies and Mobility

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