5

Urban Transport Patterns

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Facilities for the transport of people and freight within urban areas vary widely. The greater share of personal travel is now carried out by private means of transport although public passenger rail and bus undertakings are still of importance for commuter movements. The level of public transport available in Third World cities is much lower than in industrialized countries and private car travel is still largely confined to Western urbanized societies.

Introduction

The focus of attention in this and the succeeding chapter is transport in the world's urban areas, where the concentration of industrial and commercial activity has been accompanied by the growth of intricate patterns of movement. The demands currently made by both freight and passenger traffic upon urban transport infrastructures are invariably greater than the available capacity, producing a situation in which most of the world's towns and cities require programmes of transport improvement. Consequently much of the content of contemporary urban transport geography has a problem-orientated approach with a particular concern to identify the spatial aspects of transport-planning programmes. These approaches are discussed in Chapter 6, but as a prelude this chapter reviews the relationships between traffic and land-use patterns, the principal types of movement and the attributes of urban transport modes. Variations in the pattern of urban land uses will induce alterations in the volume, type and directions of personal and freight movements; the distribution of traffic between road and rail transport and between the public and private sectors is also influenced by changes in social and economic conditions both at the national and local scales (Webster, 1988).

Each mode is recognized by transport planners as having particular advantages with respect to specific types of intra-urban movement and to its contribution to the overall efficiency of the urban transport system. However in many instances personal preferences and perceptions can combine to produce an allocation of travel between modes whereby the least suitable modes are often the most heavily patronized but others, principally in the public sector, experience ever-declining levels of patronage (Jones et al., 1983; Sheppard, 1986).

Land use and traffic generation

The mapping of reliable patterns of traffic movements within towns first became

possible with the advent in the 1950s of comprehensive land-use transportation plans designed to promote the development of major cities and conurbations in North America and western Europe. These ambitious programmes involved the collection of data on contemporary traffic generation and transport facilities as an essential prelude to the prediction of future flows and the formulation of new or amended transport systems to cater for these changing movement patterns. Although the overall pattern of intra-urban flows comprises both freight and personal movements, emphasis has been firmly upon the latter in most of the major transportation surveys, and data are collected relating to both individual and household tripmaking behaviour and the broader travel structures associated with specific zones within a city.

At the individual or disaggregate level information on travel is collected for a specific time period, usually up to one week, with regard to trip purpose, trip time, destination, mode of travel and route selected. Particular note is taken of multipurpose and multimodal journeys as these are becoming of increasing significance within the overall pattern of movements (Barber, 1986).

Freight-traffic generation by industrial and commercial premises has received much less attention than personal travel but sufficient studies have been made to relate different scales and categories of industry to certain levels of traffic (Starkie, 1967; Bartlett and Newton, 1982). Data on tripmaking obtained from surveys of individual households and industrial premises can be augmented with information collected from vehicle drivers passing through traffic cordons drawn at various radii from city centres. These data are then mapped on a zonal basis; the urban area is sub-divided into traffic districts and zones and the size and shape of each division is determined by physical urban structure and land-use patterning. An aggregate picture of trips with origins and destinations in each traffic zone can then be produced and most of the major transportation surveys incorporate these interzonal flow maps. The basic map depicting all categories of trip may be supplemented by maps devoted to modal choice, journey purpose or time; these trip characteristics may then be analysed in the context of the dominant land use within individual traffic zones.

Taking the UK as a representative example of a highly urbanized industrial nation, one-fifth of all road traffic is associated with built-up areas with a similar proportion of private cars and light vans. A large share of the national bus and coach fleet is allocated to urban services and 29 per cent of the total traffic is recorded in towns and cities. In contrast only 14 per cent of the heavy goods traffic is found in urban areas and this proportion has been decreasing since the 1970s (Table 5.1) (Department of Transport, 1990a).

Personal travel

Travel surveys

One drawback of many transportation surveys is their disregard of pedestrian journeys and the inclusion only of trips of over one-quarter of a mile made by a motorized mode, a selective exercise that omits the walking which can account for up to 30 or 40 per cent of all personal travel. Information on personal tripmaking is obtainable from national surveys and, at the local level, from regional- and urban-transportation studies. In the UK the National Travel Survey was launched in 1964 and the most recent was completed in 1985. Data were obtained primarily on a household basis. Nine categories of journey purpose are defined associated with work, education, escorting (work and education), shopping, personal business requirements, social and entertainment trips and holiday and related activities. In practice many urban trips fulfil several purposes, with one car, for example, being used by a number of occupants, each with different travel

Table 5.1 Great Britain: traffic on major urban and non-urban roads

(a) *Traffic distribution by vehicle types (percentage of total vehicle – kms.)*

	Cars/taxis	Buses and coaches, excepting minibuses	Heavy goods vehicles	All vehicles
Motorways	22.4	17.8	38.1	23.7
Major roads in built-up areas	32.7	47.6	18.4	31.7
Other major roads	44.9	34.6	43.5	44.6

(b) *Traffic by average daily flows (000s vehicles)*

	1979	1984	1989
Motorways	31.19	34.04	54.44
Trunk roads in built-up areas	14.56	13.25	18.10
Other trunk roads	8.14	10.48	14.39

Source: Transport Statistics Great Britain 1979–89, 1990.

objectives (Hanson and Schwab, 1986). The timing of a particular journey will be strongly influenced by its purpose while the choice of mode used will be determined by socioeconomic factors such as income levels, access to a private vehicle, the quality of public transport and the size of the urban area. In the British National Travel Survey respondents complete daily travel diaries over a week together with a record of the use made of cars available to household members. Many journeys, and particularly those making use of public transport for work trips, involve several modes and these can also be associated with multipurpose trips (Table 5.2).

The journey to work

Commuting dominates the overall pattern of regular personal movements and a more detailed review of this traffic illustrates the complexity of travel within major cities. The scale and extent of travel-to-work is dependent upon the relative locations of workplace and residence, household income, the level of public transport, car availability and a variety of personal behavioural trends and has been studied in depth in many industrialized cities (Daniels and Warnes, 1983; Dasgupta et al., 1990).

Journey-to-work patterns are becoming increasingly complicated with the expansion of major employment centres on the urban periphery and by the fact that commuting now extends far beyond the limits of the built-up area so that the movements of these rurally-based workers are superimposed upon those of employees resident within the urban area (Plane, 1981). However a study of commuting in principal EEC cities showed that 71 per cent of workers lived within a 10-km. radius of their work and that only 7 per cent travelled further than 26 km. Journey-to-work trips were accomplished in less than 30 minutes by three-quarters of all employees and only one in five took more than two hours for each trip. Although there is evidence that the average length of each journey is increasing, travel time is being reduced with the use of faster modes of transport. In West Germany, for example, the percentage of workers whose journey occupied only up to 15 minutes rose from 21 to 41 between 1960 and 1978. The European survey identified a wide range in the proportions of those using the private car for journeys to work, with a variation from 36 per cent in Italy to 49 per cent in Belgium. Public transport accounted on average for just over one-fifth of all journeys but was of

Table 5.2 Great Britain: journeys by method of travel and purpose

Main mode of travel	(percentage of all journeys) Purpose					
	Work	Education	Shopping	Social/ entertain-ment	Leisure	All other purposes
Car (driver and passenger)	23	2	18	29	4	24
Local bus services	24	13	29	20	1	13
Rail	51	6	12	15	3	13
Cycle/motorcyle	46	9	11	20	4	10
Walk	13	12	21	19	19	16

NB: Only journeys of over one mile are included.

Source: National Travel Survey 1985/6.

more importance in the UK. Overall 18 per cent of all trips were carried out on foot and in The Netherlands cycling and motorcycling was used by one-third of all commuters (Pickup and Town, 1983) (Figure 5.1).

The relative importance of different modes for work trips, however, can vary in response to increasing road traffic congestion or to improvements in the quality of public transport, and especially rail services. Between 1978 and 1988, for example, the total volume of workers entering Central London during the morning peak rose by 7.3 per cent to 1.157 million, with public transport accounting for a large share of this increased traffic. Travel-to-work journeys on the London Underground increased by 38 per cent and on suburban railways by 21 per cent between 1982 and 1989, whereas road-based commuting by bus fell by 26 per cent and in cars by 18 per cent (Department of Transport, 1990b).

The commuting pattern also includes many examples of multipurpose journeys involving shopping and education, and the routes followed between home and workplace are often indirect in order to complete these various tasks. A survey of commuting in Reading indicated that eight per cent of all work trips involved additional objectives of this nature (Rigby and Hyde, 1977).

Within major cities in the USA, journey-to-work trips account for one-quarter of all household travel and the private car is firmly established as the dominant mode despite the comprehensive public-transport systems available in many of the larger urban areas (Fielding, 1986) (Table 5.3). However, between 1977 and 1983 the largest percentage increases in work trips were recorded in smaller American cities of less than 250,000 population and in the largest (three million plus) centres the increase has been only just over seven per cent.

Recent USA personal-travel surveys also indicate that the number of non-work trips is now increasing more rapidly than the commuting journeys, even during peak travel periods, and work trips are becoming shorter as the suburbs attract more employment centres (Gordon et al., 1988). Commuting patterns in many major industrial cities are also beginning to show the effects of the redistribution of population associated with urban renewal, with an increase in the proportion of low-income and less-skilled workers who are resident in inner-urban areas. In Manchester an increased dependence upon public transport in the inner city has been reported as low levels of car ownership among the less skilled has limited their opportunities for employment in peripheral urban areas (Dasgupta, 1983).

By 2000 AD 20 out of 24 cities with populations in excess of 11 million will be in the Third World and the commuting patterns in these and in lesser cities differ markedly from those in industrialized states. Deficiencies in the public-transport system, the

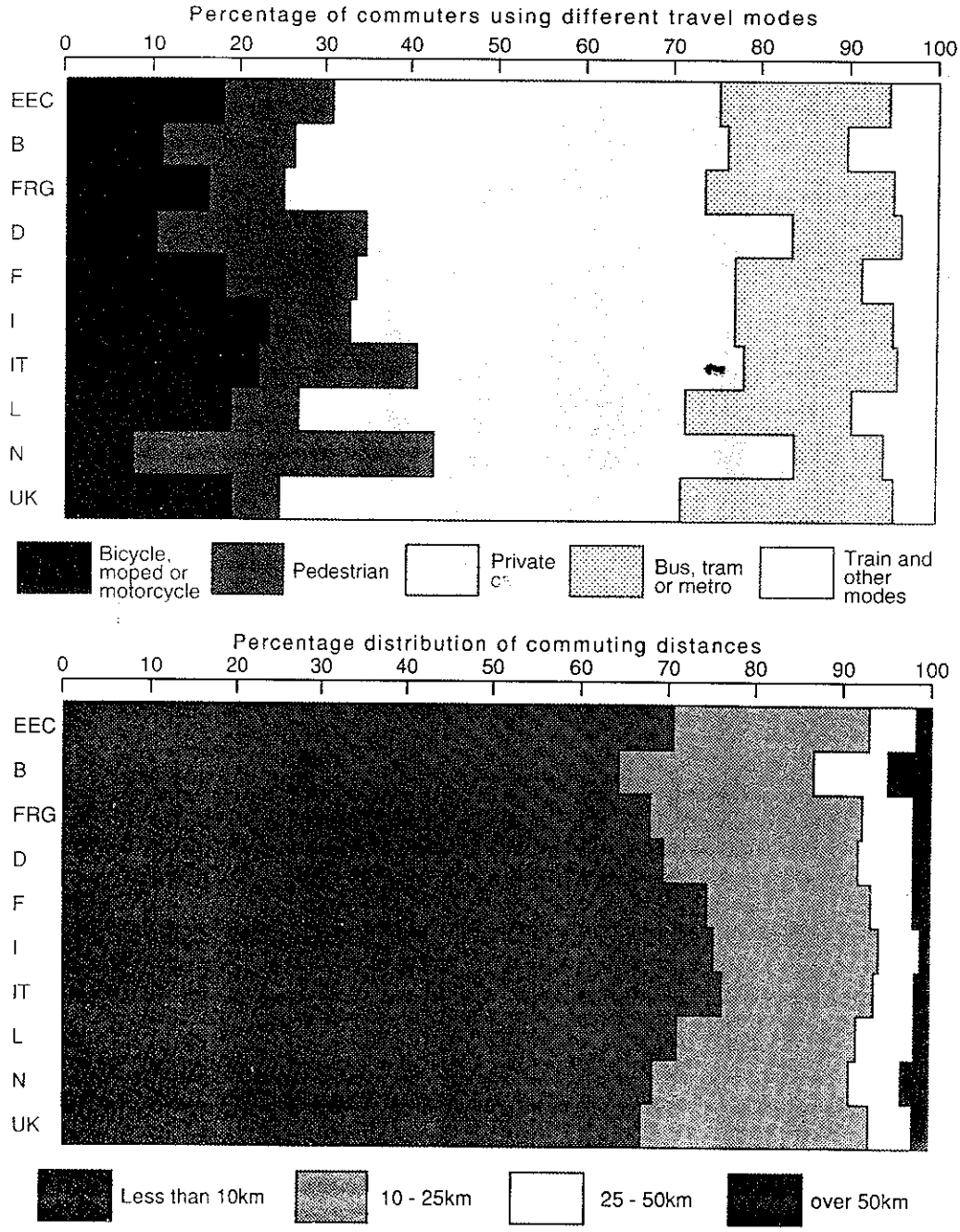

Figure 5.1 Commuting modes and distances in European Economic Community states.

