Unit No. 2 Urbanization and Transportation
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Factors influencing Transportation Needs
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Road Congestion
Impact of transport on environment

Factors influencing Transportation Needs

Transportation needs of an urban area are affected by a wide variety of factors including: total population, population distribution, geography, income levels, and government policy on urban development.

a) **Total population**: The greater the total population of the area, the more extensive the transportation system that will be needed to serve the large number of intra-city trips made by the population. For example, the large metropolitan centers of the world such as Mumbai, Tokyo and New York depend very heavily on mass transit, generally fixed rail transport. On the other hand, small cities like Mathura, Kancheepuram and Chengalpattu are totally dependent on the street system and private transport. In the middle range of population, e.g. cities such as Madurai and Vadodara, there can be effective utilization of public bus transit on a well planned street system that also serves private transport.

b) **Population distribution**: When the density of population is low, private transportation is economical and the energy efficient mode. However, at high levels of density, private transportation is inefficient, and rail and bus transit become economical and financially feasible.

c) **Geography**: Rivers and hills in the urban area create restrictions to transport systems. Bridges and tunnels may be required. Capacity addition can be achieved by maximum utilization of existing facilities.

d) **Income**: levels Increased per capita income leads to proliferation of private transport and reduction in the use of public transport.

e) **Government policy**: A government policy that encourages ownership of detached housing units leads to low density travel patterns and reliance on private transport. Encouragement to high density residential patterns will be conducive to effective operation of public transport, especially rail rapid transit.

Transportation Demand

Transportation demand is concentrated at specific times that are related to the current activity pattern of the society. The demand is temporal as well as spatial. In some cases, e.g. trips to work and school, the demand has a certain amount of regularity which allows detailed estimates to be made. In other instances, e.g., social and recreational trips, there is a great amount of uncertainty, and in these cases the reliability of demand forecasts will be poor.

Types of Trips

A trip is a movement from an origin to a destination. The distance between the origin and the destination is called the trip length. The time taken to go from the origin to the destination is known

as the travel time or journey time. The expenditure in money terms to perform the trip is referred to as travel cost. The origin and the destination constitute the two trip ends.

Trips may be broadly classified as Home-based trips and non-home-based trips, as shown in Fig. 1. A trip which has one end of the trip at the home of the trip maker is called a Home-based trip. If the trip does not have the home as a trip end, e.g., a trip from workplace to a shop, such a trip is called a non-home-based trip. In most urban areas, home-based trips constitute 85 to 90% of the total trips.

Depending on the purpose of the trip, trips can also be classified as work trips, school trips, shopping trips, and social-recreational trips. Of these, the work trips and school trips are performed at regular timings on every working day, and these trips are called commuter trips.

The shopping trips and the social-recreational trips do not have regular schedule. Usually, the commuter trips constitute about two-thirds of the total home-based trips.
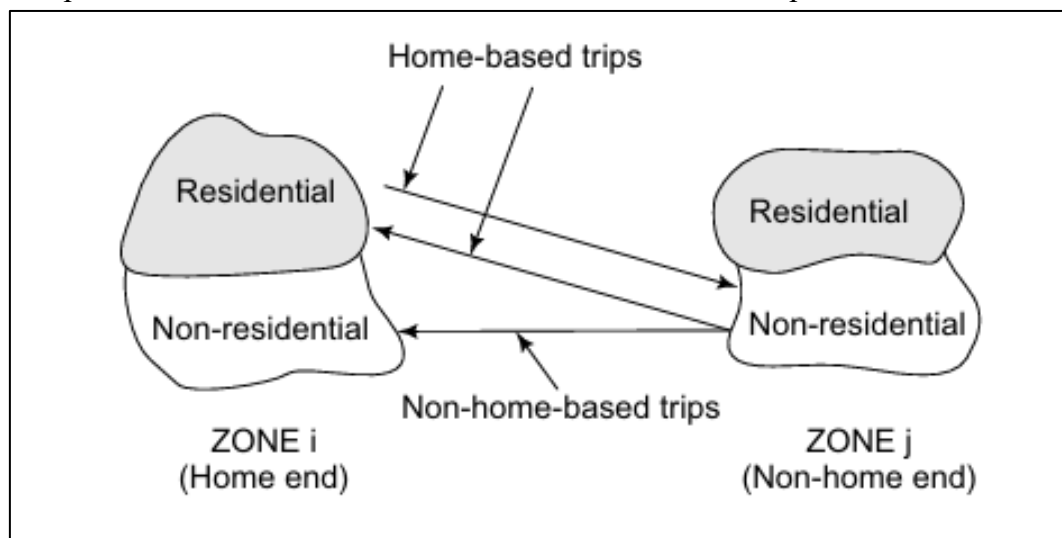

Figure 1 Broad Classification of Trips

Modes of Travel

In urban areas, the movements from and to places of residence (home-based trips) form the major portion of the total trips. For example, in Chennai, home-based work trips constituted 42.9 % and home-based education trips 37.6 % in 1992. A large part of the trips will continue to involve walking. Planning and design of pedestrian movements should be accorded equal attention as for mechanized person transport. The mix and use of the various modes of travel are determined by a complex interaction among factors such as the city size, shape, geography, demographic and economic characteristics, and the available technology.