EEC	European Economic Community	I	Ireland
B	Belgium	IT	Italy
FRG	Federal Republic of Germany	L	Luxembourg
D	Denmark	N	Netherlands
F	France	UK	United Kingdom

Source: Pickup and Town, 1983.

Table 5.3 Commuting in selected United States cities

(a) *Travel in selected cities 1976*

	Mode of transport			
	Private car	Public transport	Walk	Other modes
New York	47	44	8	1
Baltimore	83	12	5	1
Houston	93	4	3	1
Raleigh	95	2	3	1
Oklahoma City	95	1	3	1
Seattle	87	8	3	1
Denver	87	5	5	2

(b) *Changes in proportion of commuting trips into Central Business Districts made by public transport (percentage)*

	1970	1980
Boston	60.6	58.5
New York	60.6	60.2
Chicago	74.9	74.1
St Louis	29.7	26.7
San Francisco	47.9	52.4
Los Angeles	21.4	23.8

Source: Hanson, S. (ed.), *The geography of urban transportation*, 1986.

presence of workforces dominated by low-income groups and the distribution of low- and high-income residential areas combine to produce journey-to-work patterns where non-motorized modes and informal public-transport services assume a far greater significance than in Western urban society (Rimmer, 1986). Whereas in the latter the choice in general lies between motorized private and public transport, in the developing countries the urban commuter has the option of using grossly inadequate scheduled public services, a range of informal transport facilities or of walking or cycling to work. The rapid growth of Third World cities, with the expansion of peripheral low-grade housing areas, has resulted in an increasing separation of home and workplace for many of the lower-paid workers, who in Rio de Janeiro, for example, can spend up to 25 per cent of net income on fares for bus journeys. Third World urban workers also suffer a time penalty when using public transport. A recent survey of journeys-to-work showed single trip times of 89 minutes in Lima, Peru, and 77 minutes in Ibadan, Nigeria, compared with an average of 49 minutes for a sample of 44 United States cities and 48 in British provincial cities. In Delhi the regular use of a bus for commuting can account for 36 per cent of the disposable income of low-paid workers and in many Indian cities journey-to-work travel costs, expressed in terms of the percentage of GDP per head, can be almost fourfold those in Britain (White, 1990).

Freight traffic

Several different categories of goods movement and distribution within urban areas may be recognized. The most complex activity involves the regular delivery of essential commodities to individual households but in most advanced nations much of this is now achieved by means of permanent distribution networks of pipelines and cables for water, sewage, gas and electricity. Road transport is still necessary however for solid refuse, mail, milk and some other food supplies and these regular but often slow-moving services account for a large part of urban freight traffic. Goods pickup and delivery trips in a sample 11 United States towns represent 41 per cent of all urban commercial vehicle movements, with peak traffic occurring between the daily commuting periods (Barber, 1986) (Table 5.4). A second category of freight traffic is the transfer of finished and semifinished manufactured goods between plants, where the level of movement depends upon the degree of dispersion of industrial activity within the urban area and the extent to which manufacturing is confined to specific zones. The transport of freight between urban industrial premises and destinations in other parts of the country also contributes to the overall pattern of goods movements, as does commercial traffic in transit through a town. The types of vehicle used for these various movements is determined by the size and nature of the consignments carried. The

Table 5.4 Urban truck traffic in the United States (based on data from 11 US urban areas)

Trip purpose at final destination	Percentage of total daily trips
Return to home base	19.3
Personal use	9.1
Pick-up and delivery operations	41.1
Mail and express services	6.1
Construction	4.9
Maintenance and repair	8.0
Business use	7.2
All other	4.3

Source: Hanson, S. (ed.), *The geography of urban transportation*, 1986.

Table 5.5 Third World city travel by car, bus and informal urban transport

(a) *Motorized transport modes*

	Percentage of urban trips by:		
	Car	*Bus*	*Informal transport*
Bangkok	29	59	12
Hong Kong	30	39	31
Jakarta	29	49	22
Karachi	16	63	21
Manila	29	22	49

(b) *Travel by bus and informal sector*

	Percentage of urban trips by:	
	Bus	*Informal transport*
Delhi	78	22
Hyderabad	49	51
Bangalore	48	52
Kampur	6	94
Jaipur	18	82
Agra	13	87
Baroda	45	55
Chieng Mai	7	93

(Data from various surveys made during period 1970–80)

Source: Dimitriou, H. (ed.), *Transport planning for Third World cities*, 1990.

frequency of use is similarly related to the needs of the market, with daily household deliveries being at one end of the scale and occasional visits of large commercial vehicles to major industrial plant at the other. A study of goods movements in Hull showed that road transport accounted for 81 per cent of inbound and 88 per cent of outbound traffic, with rail and waterways carrying the remainder (Wilbur Smith, 1977).

The principal modes of urban travel

Walking

Until the successive introduction of horse buses, electric trams and motor buses, walking was the dominant mode in towns and cities of the Western world. Today it can still account for up to 35 per cent of all journeys in these cities and in addition almost all trips which are classified as primarily car- or public transport-based do of necessity incorporate some walking at the beginning and end of the journey. Regular walkers are obviously concentrated within those groups who lack access to a car or are unable to drive through reasons of age or infirmity; trips to school in particular are largely carried out on foot. Walking is still the dominant mode for urban shopping trips but for most other activities such as work, entertainment and leisure it ranks below the private car but above public transport. Most trips are made in city centres, involving journeys between car parks, bus and rail stations and workplace and between office premises, shops and restaurants.

However, it is in Third World cities that walking assumes the greatest importance as a means of personal mobility and a large proportion of all journeys are made by pedestrians. In India the lower income groups depend upon walking for almost 60 per cent of all urban journeys and in Delhi two-thirds of urban squatters walk to work, often over distances in excess of 10 km. (Rao and Sharma, 1990). Residents in African cities are less dependent upon walking than their Indian counterparts and make more use of bus services, although survey evidence indicates that at times when money is in short supply other financial commitments take precedence and walking replaces the bus trip.

Non-motorized vehicles

In Western cities the pedal cycle is the principal vehicle in this category but its use is only of limited significance in the overall travel pattern. In the less-developed countries, however, the cycle and related forms of transport assume considerable importance as a means of mobility and as with walking it is the lower income groups who depend upon them for many of their essential journeys (Table 5.5). The principal vehicles in use are cycle-rickshaws, horse-drawn carts such as the tonga and the hand-drawn rickshaw, although the latter is now confined to Calcutta. In Indian cities of between 500,000 and one million population 60 per cent of households make use of one or more pedal cycles and one in five urban inhabitants own a machine. The ownership level in Chinese cities is about 460 cycles per 1000 (or about one in two) persons and in both China and India the level of access to cycles is increasing (Cai Jun-shi, 1988). In contrast the cycle ownership rate in many African cities is only about 20 per 1000 (or one in 50) persons, a level which is possibly explicable in terms of costs in relation to disposable income or by the fact that the cycle does not enjoy as high a status as a means of transport as it does in Indian cities (Maunder and Fouracre, 1988). In the latter, cycling can account for up to 30 per cent of all urban trips whereas in Africa the proportion is usually below two per cent. In major Chinese cities the cycle is used for up to 80 per cent of all trips and surveys of traffic in Indian cities show that cycles can represent up to one-half of total flow, with volumes of 7,500 machines on some principal roads in Delhi. Low-income commuters in the Indian capital make use of cycles for 40 per cent of all work trips involving distances of up to 8 km. but for longer journeys the bus assumes greater importance.

In South-East Asia the cycle rickshaw, with a capacity for two persons, is used extensively as a means of public transport and in some Indian cities can account for up to one-fifth of all trips and form a similar proportion of traffic on main roads. Rickshaw costs inhibit their use by the lower paid, however, and the average distance travelled by passengers is usually less than those journeys made by cycle.

Private cars

In the industrial world the rapid expansion in the ownership and use of the private car has been responsible for more changes in the structure of personal travel in urban areas than any other means of transport (Figure 5.2). In Europe and North America the car is now the leading mode for all categories of journey and with the growing trend towards decentralization of many urban activities which have traditionally been located at the city core private transport is becoming of even greater significance. The popularity of the car within the urban environment is explicable in terms of its flexibility and personal convenience which enables the user to organize the daily travel programme with a minimum of constraints. Trips that start from home can usually terminate at a point conveniently close to the required destination and in many urban areas workplaces are now equipped with car-parking facilities which minimize the walking element in the overall journey. Shopping in city centres will usually involve a choice of car park and some walking; but suburban and out-of-town retail, employment and leisure centres are able to offer car parks whose capacity is far in excess of those in central areas.

Although a large proportion of car trips are made by the driver only, shared vehicles are of particular significance during the peak periods for work journeys. What is described in the USA as carpooling is the second most important means of commuting and one-fifth of all workers who commute now do so in shared cars. The overall trip time will usually be longer than that of the single driver but it is considerably less than the time required for the equivalent journey by public transport and travel costs per person contributing to a carpool are reduced by at least 50 per cent. Carpooling can offer particular benefits

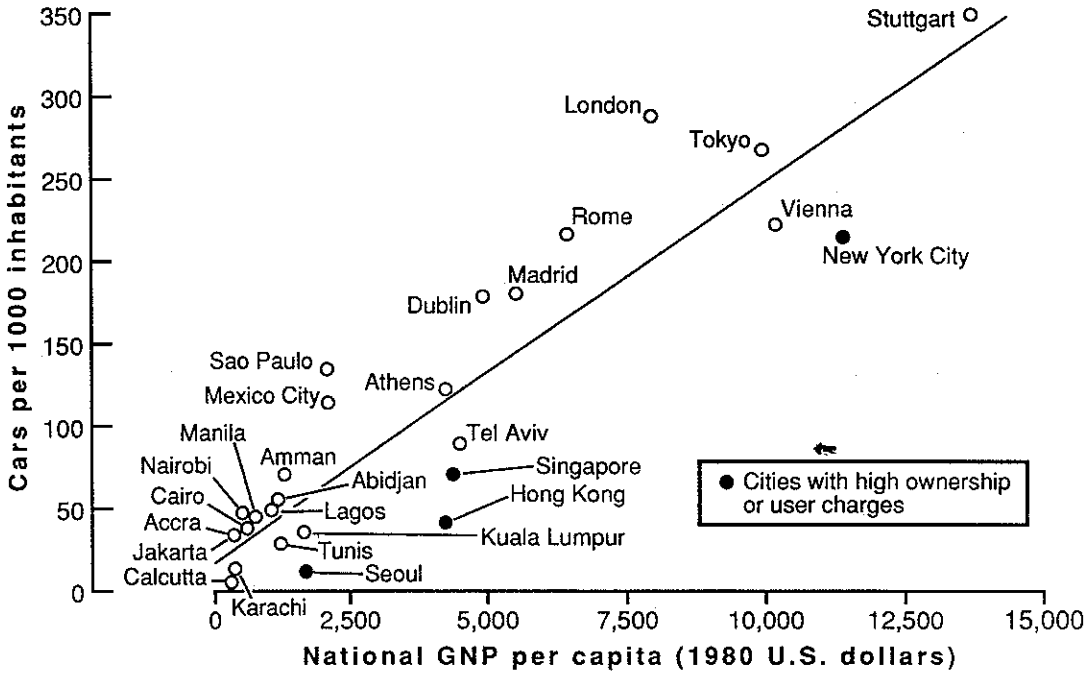

Figure 5.2a Private car ownership and GNP per capita in selected major cities.

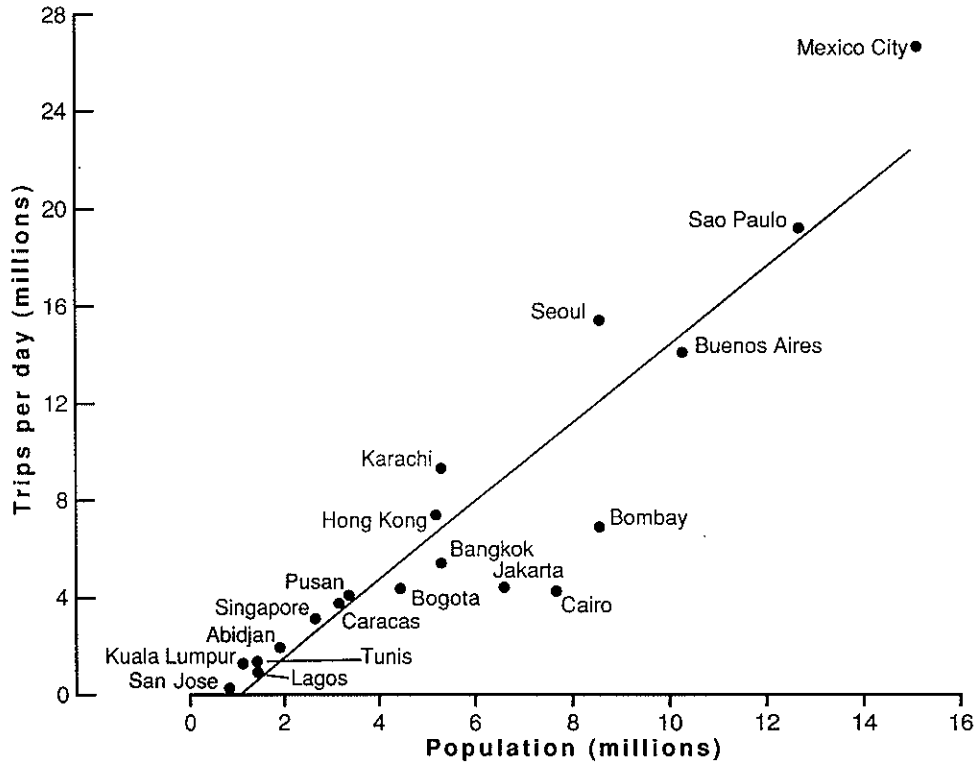

Figure 5.2b Private car trips per day in selected major cities.
Source: Dimitriou, 1990.

when all occupants are from the same household, as is the case with 35 per cent of all carpoolers in the USA (Teal, 1987). It is workplace location rather than residence location that usually influences the pattern of car sharing, as the vehicle can be parked during the day at a point convenient to most of the occupants. Carpooling is not used so extensively in the UK although a recent survey of office workers showed that the percentage of employees from the same office who shared cars for the journey to work varied from 32 to 65 per cent, with the average vehicle occupancy ranging between 2.38 and 4.44 persons (Daniels, 1980).

The perceived advantages of car travel in Western urban society have resulted in continued increases in the number of households with one or with two or more vehicles, although considerable variations between towns do exist in terms of household-car ownership. The low rates of car ownership in Third World cities are a direct reflection of income levels and a comparison of the world's major cities on the basis of cars and GNP per capita reveals some marked contrasts (Dimitriou, 1990). Whereas London, New York, Tokyo and Rome have at least 200 cars per 1,000 inhabitants and a national GNP per capita in excess of $6,000 (1980 level) centres such as Calcutta, Manila, Nairobi and Seoul have fewer than 50 vehicles per 1,000 and a GNP of below $2,500 (Figure 5.2).

Public transport

Urban public road transport in the industrialized world dates from the nineteenth century introduction of horse-drawn buses and trams, superseded in the 1890s and 1900s by electric trams. These were complemented and eventually largely supplanted by the motor bus in the twentieth century although tram systems still play an important role in many European cities. Railborne services for the urban traveller were first introduced as adjuncts to inter-urban networks but by the mid-nineteenth century urban railways specifically designed to link city centres and outlying residential areas were being constructed. New inner-city lines also appeared following the successful opening in 1863 of the sub-surface railway linking the London mainline terminus at Paddington with the city. The perfection of electric traction in the 1880s enabled the building of deep 'tube' railways. Complex systems were established in London and many other European cities, although in the USA there was often a preference for elevated systems along existing streets. These railways and road-passenger services together offered the urban population a previously unknown facility for rapid and generally cheap transport, especially for work journeys, and provided the only mechanized forms of travel until the advent of the private car.

Many urban railway systems have a distinctive radial form as they were initially designed for travel into city centres which contained the principal sources of employment. Facilities for travel between peripheral areas are normally more limited, although the London and Paris networks possess inner loops which allow for some direct movements not involving the central area (Figure 5.3).

Bus networks are more flexible in their operation although here again the emphasis is still firmly upon providing services into and out of central business districts. Another basic distinction between public rail and road transport is that access to the former is confined to stations that are generally spaced at least one kilometre apart whereas bus boarding and alighting points are usually at intervals of about 400 metres. In larger urban areas most of the population is within 500 to 750 metres of a bus route.

There is a general correspondence between city size and the level of provision of public transport in industrialized nations, but in the less-developed world the dramatic expansion of towns and cities has rarely been matched by the provision of what can be seen by Western standards as even a minimal level of such facilities. Urban rail networks in

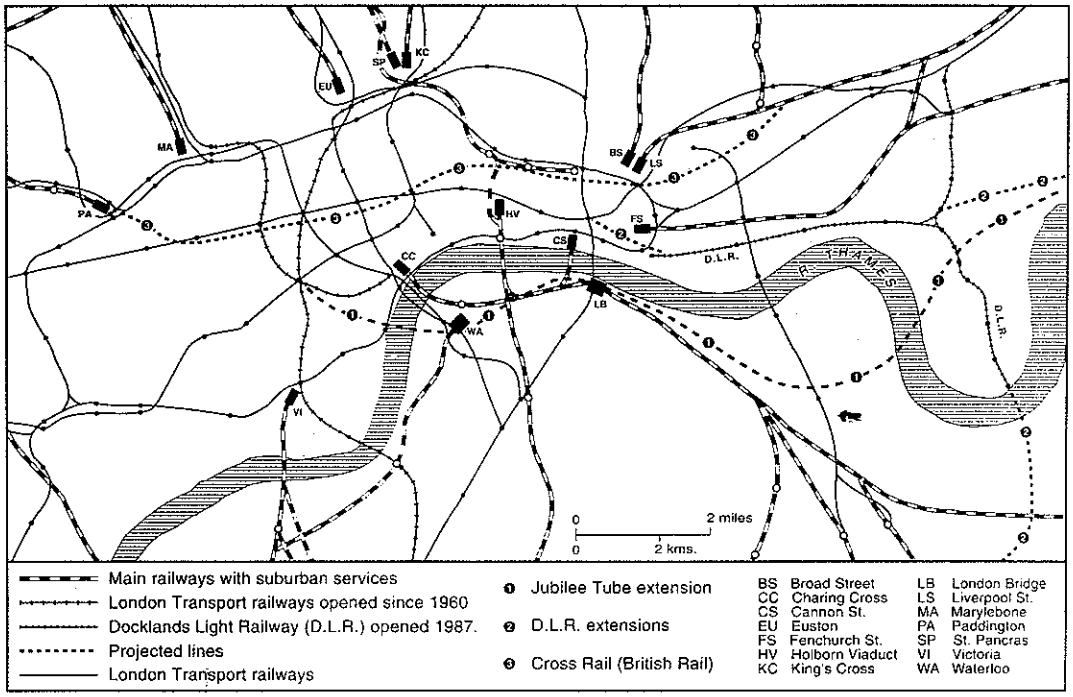

Figure 5.3 Existing and projected surface and sub-surface passenger railways in central London, 1990..

Sources: British Rail and London Underground maps; *Modern Railways*.

particular are much more restricted in their distribution than in Europe or the United States and buses carry the bulk of public travel in most cities. The eight cities in India with populations of between one and four million have no suburban rail services and the bus, which is the only available form of public transport, carries up to 40 per cent of all intra-urban trips. Within India there is also a marked imbalance between the distribution of urban centres and that of bus undertakings, with these eight large metropolitan areas containing nine per cent of the urban population but 21 per cent of the national bus fleet, whereas the 204 cities between 100,000 and one million population are provided with only 16 per cent of all buses to serve a demand created by 27 per cent of the total urban population (Nagakaja, 1988).

Singapore's population of 2.6 million is served by over 250 bus routes operated by two major private undertakings and several smaller companies. The bus network within this densely built-up area is within a five-minute walk of most inhabitants and the fleet of 3,200 vehicles provides a frequency of ten minutes or less on 80 per cent of the services (Rimmer, 1986). Such high frequencies are uncommon, however, and in many Third World cities bus users must adapt to much longer service intervals. Buses are generally used more intensively in cities of the less-developed world than in Europe and high fares, as seen in the context of disposable incomes, act in conjunction with the inadequate capacity of the fleets as a whole to limit the overall market (White, 1990).

Many cities in the less-developed world are largely dependent upon informal bus services which, together with various forms of shared taxis and non-motorized modes, provide

Table 5.6 Basic characteristics of urban transport modes

Facility	*Maximum capacity in persons/hour*	*Average speed (kms p. hour)*	*Interval between access points (kms)*
Bus on conventional road network	9–10,000	16–24	0.2–0.5
Bus using reserved lane on express highways	20,000	56	0.8–1.6
Urban railway	50–60,000	32–48	1.6
Light rapid transport system	40,000	26–38	0.5–1.3
Private car on conventional road network*	1,000	19–40	
Private car on urban motorway network*	3,000	72–80	

* Assuming 1.5 occupants per vehicle.

Source: World Bank Reports.

what is known as paratransit. The small-capacity vehicles which usually characterize this sector, however, are less efficient as carriers than conventional buses. The Turkish dolmus, for example, with its five seats is able to convey only 1,800 passengers per hour compared with the 5,000 capacity of a standard bus. However, the services offered by paratransit vehicles do satisfy a market whose demands cannot be fully satisfied by the formal public-transport sector in many Third World cities (White, 1990).

The urban taxi plays only a minor role in the public urban-transport system, constrained in its use by cost and limited capacity. However, it is of significance within inner cities for short-distance trips made for shopping, business or in connection with other public-transport modes and the demand for taxi services is rising. In London the vehicle fleet increased by 18 per cent in the 1977–87 period to a total of 14,800 taxis, but this excludes the large numbers of minicabs which are not subject to the strict controls imposed upon taxis. Apart from trips within cities the taxi is frequently used on a shared basis for central city to airport journeys or between main-line rail termini (White, 1989). In the Third World, however, taxis make up a significant part of the informal public-transport sector, with unofficial capacities of up to 12 or 14 per vehicle.

Modal choice

The selection by the consumer of what is perceived as the most desirable and convenient mode of travel within urban areas is influenced by personal income, degree of access to a car, journey purpose and time, and availability of public transport. The choice of means of transport is particularly critical during the commuting periods. The capacity of individual modes varies widely and some consideration of this attribute must be made at this stage (Hanson and Schwab, 1986). Table 5.6 summarizes the speeds and carrying capacities of the principal modes and it can be seen that maximum effective capacity ranges from 1,000 to 60,000 persons per hour with speeds varying from 10 to 50 miles per hour. Assuming an average loading of 1.5 persons the private car is the least efficient mode with a capability of transporting only 1,000 persons per hour on each lane of a conventional road network, increasing to 3,000 persons on an urban motorway. The bus, with a capacity of up to 80 or 100, can carry up to 10,000 people per hour at maximum frequency within cities but if reserved lanes on an urban expressway are available this total can rise to 20,000. Modern tramway networks can cater for up to 20,000 passengers per hour but a light rail-transport system is capable of carrying up to 40,000 persons under the most favourable operating circumstances. Underground, surface or elevated rail

services can cope with up to 65,000 passengers per hour although the level of access to such systems is much lower than that for bus or tram networks.

The choice between public and private transport is especially influenced by the variations in frequency of buses and rail services which are usually at a maximum during the journey-to-work periods. In smaller urban areas the choice will normally be between bus and car and final selection will also be strongly influenced by journey purpose (Mitchell, 1980). For shopping trips, walking remains the dominant mode and still ranks second after the car for work, social and leisure trips. Public transport by either bus or train only appears as the leading choice in larger cities where journeys-to-work are involved, although difficulties are associated with the peak hours and the selection of the car as the favoured mode for most non-work trips may be explained by its attractions in terms of flexibility, adaptability and comfort.