The modes of travel can be broadly classified into three categories as Private Transport, Public Transport, and Intermediate Public Transport. Private transport modes comprise walk, bicycle, motorized two-wheeler and car. The vehicles are privately owned and operated by users for their own use, usually on publicly provided and maintained roads. Bus, tram, and railway train constitute the public transport modes. Public transport is also known as transit, mass transit, or mass transportation. The service is available for use by all persons who pay the established fare. Intermediate public transport (also known as paratransit) modes include hired vehicles such as taxi, autorickshaw, jeepney, and dial-a-ride. In some transport planning reports, intermediate public transport modes are treated as part of private transport. These basic transportation modes are not likely to be replaced in the near

future; but the share of the market available to each mode may be modified with changes in economic and demographic characteristics of the region.

The route and schedule are fixed for public transport, whereas they are flexible for private transport. For intermediate public transport, the schedule is flexible; but the route is flexible for hired vehicles like taxi and autorickshaw, while it is fixed for jeepneys and similar paratransit services and is essentially fixed for dial-a-ride.

Transit refers to urban public transportation with emphasis on capacity and frequency of services. Mass transit is transit with emphasis on high capacity and energy efficiency, e.g., bus and suburban railway. Rapid transit is mass transit with emphasis on high speed, e.g., rapid rail transit (RRT). Transit can also be classified as (a) Bus transit; and(b) Rail-based transit. The latter includes rapid rail transit, light rail transit, suburban rail, monorail and tram.

A hypothetical integrated system involving different modes is shown in Fig. 2. The total mass transportation system may be composed of circulation system, feeder system, and line haul system. A circulation system transports people within a CBD or a major activity centre. A line haul system is the long fast movement from the collection point to the distribution point, and may extend bothways. It is usually in the form of rapid rail transit with exclusive right-of-way. A feeder system carries passengers between the residence/workplace/park-and-ride lot and the nearest station/transit stop of the line haul system. Park-and-ride facilities may be provided at convenient locations, either at transit stops or at other locations from where a feeder bus is made available to connect to a transit stop.

The aim of urban mass transit is to provide a quick transport service for its ridership in a safe, economical, reliable and comfortable manner. For the community, the objectives include: freedom from air pollution and noise pollution, and better space utilization. The objectives for the transport agencies are: meeting the demand at minimum cost, optimum utilization of infrastructure, and customer satisfaction.

Passengers exercise choice of the mode of transport and class of service. Their choice is influenced by consideration of five factors: (a) travel cost; (b) reliability of service; (c) travel time; (d) convenience of access; and (e) travel comfort. For patrons from low income group, the travel cost is the most important consideration. In developing countries, urban households spend about 8 to 10 % of the household income on transport. People may avoid a bus taking a long zigzag route and may opt for a route having less travel time. Easy accessibility from home to a bus stop or railway station may influence the choice. In developing countries, the riders normally have limited choice and they become captive riders.
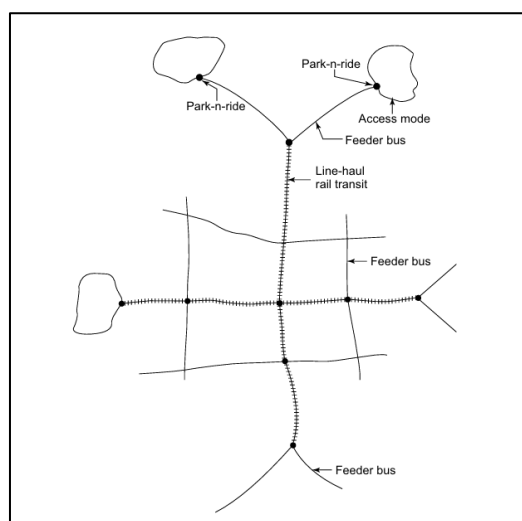
Figure 2 Integrated System Involving Different Modes

Urban Transportation Scene in India

The urban population in India is in excess of 286 million (2001). Over 60% of the urban residents live in about 300 cities with a population exceeding 100000. There are 35 metropolitan cities having a population of one million and above. The general lack of adequate public transportation has resulted in a disproportionate growth of private transport vehicles leading to chronic congestion on the city roads. The number of vehicles increases rapidly without corresponding expansion of the road space. Pressure on the road network and consequent levels of road congestion are expected to become more acute in future with increase in road traffic.