An analysis of office commuters in the UK indicated substantial differences between male and female employees when means of travel were examined. Between 84 and 94 per cent of all male workers were able to drive whereas only between 54 and 62 per cent of women had licences. Women driving to work represented only one-quarter of all car drivers and almost all car passengers were female. As a result women employees made up the large majority of bus passengers and although public transport was used by only 32 per cent of all workers in the survey this proportion increased to between 65 and 80 per cent for women commuters (Daniels, 1980).

In the Third World, however, the choice of personal transport is often inevitable since public facilities are so frequently incapable of meeting demand or have fares which low-income groups cannot afford and an alternative mode must of necessity be selected. In major Chinese cities the pedal cycle is used for over one-half of all journeys whereas public transport accounts for only 30 per cent in Guang Zhou and 43 per cent in Beijing, both major cities with populations of 3.29m and 5.86m respectively (Cai Jun-Shi, 1988).

Conclusions

Journeys within urban areas are made to satisfy a set of well-defined and regularly patterned needs linked with social and economic activities so that the general nature of travel does not vary greatly from city to city. However, there are significant differences in the overall structure of journey patterns and in the means of transport which are used for personal travel and for freight carriage. In particular the levels of personal mobility associated with access to the private car differ greatly between industrialized and developing countries, and the quality and quantity of public transport available also displays substantial variations.

There are trends in almost all areas towards increases in the volume and complexity of intra-urban movements which impose considerable strains upon the road and rail infrastructure. In particular the decentralization of many urban functions, such as retailing and leisure, which have traditionally been sited in central areas, has led to a reorientation of many trip destinations. The following chapter examines the nature of the urban congestion and interrelated problems which these changes have caused, together with the remedies that have been applied or that are currently under active consideration.

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6

Urban Transport Problems and Solutions

Brian Turton and Richard Knowles

In towns and cities of the developed world the principal transport difficulties are caused by the dominance of the private car, leading to severe congestion on urban roads, together with a steady decline in the patronage of public transport. In Third World cities public transport facilities are grossly inadequate and inner areas are congested with a mixture of motorized, animal-drawn and pedestrian traffic. Solutions to transport problems include new road construction, traffic-management schemes, rail-based rapid-transit systems and transport coordination programmes.

Introduction

Almost all the world's urban areas face difficulties in accommodating the complex variety of movements described in the previous chapter. Major cities in particular provide an arena in which the principal transport modes exist in a competitive environment and create what can often be seen as intractable problems. Devising and implementing solutions to ensure a more efficient and acceptable use of the urban-transport infrastructure has been the principal concern of planners and policy-makers. Many of the issues involved, such as environmental conflict, transport policy and administrative control, are discussed at greater length elsewhere in this book. In this chapter the leading difficulties and remedies are examined. These two are interrelated in what is termed the urban transport-planning process, involving the identification and categorization of travel patterns, the forecasting of future movements in the context of urban developments and the modes of transport available, and the preparation and implementation of plans to cater for this traffic in the most acceptable manner (Dimitriou, 1990a). It is not the intention here to describe all aspects of these processes and attention will be concentrated upon the spatial aspects of the principal problems and of the policies and plans advanced to alleviate them. The nature and scale of transport problems vary with the size of urban area, the balance between the use of private and public transport and the level of highway and public transport infrastructure available. One major contributory factor is the tendency for increasing distances to be established between homes and the principal destinations of daily trips, resulting in a higher level of personal tripmaking and lengthier journeys. These in turn impose greater demands upon road and public-transport systems already nearing or surpassing their capacity (Hanson, 1986).

Traffic congestion is thus one of the most basic difficulties experienced to some extent by almost all towns and cities. But more

Table 6.1 Basic transport data for selected Third World cities

City	Population (1985) in 000s	Cars per 1000 popn. in 1980	Cars annual growth rate 1970–80 (per cent)	Bus per 1000 popn. in 1980
Bangkok	6,100	71	7.9	1.22
Bogata	4,500	42	7.8	2.13
Bombay	10,100	21	6.1	0.36
Buenos Aires	10,900	53	10.0	1.20
Cairo	7,700	32	17.0	1.10
Calcutta	11,000	10	5.6	0.33
Hong Kong	5,100	39	7.4	1.83
Jakarta	7,900	33	9.8	0.72
Karachi	6,700	35	8.4	2.32
Manila	7,000	45	8.0	5.30
Mexico City	17,300	105	–	1.23
Rio de Janeiro	10,400	104	12.1	1.20
Sao Paulo	15,900	151	7.8	1.28
Seoul	10,300	15	11.7	1.55

Source: Dimitriou, H. (ed.), *Transport planning for Third World cities*, 1990.

recent additions include atmospheric pollution and other environmental issues and the complex problem of equity in terms of personal accessibility for different groups within urban society.

The problems

Congestion

Traffic congestion may be simply defined as the situation that arises when road and rail networks are no longer capable of accommodating the volume of movements that occur on them. The location of congested areas within a town is determined by the physical transport framework and by the patterns of land use and their associated trip-generating activities. The level of traffic overloading will also vary in time, with a particularly well-marked peak during the daily journey-to-work periods. Although congestion on urban roads is largely attributable to overloading there are other aspects of this basic problem that also require solutions. In industrialized nations increasing volumes of private car, public transport and commercial vehicle traffic have exposed the inadequacies of urban road systems, particularly in city centres where street patterns have often survived largely unaltered from the nineteenth century and earlier. The intricate nature of many city centres makes motorized movement difficult and long-term car parking almost impossible. In the Third World the problem is particularly acute in Indian and South-East Asian cities whose cores are composed of a mesh of narrow streets often accessible only to non-motorized traffic.

The rapid growth in private car ownership and use in cities of the Western world in the second half of the twentieth century has rarely been matched by a corresponding upgrading of urban road systems; these increases will probably continue into the next century. In urban areas of the less-developed countries car ownership is at a much lower level but there is evidence of an increased rate in recent years, especially in South America and South-East Asia (Table 6.1) (Rimmer, 1986). Satisfactory definitions of the saturation level of car ownership vary but if a figure of 50 cars to 100 persons is taken, then in several United States cities the level is now 80 per 100 whereas in cities of South-East Asia the figure rarely exceeds 10 per 100. One factor contributing to congestion in Third World cities is the uncontrolled

intermixing of motorized and non-motorized vehicles. The proliferation of pedal and motor cycles causes particular difficulties.

Public transport decline

Congestion on public-transport systems is a major problem but is only one of a group of interrelated factors initiating a cycle of deterioration that results in reduced services and declining revenue. Buses and tramcars contribute to the overall problem of excessive vehicle flows and there can also be overloading and unacceptable conditions for passengers within individual vehicles. Urban railway networks also experience congested conditions when, even at maximum frequency and capacity, trains are incapable of meeting demands and overcrowding becomes a permanent feature of rail travel during peak morning and evening periods.

One common problem directly attributable to the growth of car ownership and usage is the decline in public-transport patronage. Reduced revenues are countered by lower frequencies and higher fares which in turn discourage the use of public services and produce a cyclic effect which, unless it is arrested, can result in the virtual elimination of public transport in smaller urban areas and a substantial rationalization in larger cities. There are marked differences in the levels of patronage of public transport throughout the working day, and the concentration of traffic into the peak periods creates serious problems for operators when attempting to provide the most efficient services in terms of staff and vehicle deployment. Difficulties are also encountered at other periods when the levels of patronage are often insufficient to justify the provision of services.

Car parking

The provision of carparking space within or on the margins of central business districts for city workers and shoppers is a problem that has serious implications for land use planning. A proliferation of expensive and visually-intrusive multistorey storage facilities can only provide a partial solution and supplementary on-street parking can only compound traffic congestion. The extension of pedestrian precincts and similar features in city centres is intended to provide more acceptable environments for shoppers and other users in central areas. But such traffic-free zones in turn produce problems as they create new patterns of access to commercial centres for car-borne passengers and users of public transport, while the latter often lose the advantage of being carried directly to the shopping zone (Roberts, 1981).

Changing land-use patterns

Contemporary moves towards locating retailing complexes, leisure centres and business parks on the periphery of major urban areas have also resulted in transport problems. Bus routes which traditionally focus upon centrally located shopping centres rarely offer convenient access to the new out-of-town complexes. The larger stores often find it necessary to introduce their own bus routes to attract custom from suburban residential areas. Car-borne shoppers who make use of these new centres on the urban fringe often create traffic problems as they drive through suburban areas and similar cross-city journeys are made by patrons of leisure centres and workers in business and science parks (Hall, 1989). Although the development of these various peripheral retail and employment centres is beneficial in that they reduce the volume of traffic focusing upon urban cores, the traffic patterns they have created need to be considered in future transport-planning programmes.

Third World city problems

Deficiencies in public-transport services may be identified in almost all the world's towns and cities but the problems are particularly

severe in urban areas of the less-developed countries. Rapid rates of urbanization in these nations frequently involve the extension of low-income unplanned settlement on city peripheries and workers from these areas are exerting increasing pressure on already inadequate public-transport facilities. Although rising car ownership is a feature of Third World urban expansion, the majority of journeys are still made either on foot or by bus, and to a more limited extent by railway. This problem of expanding demand would be greater if it were not for the fact that low disposable incomes prevent many workers from making regular use of public transport (Roth, 1984). For example, in India the costs of public transport, expressed in terms of GDP per capita, can be four times those in the UK and in Delhi up to 36 per cent of disposable income can be expended on bus travel (White, 1990). Those that can afford to make regular use of buses face long, slow, uncomfortable journeys on poorly maintained vehicles and heavily congested roads, and wherever practicable urban migrants try to locate their households as near as possible to their workplaces. The purchase of new buses and the maintenance to a satisfactory standard of existing vehicles is frequently hampered by a lack of foreign currency. It is not unusual for between 60 and 80 per cent of a bus fleet to be out of service because of a lack of spare parts and skilled labour, yet a 70 per cent level of availability is generally regarded as the minimum acceptable to ensure satisfactory services (Dimitriou, 1990b). As a result of the shortage of both new vehicles and of reliable existing buses, few undertakings in the less-developed countries are able to meet the growth in demand for services in existing urban areas and the creation of new demands in recently built-up zones. It is forecast that users of public transport will experience increasing difficulties, particularly in the cities of Brazil, China, Indonesia, India and Nigeria in the next century as a result of rapid population rises.

A comparison of the availability of buses illustrates the difficulties faced by many Third World cities. Whereas in the UK there are 0.9 buses per 1,000 population the ratio in the less-developed nations is about 0.6 per 1,000, falling to only 0.3 per 1,000 in some Indian cities. However, the relative smallness of the bus fleets is countered by a much more intensive usage of vehicles, with a total of 70,000 kms per annum in some Third World cities compared with only 45,000 kms per annum in British urban areas (White, 1990). The inadequacies or poor representation of the formal public-transport sector have encouraged the expansion of paratransit modes, which flourish on routes alongside conventional vehicles and in those city areas where larger buses are physically prevented from operating because of narrow streets. Minibuses now carry a substantial share of the market and although these vehicles and hand-drawn and motorized rickshaws and allied vehicles meet a need for transport they do in turn create serious difficulties as a result of slow speeds and frequent stops to pick up and set down passengers. Because of the small scale of the businesses that own paratransit vehicles they often concentrate their carrying activities in areas where revenue is likely to be maximized; other areas where a demand for public transport exists tend to be ignored or poorly served.

The transport-deprived groups

Investigations into the travel habits and potential requirements of individual household members indicate that there are several clearly defined groups within the urban community who experience considerable difficulty in securing an acceptable level of mobility and accessibility to essential daily or periodic facilities. The elderly, the sick and disabled, those on very low incomes and those below the legal driving age are those most commonly disadvantaged in this respect. Recent research indicates that the numbers of persons who suffer from transport-deprivation and have been described as the 'transport poor' are increasing. In the UK six million people, or about

12 per cent of the adult population, suffer from some form of disability and by 2025 AD 20 per cent will be aged over 65, with two million persons over 80 years (Oxley and Benwell, 1985). In the USA an official survey of Worcester, Massachusetts, indicated that the proportion of persons aged over 65 rose from 11.9 to 13.4 per cent between 1960 and 1980 and that the percentage of families defined as below the poverty line increased from 5.4 to 7.5 in the decade 1970–80 (Hanson, 1986). Although many people in these categories are able to drive, to be driven or to make use of specially adapted cars, eventually their level of mobility is bound to decline and they become dependent upon relatives and friends or upon public-transport facilities. Bus and rail undertakings recognize the needs of the disabled traveller and modifications such as wheelchair access ramps at terminals and buses with low-level access have been introduced but these aids are not widespread at the present time.

Surveys of the elderly in urban areas indicate that this group generally makes much less use of cars than the employed and that they encounter more difficulties in travelling by public transport or on foot. Certain facilities used on a regular basis, such as post offices and food shops, are often accessible by walking but longer trips which necessitate bus travel present problems in terms of physical access to the bus and services are not always convenient. Unavoidable trips, such as those to hospitals, clinics and doctors, can cause particular problems for those elderly persons who cannot rely upon assistance from car-driving friends and relatives and who cannot afford the use of taxis. Distances travelled overall by the elderly are shorter than the average, indicating that their radius of action and hence the range of facilities available to them is also limited. The problems of this group are progressive with age as mobility is gradually diminished by events such as the death of the car-driving partner or increasing physical infirmity (Hopkin et al., 1978). Those under the legal age for car-driving also form a transport-deprived group although many social and leisure trips are made in a family unit. In many advanced nations journeys to school and college are confined to acceptable distances by a planned distribution of institutions and catchments throughout the built-up area and by the use of free or subsidized school-bus services but in Third World cities access to education can present serious problems. In the UK most children who live within one km. of their school either walk or cycle but traffic accidents and other hazards are associated with these journeys.

Environmental problems

The detrimental impact that many aspects of transport can exert upon the environment are fully discussed elsewhere. It is sufficient at this point to state that within urban areas both the problems associated with transport systems and the solutions advanced to combat them can have severe environmental implications. Excessive flows where heavy commercial vehicles form a large proportion of the total traffic cause atmospheric pollution, high noise levels, vibration which can progressively undermine older structures and visual intrusion. Construction of new urban highways and some types of rail networks can in turn lead to community disruption and create for adjacent built-up areas the same conditions of excessive noise produced by traffic on the routes they are intended to supplement.

Road safety

Within the UK and many other industrial nations the greater proportion of serious accidents occur in urban areas. Roads in built-up zones display an accident rate up to three times greater than in other road categories. Pedestrians and cyclists are especially vulnerable and 95 per cent of pedestrian accidents in Britain are recorded in urban areas with one half of these occurring

in town centres. For the young the problem of accidents is highly localized: 90 per cent of incidents involving the under-five group is recorded within a quarter mile of home, often on minor roads in residential areas. The vulnerability of the young to traffic accidents in the UK is closely related to the problem of the 'transport deprived' in that children account for almost one-third of pedestrian trips and form 39 per cent of all pedestrian casualties (Whitelegg, 1987).

The solutions

The urban transport planning process can produce a wide variety of proposals designed to alleviate problems associated with freight and passenger movements. Comprehensive plans for transport-improvement programmes over periods of up to 20 years for major towns and cities are now an accepted procedure but there is frequently an urgent need for more immediate short-term proposals which can provide temporary relief for difficulties such as traffic congestion in localized parts of an urban road system. Although it is possible to categorize solutions according to their principal objectives and methods of operation, it must be recognized that most urban-transport problems are interrelated and plans to solve them are similarly interlinked. The implementation of a scheme to alleviate congestion on one part of an urban-road network may well create difficulties elsewhere: the more ambitious plans involving the construction of motorways or new rapid-transit systems can have great deleterious effects upon the physical and social structure of urban communities bisected by these new lines of communication (Buchanan, 1963; Schaeffer, 1975). The costly schemes introduced in Western industrial cities also contrast markedly with the limited extent to which Third World cities have been able to combat their transport problems.

Investment in additional road capacity

One of the most commonly adopted methods of combating congestion in small towns or in districts of larger urban centres is the construction of bypasses to divert through traffic. In Britain these date from the 1930s and the extension of the principle to the orbital or sub-orbital road has produced routes such as the M25 motorway around Greater London or the M42 ring-road which interconnects the M5, M6 and M40 motorways converging on Birmingham. Although an effective bypass will remove a large part of the traffic from a town centre there will usually be some routes carrying through traffic which continue to cause congestion within the urban area. Orbital routes themselves can also soon become overloaded if the initial forecasts of traffic volumes have been inaccurate. The inadequacies of the M25 motorway opened in 1986 are now being corrected with the construction of additional carriageways in both directions.

The solution to congestion on intra-urban road networks was also seen by mid-twentieth-century planners as the provision of additional capacity in the form of new or improved highways. Since the pioneer transportation studies of the 1950s and 1960s were carried out in US metropolitan areas where the needs of an auto-dominated society were seen to be paramount, this construction of additional road capacity was generally accepted as the most effective solution to movement problems and urban freeways were built in many large cities such as Chicago, San Francisco and Los Angeles (Dunn, 1981). Transport planners in Western Europe incorporated many of their American counterparts' proposals into their own programmes and urban motorways became a leading component in many road-improvement schemes (Muller, 1986). However, it soon became evident that the extra capacity gained from road construction was rapidly filled with additional traffic attracted to the new facility. Construction of urban motorways and their complex junctions with the conventional road system

requires large areas of land and the demolition of tracts of housing and commercial properties. Planners and policy-makers came to accept that the investment of massive amounts of capital in new highways dedicated to the rapid movement of motor traffic was not necessarily the most effective manner of solving transport problems (Starkie, 1982). Although US cities contain many examples of complex freeway networks, urban authorities in Western Europe have tended to be more selective in their adoption of motorways and in the UK in particular road-building programmes have been substantially modified from the original design. What has been described as 'heroic structural change' has been replaced by a concern to make the most efficient use of existing facilities. In London, for example, the ambitious plans for inner-orbital motorways which aroused such fierce opposition in the early 1970s were abandoned and replaced by a programme based upon more selective road improvements (Bayliss, 1977).

Traffic management measures

Temporary and partial relief from road-traffic congestion may be gained from the introduction of traffic-management schemes, which involve the reorganization of traffic flows and directions without any major structural alterations to the existing street pattern. Among the most widely used devices are the extension of one-way flow systems, the phasing of traffic-light controls to take account of traffic variations and restrictions on parking and vehicle-loading on major roads. In Glasgow, for example, an experimental computer-controlled scheme to coordinate traffic at inner city intersections increased peak hour speeds by 16 per cent. On multilane highways which carry heavy volumes of commuter traffic, certain lanes can be allocated to incoming vehicles in the morning and to outgoing traffic in the afternoon, producing what has been described as a tidal-flow effect.

Traffic management has received particular attention within urban residential areas, where excessive numbers of vehicles create problems of noise, vibration, atmospheric pollution and, above all, accident risks, especially to the young. The concept of 'traffic calming' has been introduced to many cities in Europe and involves the creation of an environment in which cars may travel but where priority is accorded to the pedestrian. Carefully planned street-width channelling, parking restrictions and speed-control devices such as ramps are combined to secure a safe and acceptable balance between the vehicle and the pedestrian (Tolley, 1990).

Bus priority and allied proposals

Many transportation-planning proposals have been directed specifically towards increasing the speed and schedule reliability of bus services and most large European cities have adopted bus-priority plans in an attempt to boost the attractions of public transport. Bus-only lanes, with or against the prevailing direction of flow, may be designated in heavily congested roads in order to secure time savings although such savings can be dissipated when buses enter inner-city areas where priority lanes are absent. Buses may be accorded priority turns at intersections and certain streets may be reserved for buses only, particularly in pedestrianized shopping areas.

An effective use of buses may be made by incorporating bus-only lanes within new highways, allowing both private and public traffic to benefit from the new route. In the USA this method is the main means of providing bus-priority measures. It dates from the early 1970s, when bus lanes were provided on freeways approaching Washington, New York and San Francisco. In its first year the exclusive bus lane provided on the link between the New Jersey Turnpike and the Lincoln Tunnel carried a daily average of 34,000 persons in 800 buses but these totals are nowhere near the maximum capacity of a bus lane, which

could be 60,000 persons per hour in 1,200 vehicles. The latter total is far in excess of current urban demand; bus lanes are therefore not fully utilized but they do provide a highly efficient means of conveying bus passengers into city centres (Westwell, 1983).

Where entirely new towns are planned there is an opportunity to incorporate separate bus systems within the urban road network and thus enable buses to operate to schedules unaffected by conventional road-traffic conditions. In the UK, Runcorn New Town, built as an overspill centre for the Merseyside conurbation, was provided with a figure-of-eight busway linking the shopping centre, major industrial estates and residential areas. About 90 per cent of the town's population were within five minutes walk of the busway and operating costs were 33 per cent less than those of vehicles on the conventional road network (Vincent et al., 1976). Although the system is not used to the extent originally envisaged, it successfully illustrates the integration of public-transport planning with urban development. The introduction of bus-only roads also permits the use of vehicle-guidance systems, whereby the bus is not steered but controlled by lateral wheels; conventional control is used when the public-road system is re-entered. Such systems are in use in Adelaide and experiments have been carried out in many other cities (Adelaide, 1988). The bus can also be given additional advantages in the redevelopment of major retailing and transport complexes in city centres. Rebuilding or remodelling of commercial centres to accommodate covered malls or precincts can provide the opportunity to site bus termini in more convenient locations for shoppers. Major reconstruction of rail stations and termini can also allow bus stations to be integrated more closely with rail facilities. The 'park and ride' scheme, now adopted by many European cities, is intended to reduce the number of cars entering central areas, particularly at weekend peak-shopping periods. Large open spaces on the urban fringe act as temporary carparks and drivers are carried by bus into city centres at an overall charge that matches or betters central area parking costs. The advantages of the bus as an efficient carrier can be secured and the costs of providing parking accommodation are considerably lower on the outskirts than in city centres. Commuters can also be catered for in a similar manner with the provision of large capacity carparks adjacent to suburban rail stations.

Unconventional bus services

Many towns and cities have attempted to promote bus transport by increasing its flexibility and level of response to market demand. In suburban areas the dial-a-ride system has met with partial success, with prospective passengers booking seats by telephone within a defined area of operation. Such vehicles typically serve the residential areas around a district shopping centre and capacity is limited, so they are best suited to operations in areas of low demand or in off-peak periods. Fares are higher than on conventional buses since about one third of revenue is required to finance the control centre which receives booking calls and despatches buses to travellers' homes or close by (Martin, 1978). Before the widespread introduction of minibus services following deregulation, experimental services were introduced with small-capacity vehicles which could be hailed in the same way as a taxi and which could negotiate the complex street patterns of housing estates more easily than larger buses. As with the dial-a-ride system, however, these hail-stop minibuses could only cope with a limited demand.

Vehicle restraint schemes

These priority measures designed to enhance the efficiency of bus services can also be combined with plans to restrain the use of inner urban streets by private motorists. A filter system can be applied whereby cars are

only allowed into congested inner-city zones if vehicles are fully loaded, thus promoting a more efficient use of cars than is usually the case. In the UK the Nottingham experimental zone and collar scheme introduced in the 1970s was an attempt to restrain morning peak-hour traffic originating in two suburbs from penetrating the city centre by the use of specific zone exits and park-and-ride services into the core (Collins, 1975). Other methods are based upon fiscal restraint and involve the levying of premium tolls or taxes on drivers wishing to enter inner zones with payment made either on entry or exit. Another variation is based on an electronic-metering programme whereby roadside computers can determine the journey lengths made in restricted zones and despatch accounts to the drivers. These schemes can make substantial contributions to the reduction of road congestion but their implementation by local urban authorities can meet with strong resistance from the motoring lobby, with implications for the political survival of the local authority responsible.

Any plans that involve the introduction of priority measures for fully laden vehicles, area licensing or vehicle filtering should favour the expansion of carpooling which has already been noted as a significant element in American commuting patterns (Teal, 1987). Although the method is not popular with many commuters, an expansion of car-restraint schemes could stimulate its adoption in the future.

Rail rapid transit

Investment in rail-based rapid-transit schemes has been used to encourage suburban development, to provide an alternative to congested urban roads, and more recently to help regenerate the declining economies of city centres, inner cities and derelict docklands (Church, 1990; Roberts, 1985; Williams, 1985).