Motorised Vehicles	Animal Drawn Vehicles	Human Powered Vehicles
Two-wheeler	Horse Cart	Hand Cart
Car/Jeep	Bullock Cart	Tricycle
Auto-rickshaw	Camel Cart	Cycle-rickshaw
Taxi		Bicycle
Van		
Bus		
Light Commercial Vehicle (LCV)		
Truck, Heavy Goods Vehicle (HGV)		

Table 1 Mixed Traffic on Indian Roads

A wide variety of vehicles are operating on the roads as shown in Table 1. These include: personal vehicles such as cars/jeeps, motorized two-wheelers and bicycles; public vehicles comprising buses and mini-buses; intermediate public transport (hired) vehicles such as taxis, auto-rickshaws, cycle rickshaws and tongas; goods vehicles such as trucks (HGV) and light commercial vehicles (LCV); and animal drawn carts and handcarts. Motorized two-wheelers constitute almost 70% of the total motor vehicles in India. The mixed traffic poses peculiar problems to smooth and safe operation of traffic, resulting in serious traffic congestion, inordinate delays, increased accidents, environmental pollution and a deteriorating quality of life.

The number of motor vehicles registered in the NCT of Delhi 1 as on 1 st April of the years 1981, 1991, 1994 and 2005 are indicated in Table 2. It can be seen that the motorised two-wheelers constitute about 64 % of the total vehicle population. The predominance of two-wheelers contributes to the road congestion, and also leads to increase in road accidents. In 1997, out of 33.8 million motor

vehicles in India, 7.7% were in Delhi, the corresponding figures for Mumbai, Kolkata and Chennai being 2.1%, 1.5% and 2.3%, respectively.

Vehicle Type	1981	1991	1994	2005
Car/Jeep/Van	1,19,495	3,98,479	5,22,264	14,71,858
M.Cycle/Scooter	3,45,109	12,20,640	14,92,201	30,78,660
Taxi	6,385	10,157	11,846	20,646
Autorickshaw	20,379	63,005	72,102	74,188
Bus	8,044	18,858	24,211	25,511
Truck	36,599	1,01,828	1,16,379	1,28,193
Total	5,36,011	18,12,967	22,39,003	47,99,056

Table 2 Registration of Motor Vehicles in NCT of Delhi

Road Congestion

Congestion on the road is the most frequent manifestation of the urban transport problem. Congestion increases vehicle operating costs, requiring higher fuel consumption, and also leads to environmental pollution. Road congestion is bad for the economy as it imposes high costs on industry and other users. Several solutions have been advocated and attempted such as: restrictions on on-street parking, one-way operation, banning of turns, priority traffic control, and provision of grade-separated pedestrian crossings. Other measures include effective exclusion of stray cattle on the road and carrying maintenance work at night. The more effective approach would be to encourage high-capacity public transport vehicles which are more efficient in use of energy and utilisation of road space, besides intraurban and suburban rail service in all metropolitan cities.

Impact of Transport on Environment

The impacts of transport on the environment include the following: (a) Air pollution; (b) Noise pollution; (c) Impact on communities by way of severance and visual intrusion; and (d) Accidents and damage to human health.

Vehicle	Space Required for Movement Per Passenger (m²)	Estimated Total Energy Consumption Per Passenger-km (kWh)
Car	40	1.12
Two-wheeler	17.5	0.29
Bus	4.5	0.12
Rail	2.5	0.09
Bicycle	8.5	0.06
Walk	0.7	0.04

Table 3 Typical Mode Characteristics

Transport causes air pollution due to various emissions from the vehicles as indicated in Table 3. Carbon monoxide (CO) causes greenhouse effect, and even low dosage impairs vision and causes headaches and drowsiness. Nitrogen oxide (NO_x) at high doses leads to respiratory irritation, acid rain and damage to vegetation. Sulphur dioxide (SO_2) causes respiratory problems. Particulate matters (PM) cause respiratory problems and damage buildings. Ozone (O) causes acid rain, photochemical smog and leads to respiratory problems. Increase of Carbon dioxide (CO_3) in the atmosphere will lead to increase in global warming. It is estimated that vehicles contribute about 70% of the air pollution in Delhi.

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Serious transport noise disturbs sleep, affects performance of school children and reduces quality of life. Reduction in walking and cycling has contributed to greater incidence of heart ailments, obesity and diabetes. Provision of roads and rail lines severs communities and results in visual intrusion. Traffic related accidents are on the increase in urban areas and these lead to health hazards and human suffering. For example, the number of fatalities from road accidents 6 in Delhi increased from 694 in 1977 to 1878 in 1991 and to about 2000 in 1998.

The adverse effects of transport on the environment can be reduced if the share of public transport in the overall use of vehicles is increased and use of private transport is reduced. Typical emissions of different vehicles are shown in Table 4. It is evident that the emission of carbon monoxide is higher from petrol cars than from diesel buses. The noise level at 15 m from the source is about 90 dBA for a bus and is about 70 dBA for a car. If more people take to bus instead of using private vehicles, the ambient noise level can be reduced.

Vehicle	Total Emission (kg per 1000 Vehicle-km)	Carbon Monoxide (kg per 1000 Vehicle-km)
Bus	38.1	12.7
Truck	38.1	12.7
Car (Petrol)	49.6	40.0
Car (Diesel)	3.2	1.1
Three-wheeler	35.8	25.5
Two-wheeler	27.3	17

Table 4 Typical Emissions from Vehicles