Trains and trams (streetcars) were the earliest nineteenth century mass-transit modes and enabled the first complete separation of place of residence from workplace (Kellett, 1969; Ward, 1964). Underground railways are mainly twentieth-century developments, although they started with London's Metropolitan Railway in 1863 and London's first deep-level electrified tube line in 1890. From the 1930s, mass car ownership encouraged suburbanization and urban dispersal to occur on a much larger scale and in a less concentrated form. Motor vehicles now competed for congested urban road space with trams which ran on the road, except for a few segregated suburban lines. Trams were regarded as an outdated mode of transport and the British response from the late 1930s onwards, encouraged by government advice from 1946, was to replace trams with buses in all towns and cities. This was typically completed by Manchester in 1949 and London in 1952, although trams survived in Sheffield until 1960 and Glasgow until 1962 and were retained along the Blackpool seafront. In contrast, the German response was to modernize trams into Light Rail (Stadtbahn) systems and put them underground in congested city centres and inner cities to avoid conflict with road traffic. Cologne, Essen and Hannover provide good examples (Hall and Hass-Klau, 1985).

An alternative response was to develop and/or electrify suburban railway lines as in Copenhagen, Glasgow and London, or underground Metros as in London, Munich and Stockholm. This was particularly successful where land-use zoning powers were used to concentrate high-density suburban development around railway stations. The three Scandinavian capitals provide notably successful postwar examples with Copenhagen's five suburban rail corridors developed from its famous 1947 Finger Plan, and Stockholm's numerous metro lines and Oslo's four metro lines developing similar suburban corridors (Fullerton and Knowles, 1991).

In the UK the most widespread response to urban congestion in the early 1960s was to try and provide more roadspace for the sharply increasing volume of cars by building or widening roads, and by traffic management.

Table 6.2 Typical characteristics of urban rail systems

	Streetcars	*Light rail*	*Suburban rail*	*Metro*
A *Urban size*				
Population	200K–500K	100K–1 million	Over 500K	Over 1 million
CBD employment	Over 20K	Over 20K	Over 40K	Over 80K
B *Route characteristics*				
Route length from CBD	under 10Km	under 20Km	under 40Km	under 24Km
Track	On street	over 40% segregated	segregated	segregated
CBD access	surface	surface	surface to CBD edge	underground
Station spacing in suburbs	350m	1 Km	1Km–3Km	2Km
Station spacing in CBD	250m	300m	–	500m–1Km
Maximum gradients	10%	8%	3%	3%–4%
Minimum radius	15m–25m	25m	200m	300m
Engineering	minimal	light	medium	heavy
C *Rolling stock*				
Carriage weight	16 tonnes	under 20 tonnes	46 tonnes	33 tonnes
Number of carriages	1 or 2	2 or 4	up to 12	up to 8
Carriage capacity	50 seats	40 seats	60 seats	50 seats
	75 standing	60 standing	120 standing	150 standing
Carriage access	step	step or platform	platform	platform
D *Performance*				
Power current	DC 500–750V	DC 600–750V	DC 600–1.5KV or AC 25KV	DC 750V
Power supply	overhead	overhead	overhead or 3rd rail	3rd rail
Average speed	10–20 Kph	30–40 Kph	45–60 Kph	30–40 Kph
Maximum speed	50–70 Kph	80 Kph	120 Kph	80 Kph
Typical peak headway	2 minutes	4 minutes	3 minutes	2–5 minutes
Maximum hourly passengers	15,000	20,000	60,000	30,000

Source: Knowles and Fairweather, 1991.

American transport consultants ignored rail-transit investment and advised city after city to build extensive and expensive urban-motorway networks (Starkie, 1982). Urban-motorway plans were soon abandoned or curtailed because of cost and an environmental backlash and transport consultants started advocating Mass Rail Transit schemes. Recommendations for rail electrification and reopening the Argyle Line in Glasgow in 1968, a Link and Loop rail connection underneath central Liverpool in 1969 and the Tyneside (Light Rail) Metro in 1971 were all accepted and built within ten years, partly financed with government grants (Fullerton and Openshaw, 1985; Halsall, 1985; Robinson, 1985; Westwell, 1983). In London the Victoria and Jubilee underground lines were opened in 1968 and 1979 respectively, the first such lines since the 1920s. However, Manchester's Picc-Vic underground link was rejected on cost grounds in 1975 (Knowles, 1985).

Metros need a large volume of potential users to justify the expense of tunnelling and the long period of disruption to city streets during construction. Metros are, therefore, rarely built in cities of under 500,000 people, and are more typical of million plus cities. The Soviet Union actually has a policy of building a metro when a city has grown to a million people (Jackson, 1989). Metros are usually fully segregated from other rail traffic with stations 0.5 km. to 1 km. apart in city

Table 6.3 Metro systems in operation 1991

Country	*Number of systems*	*City*
Europe 28		
Austria	1	Vienna
Belgium	1	Brussels
Czechoslovakia	1	Prague
Finland	1	Helsinki
France	4	Lille; Lyon; Marseille; Paris
Germany	6	Berlin; Cologne; Frankfurt am Main; Hamburg; Munich; Nuremburg
Greece	1	Athens
Hungary	1	Budapest
Italy	2	Milan; Rome
Netherlands	2	Amsterdam; Rotterdam
Norway	1	Oslo
Portugal	1	Lisbon
Romania	1	Bucharest
Spain	2	Barcelona; Madrid
Sweden	1	Stockholm
United Kingdom	2	Glasgow; London
North America 12		
Canada	2	Montreal; Toronto
United States	10	Atlanta; Baltimore; Boston; Chicago; Cleveland; Miami; New York/Newark; Philadelphia; San Francisco/Oakland; Washington DC
Soviet Union 13		Baku; Dnepropetrovsk; Gorky; Kharkov; Kiev; Kuibyshev; Leningrad; Minsk; Moscow; Novosibirsk; Tashkent; Tbilisi; Yerevan
Asia 17		
China	2	Beijing (Peking); Tianjin
Hong Kong	1	Hong Kong
India	1	Calcutta
Japan	9	Fukuoka; Kobe; Kyoto; Nagoya; Osaka; Sapporo; Sendai; Tokyo; Yokohama
North Korea	1	Pyongyang
Singapore	1	Singapore
South Korea	2	Pusan; Seoul
Latin America 7		
Argentina	1	Buenos Aires
Brazil	2	Rio de Janeiro; Sao Paulo
Chile	1	Santiago
Colombia	1	Medellin
Mexico	1	Mexico City
Venezuela	1	Caracas
Africa 1		
Egypt	1	Cairo

Source: Knowles and Fairweather, 1991.

centres, and about 2 km. apart in the suburbs. They can carry up to 30,000 people per hour in one direction and extend up to 24 km. from the city centre (Table 6.2). Metro systems are widespread with 77 operational worldwide, 27 of them in Europe and a further 36 under construction or in design (Knowles and Fairweather, 1991) (Table 6.3). The World Bank advises Third World countries not to invest in metros in their burgeoning capitals unless cheaper and more flexible road-based public-transport systems cannot cope.

Suburban rail provides frequent local passenger services on main-line surface railways up to about 40 km. from the city centre as in Dublin, Manchester, London and hundreds of other cities in dozens of

countries in all five continents (Knowles and Fairweather, 1991). Suburban rail is sometimes separated from long-distance rail routes and can be extended under city centres through short sections of tunnel, as in Copenhagen, Glasgow, Liverpool and Munich. Suburban trains are longer, with stations more widely spaced, gradients shallower and speeds higher than for metro systems (Table 6.2).

The revival of metro and suburban rail investment in Europe and North America gave way, in the 1980s, to light rail investment. Electrified light rail systems offer many of the advantages of metros and suburban rail, but at much lower cost as the routes are less heavily engineered and the lighter carriages can travel up steeper gradients and around tighter curves. Light rail requires at least 40 per cent of its track to be segregated from road traffic to avoid road-traffic congestion, and this differentiates it from trams or streetcars (Table 6.2). A further distinction needs to be made between light rail systems such as London Docklands Light Railway, which are fully segregated and can be automatically driven, and those such as the Manchester Metrolink which are partly segregated. Light rail can operate up to 20 km. from city centres and carry up to 20,000 passengers per hour. They are usually found in urban centres with between 100,000 and 1 million people, such as Charleroi in Belgium (200,000) and Hiroshima in Japan (900,000). When they occur in larger urban areas such as Vienna (1.5 million) they normally complement a metro system (Knowles and Fairweather, 1991).

Light rail systems are operational in 100 cities, mainly in Europe and North America, but also in the Third World (Table 6.4). Light rail systems are being built, planned or considered in hundreds of cities worldwide to relieve urban road congestion or help regenerate run-down areas, including more than 40 in Britain (Figure 6.1). Regeneration routes include London Docklands Light Railway and the Don Valley Route Two of the Sheffield Supertram. Light rail systems, especially in Germany, are sometimes upgraded from streetcars, as in Stuttgart, while others such as London Docklands run on mainly new alignments. A final group, including Manchester Metrolink, Los Angeles, Tyne and Wear, and Vancouver Sky Train, utilize old railway routes. An increasing number of newer light rail systems, such as Manchester Metrolink, Sheffield Supertram and Zürich, cross the city centre on surface routes on wholly or partially segregated streets. Here they are driven 'on sight' with priority at traffic lights. This is much cheaper than tunnelling and is also more accessible and safer for passengers.

Streetcars are still found in about 250 towns and cities worldwide but they are mainly in the Soviet Union and other former communist countries, where road congestion is less significant as private car ownership has been severely restricted (Table 6.2). It is expected that most of the streetcar systems will either be upgraded into light rail or abandoned as urban road congestion increases.

Transport coordination

Successful transport planning depends to a large extent upon the integration of the various modes of urban transport and the coordination of their operations. The establishment of transport authorities by major metropolitan councils represents a significant stage in the programme to secure an efficient system. In the USA legislation to establish city mass-transit undertakings dates from the 1940s, with the creation in 1945 of the Chicago Transit Authority to purchase the existing subway system and the surface rail suburban lines. In 1952 the Authority also acquired the Chicago motorcoach system to become one of the first city-transport organizations in the world to exercise control over the majority of its public-transport network (Smerk, 1968).

In the UK the 1968 Transport Act enabled the formation of Passenger Transport Authorities and Passenger Transport

Table 6.4 Light rail systems in operation 1991

Country	*Number of systems*	*City*
Europe 62		
Austria	1	Vienna
Belgium	3	Antwerp; Brussels; Charleroi
Czechoslovakia	2	Bratislava; Brno
France	5	Grenoble; Lille; Marseille; Nantes; St Etienne
Finland	1	Helsinki
Germany	20	Bielefeld; *Bochum-Herne; Bonn; Braunschweig; Bremen; Chemnitz; Cologne; *Dortmund; *Duisburg; *Düsseldorf; *Essen-Mulheim; Frankfurt am Main; Freiburg; *Gelsenkirchen; Hannover; Karlsruhe; *Krefeld; Mannheim-Ludwigshafen; Stuttgart; Wurzburg
Hungary	1	Budapest
Italy	3	Genoa; Rome; Turin
Netherlands	4	Amsterdam; Rotterdam; The Hague; Utrecht
Norway	1	Oslo
Poland	1	Czestochowa;
Romania	6	Brasov; Cluj; Constanta; Craiova; Poleisti; Resita
Spain	1	Valencia
Sweden	2	Gothenburg; Stockholm
Switzerland	6	Basle; Berne; Geneva; Lausanne; Zürich; Neuchatel
United Kingdom	4	Blackpool; London Docklands; Manchester**; Tyne and Wear
Yugoslavia	1	Sarajevo
North America 20		
Canada	4	Calgary; Edmonton; Toronto; Vancouver
United States	16	Baltimore; Boston; Buffalo; Cleveland; Detroit; Fort Worth; Los Angeles; Newark; New Orleans; Philadelphia; Pittsburgh; Portland; Sacramento; San Diego; San Francisco; San José
Australia 1		Melbourne
Soviet Union 3		Krivoy Rog; Naberezhyne-Chelny; Volgograd
Asia 6		
Hong Kong	1	Hong Kong
Japan	2	Hiroshima; Kyoto
Philippines	1	Manila
Turkey	2	Istanbul; Konya
Latin America 4		
Brazil	1	Rio de Janeiro
Mexico	3	Guadalajara; Mexico City; Monterrey
Africa 3		
Egypt	2	Alexandria; Helwan
Tunisia	1	Tunis

* = Stadtbahn Rhein-Ruhr ** = opening 1992

Source: Knowles and Fairweather, 1991.

Executives in major conurbations, charged with providing integrated and efficient public passenger-transport systems within their areas of operation. Basic policy-making and funding is the responsibility of the PTA while the PTE is concerned directly with the planning and operation of transport facilities provided by a variety of different operators such as bus companies and British Rail. In many cases the PTEs inherited extensive bus networks from the local authorities and were responsible for their operation alongside those of other undertakings. Following the reorganization of local government areas in 1974 the PTAs and PTEs became responsible for public-transport policy and planning in major conurbations which, for the first time, were administered by one overall authority,

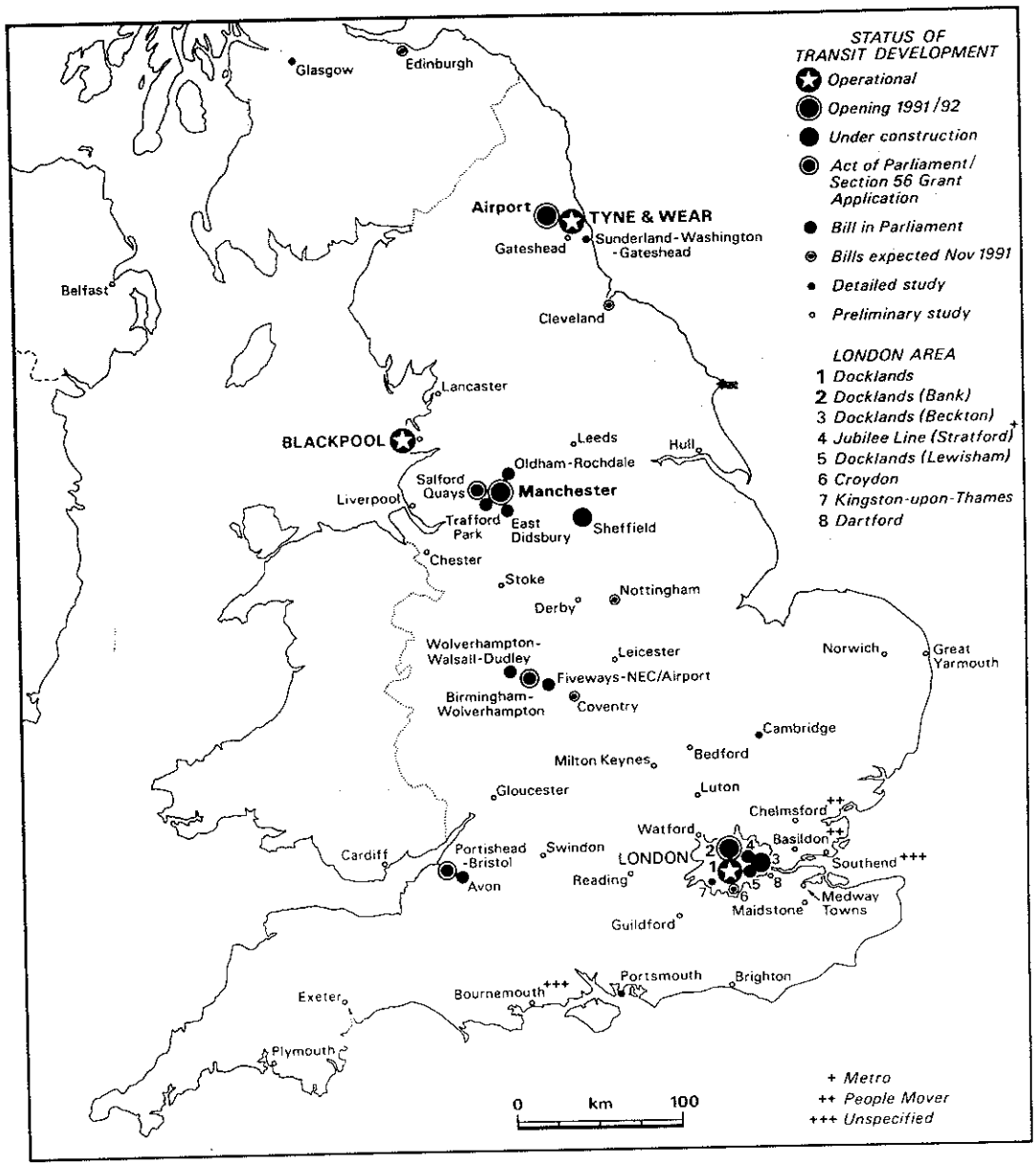

Figure 6.1 Light rail and other transit developments in the UK, 1991.

the new Metropolitan County Councils, which existed until their disbandment in 1986. The extent to which these conurbation-transport bodies achieved their objectives is closely influenced by the socioeconomic nature of their respective areas and the character of the road and rail networks subject to their control. In the USA the Mass Transit Authorities which corresponded roughly to the British PTAs and PTEs had legal powers to acquire rail and bus undertakings within their operating areas if such action was thought to benefit the travelling public. The authorities in New

York, Philadelphia and several other large cities exercised this right. In contrast the British PTAs were unable to purchase local rail lines but were obliged under the 1968 Act to enter into contractual agreements with British Rail in respect of rail services within each PTA area. Whereas the PTAs are responsible for providing funds for new or modernized stations and rolling-stock, British Rail retain the rights to operate the services.

One example of how this division of responsibility hindered the task of securing effective integration of all conurbation transport was that British Rail revised rail timetables only once a year whereas PTAs often saw the need for more frequent alterations in order to coordinate bus and rail facilities. A similar situation existed with respect to bus services, in that the PTAs subsidized undertakings which operated buses within the conurbations but without possessing any influence or control over the operating policies of the parent companies. However, the PTAs can be credited with several achievements such as the introduction of through-ticketing facilities, joint road-rail fare structures and the publication of passenger information incorporating all modes of travel available within the conurbation. They were also responsible for introducing new facilities such as the Tyne and Wear Metro, the central Liverpool underground rail loop and the extension of the Clydeside electric suburban rail network, although in many cases plans for these schemes had been initiated before the establishment of PTAs and PTEs. Although the PTAs still exist as joint boards, together with PTEs, their functions today are more limited. They have lost control over commercial bus services and the powers to promote transport integration which they possessed between 1969 and 1986.

'Non-transport' solutions

Throughout the world's cities a wide range of policies, strategies and plans have been devised and implemented in order to solve the problems of urban transport in the private and public sectors. The acceptance by transport planners that conventional patterns of socioeconomic activity, with their emphasis upon standardized working hours, dictate corresponding demand patterns for transport services creates a situation in which the development of an efficient transport system capable of meeting all requirements proves almost impossible. Many physical and transport planners now actively support proposals for changes to these established patterns of activity as a means of securing greater measures of success in their planning programmes. One of the most obvious targets is to reduce the volume of travel during the journey-to-work periods by encouraging the spread of job start and finish times over much longer timescales (Plane, 1986). The establishment of what may be described as a shift system for most of an urban workforce would be unpopular and difficult to initiate but the extension of each journey-to-work period over four or five hours rather than two could lead to a substantial and effective reduction of the congestion attributable to commuting. Already the widespread adoption of 'flexi-time' in the service sector has helped to flatten the commuter-travel peaks in many major cities during the 1980s.

Another category of 'non-transport' solution to the congestion problem lies in the growth of home-based economic activity made possible by the expansion of telecommunications, personal-computing facilities and information technology. Many jobs in the financial and commercial sector traditionally carried out in city-centre offices can be accomplished as effectively at home, with computer linkages with headquarter offices. Significant increases in the numbers of employees who could work at home in this way would again contribute to a reduction in the demand for public transport or road space within urban areas. An extension of the opening hours of retailers in city centres during the week could also encourage more workers to shop later and delay their journey home.

Solutions for the 'transport deprived'

Various remedies have been suggested and implemented to meet the special needs of the 'transport deprived' in urban areas. For the disabled who require some form of public transport to make journeys beyond the range of small electric wheelchairs the taxi is the most acceptable mode but costs are high in comparison with other alternatives. Buses may be frequent and provide transport to most of the required destinations but access problems may be insuperable and few undertakings have vehicles adapted for use by the disabled. Where disabled persons are members of special clubs, minibuses are often provided for trips into town centres and other locations and can carry wheelchairs. These facilities are generally superior to any offered by public transport. Rail journeys can present even greater difficulties but many more urban stations are now provided with ramp or lift access to platforms and much of the rolling-stock incorporates space for wheelchairs. In Manchester the Metrolink light rail transport system is fully accessible to the disabled but at an extra cost of £10 million for the first phase of the project.

Case-studies

This chapter concludes with a series of case-studies of individual cities where transport problems have been analysed and plans introduced in an attempt to solve the more outstanding difficulties. Examples have been drawn from North America, Europe, the Far East and the Third World to illustrate the complexity of the interaction between the demand for transport facilities and the response from private- and public-sector enterprises.

Glasgow – urban deprivation and transport innovation

The Clydeside conurbation, with Glasgow as its core, contains almost half of the population of Scotland in a region characterized by some of the highest unemployment rates in the UK, low levels of car ownership and extensive areas of inner-city dereliction which are currently undergoing urban renewal. When the Passenger Transport Authority and Executive were created in 1972 they became responsible for a complex system of public transport comprising a city-owned bus network, bus services operated by over 40 private or state-owned companies, an underground railway and an extensive network of local-surface railways which is the largest outside Greater London. The responsibilities and functions of the Glasgow PTA and PTE were then assumed by the Strathclyde Regional Council in 1975 following the reorganization of local government in Scotland.

In preparing a comprehensive transport policy for Glasgow the PTE had to take account of several trends in social and economic conditions. The population of the inner city fell by almost one-third between 1961 and 1981 and large numbers were accommodated in new housing estates on the periphery (Law et al., 1984). Demolition of many former residential and industrial areas bordering the Clyde had released land for new road building and the proportion of car-borne commuters was rising steadily. Travel by public transport declined by one-third in the 1970s and although the level of government support increased, operating costs also rose, creating a situation that could only be remedied by withdrawal of services, higher fares or revenue support from local ratepayers.

Electrification of the suburban railways north and south of the Clyde began in the 1960s. They were linked in 1979 with the reopening of the Argyle line passing under Glasgow Central Station (Figure 6.2). The circular underground line, opened in 1897 to serve the city centre and lower Clydeside as far west as Govan, was refurbished and reopened in 1980, with new bus or surface-rail interchange facilities at each of its 15 stations and park-and-ride facilities at several. The coordination of bus and rail,

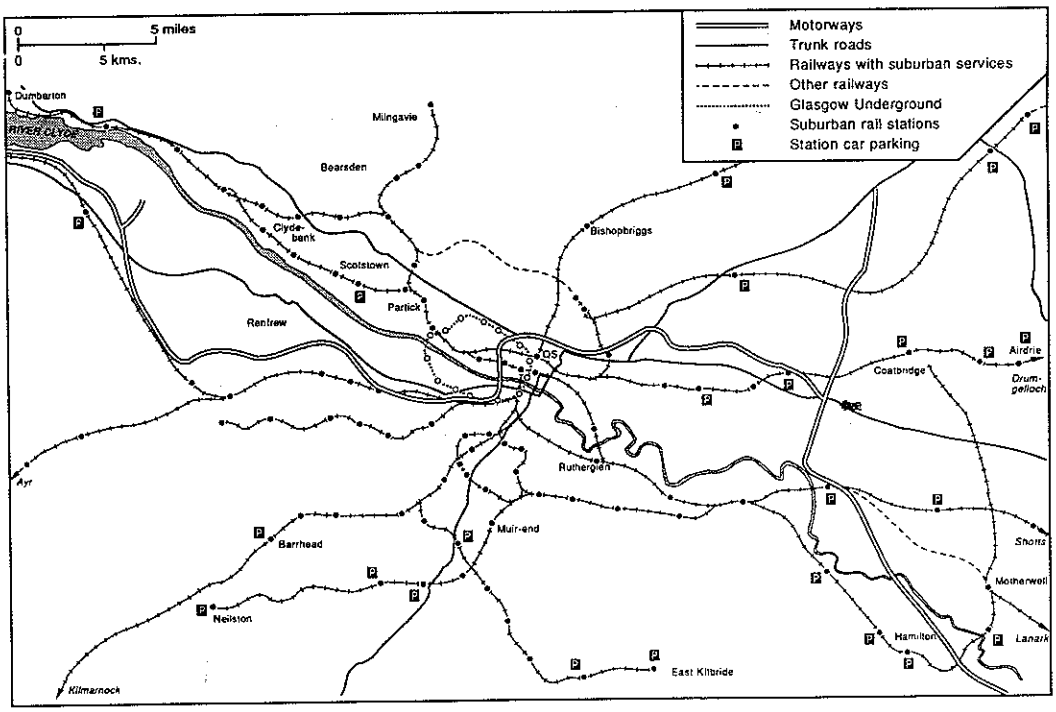

Figure 6.2 Principal roads and railways in the Strathclyde conurbation.

and of bus services provided by different undertakings, was a keystone of Glasgow's PTE policy; what was seen as undesirable competition was fought vigorously. For example, the PTE gave financial support to the newly electrified Glasgow-Ayr line, which carried a substantial commuter traffic, and during the 1970s it successfully opposed the introduction of parallel bus services. However, the 1980 Transport Act sanctioned such competition and Ayr-Glasgow bus services have eroded some of the rail traffic (Westwell, 1983). Although the injection of government capital enabled the completion of the two major rail projects in the late 1970s, patronage continues to decline and 90 per cent of all passengers travel on the bus network. Since deregulation in 1986 the appeal of the bus system, especially in the outer housing estates, has been increased with use of small-capacity vehicles which are more flexible in their operation than the double-deckers. But competition between different companies for passengers in the inner city has resulted in congestion and the levels of service coordination achieved by the PTE during the first decade of its life have been severely reduced. The most recent proposals for the conurbation include additional bus-priority measures, new stations on the rail network and options for an LRT system (Strathclyde PTE, 1990).

The South-East Asian city – private car restraint and rapid mass transit

Kuala Lumpur and Singapore have both grown rapidly since the 1960s and their expansion as commercial and administrative centres has generated formidable problems of urban transport. Programmes of public-transport improvement are seen as the most acceptable solutions to these problems but to date Singapore has achieved more progress and is noteworthy in its application of car restraint policies (Table 6.5). Proposals for transport development in Kuala Lumpur

Table 6.5 Public and private transport facilities in Kuala Lumpur and Singapore 1980

	Singapore	*Kuala Lumpur*
Population (millions)	2.3	1.0
No. of stage buses (over 50 seats)	2,900	660
No. of minibuses (14–16 seats)	800	400
No. of taxis	8,100	3,000
Private cars (thousands)	140	50
Buses per 1000 persons	105	70
Cars per 1000 persons	61	50

Source: Rimmer, *Rikisha to rapid transit*, 1986, 320.

made in 1972 and 1976 and incorporated into the 1984 Master Plan for the city are based upon the completion of inner urban ring-roads, an expansion of bus capacity, the construction of an LRT system and the adoption of area traffic-control systems (Rahim, 1988). The latter would accord priority on major highways to buses, minibuses and fully-loaded taxis and private cars and a limited form of area licensing was proposed. It was estimated that the reduction of road congestion would require a 40 per cent shift from private to public transport but the securing of this objective is highly unlikely and the emphasis upon car usage remains (Figure 6.3).

Singapore, with a population of 2.6 million, has experienced a planned expansion in the form of satellite towns along radial corridors from the city centre (Figure 6.4). Given the high density of population and the demand for efficient public and private transport, a heavy investment in a new mass-transit rail system has been coupled with an area-licensing scheme for private cars requiring access to the central commercial core. Although the decision to construct a 67 km. rail mass-transit network was made in 1982, a corporation to operate the system was not established until 1985, followed in 1987 by the creation of the Public Transport Council to approve and regulate fares and services on bus routes, taxis and the mass rapid-transit system. The latter has been opened in stages between 1987 and 1992 and is eventually expected to account for one-third of all public-transport travel. The two major bus operators, subject to the Public Transport Council policy, will have routes rationalized and new feeder services introduced as the railway network is completed; currently these two companies have 2,900 vehicles on 250 routes. It is estimated that most of Singapore's population is within five minutes walk of a bus route and 80 per cent of services have frequencies of ten minutes or less. Peak-hour car and taxi traffic since 1975 has been controlled by the Area Licensing Scheme, which requires supplementary licences for access to the city centre during the morning peak period except for fully-laden vehicles. The success of the scheme may be judged by the fact that incoming car traffic has decreased by 20 per cent since 1975, despite an estimated 30 per cent rise in the number of city employees. The principal issue in the future development of an integrated transport system is the requirement that all public-transport undertakings must be financially self-supporting; the new mass-transit network in particular must be able to maintain high levels of patronage and to minimize operating costs (Rimmer, 1986; Gray, 1988).

The African city – remedies for the current inadequacies of public transport

Although car ownership is steadily rising in many African cities, the majority of urban travellers will continue to depend upon public transport for motorized trips and the major problem facing transport planners is to increase the efficiency of existing bus, and in a few cases, rail services. Many cities in Nigeria and other West African states have either no or only poorly developed conventional bus services and most passenger transport is provided by minibuses or shared taxis (Adenji, 1983). The half-million population of Benin City in Nigeria is currently served by 600 minibuses on 20

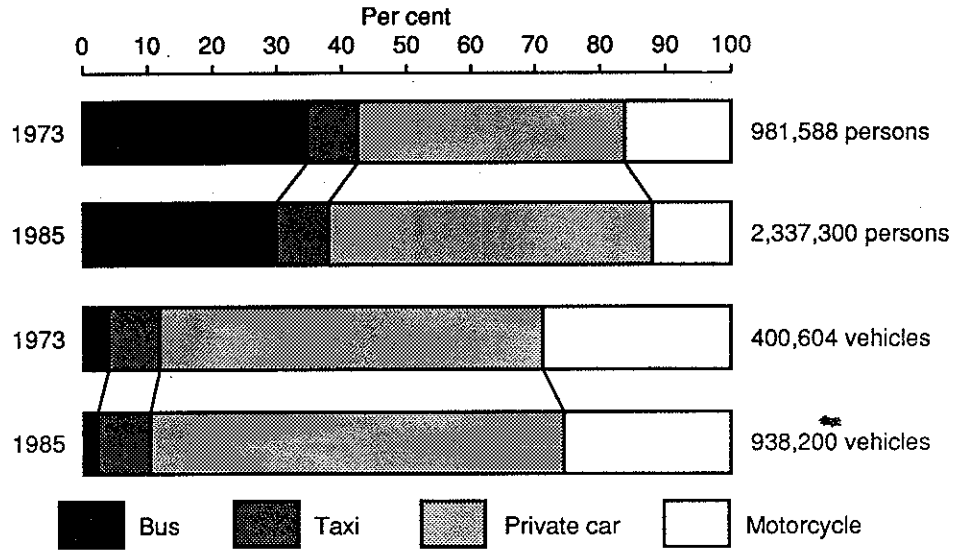

Figure 6.3 Kuala Lumpur: changes in the use of transport modes and in numbers of vehicles, 1973 and 1985. *Source:* Rahim, 1988.

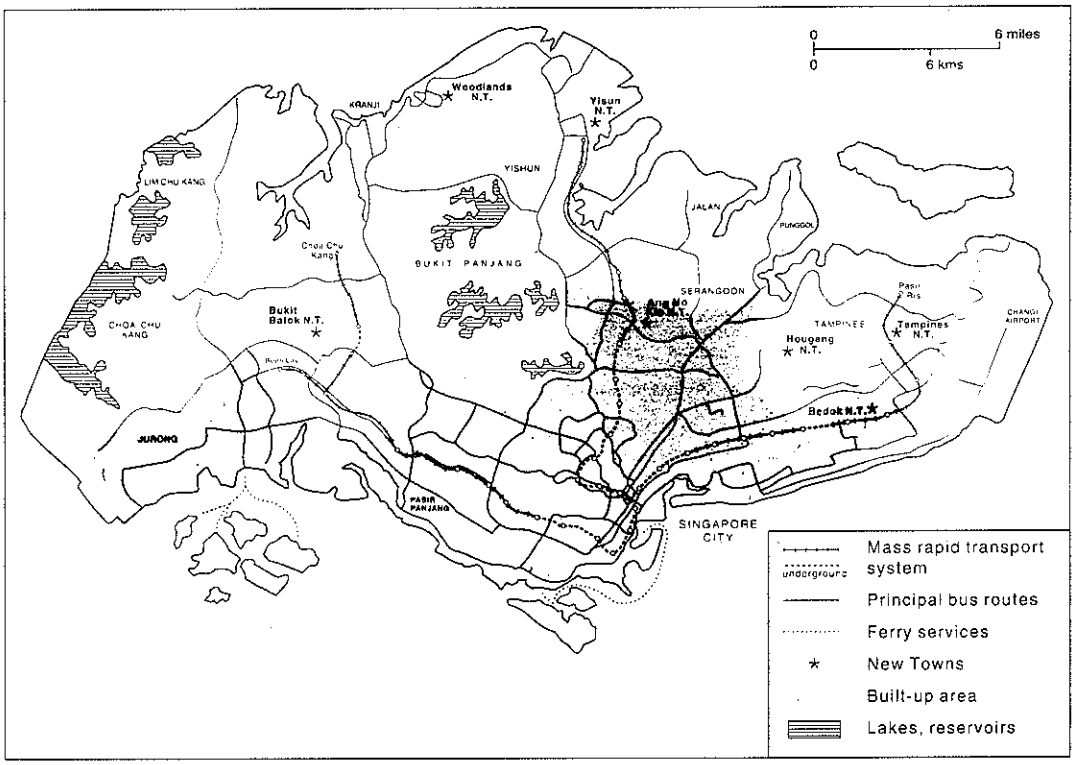

Figure 6.4 Singapore: the mass rapid-transit system lines open in 1991 and the principal bus routes.

routes operated by many small undertakings with no route-licensing system. Most of the services radiate out from the city centre and many connect with intercity taxi routes on the urban fringe. This minibus fleet accounts for about 38 per cent of all urban trips; shared taxis take a further 40 per cent of the market, catering especially for journey-to-work and social travel (Wiredu, 1989). In larger metropolitan centres such as Lagos, however, private-car movements have increased to a critical level which has prompted the application of experimental vehicle-restraint schemes similar to those in Singapore (Ogunsanya, 1984).

Harare in Zimbabwe, with a 1982 population of 900,000, has the bulk of its African workforce resident in high-density suburbs on the periphery of the city and almost entirely dependent upon public transport for access to the commercial centre and the industrial zones. A widespread network of conventional bus services is supplemented by a fleet of shared 'emergency taxis' which operate on fixed routes from the city centre to suburban termini. Severe shortages of spares creates operating problems which result in regular overcrowding and lengthy waits for vehicles. The rapid growth of the satellite town of Chitungwiza (1982 population: 170,000) has presented particularly severe problems, as workers rely upon bus services for the 20 km. journey into Harare (Atkinson, 1984). Proposals to improve public transport include a scheme for mass rail transit, combining the use of existing railway routes into the city with construction of two new lines linking the centre with the airport, the large industrial estate at Southerton and Chitungwiza. However, it is unlikely that this scheme will be implemented and investment in conventional bus services is seen as the more realistic short-term solution.

The Californian city – a reappraisal of public transport in auto-dominated societies

The conurbations of San Francisco and Los Angeles typify the development of an intra-urban pattern of travel which was dominated by the car during the mid-twentieth century. Both cities possess highly complex freeway networks designed to meet the ever-growing demand for road communications (Figure 6.5). In San Francisco the location of the central business district on a peninsula between the Pacific coast and San Francisco Bay and the growth of suburbs along the bay shores to north and south of the core has resulted in the construction of bayside freeways interlinked by three toll bridges. The Los Angeles metropolitan region is polycentric in form and the central business district contains only 8 per cent of all jobs in the county. The need for interconnection between the numerous settlements within the region was met by a network of freeways which carry some of the highest traffic volumes in the world. By the mid 1960s road congestion within and on the approaches to central San Francisco had become so acute that the existing suburban rail network was reconstructed as the Bay Area Rapid Transit (BART) system, with suburban car parks and, wherever possible, coordinated bus services (Higgins, 1981). Traffic on the system has yet to reach the levels predicted when it opened in 1972 but BART has improved urban mobility in the region and carries more than one half of all CBD-bound journeys to work. The contribution of the Los Angeles mass-transit system to commuting trips is much lower, at about 24 per cent, but both networks are seen as making an important contribution to the reduction of urban freeway congestion. The investment in public transport in these two cities exemplifies the first of two major changes that have been made in transport policy within America since the 1960s: namely, a reappraisal of plans continually to increase urban road capacity and the adoption instead of mass-transit systems (Orski,

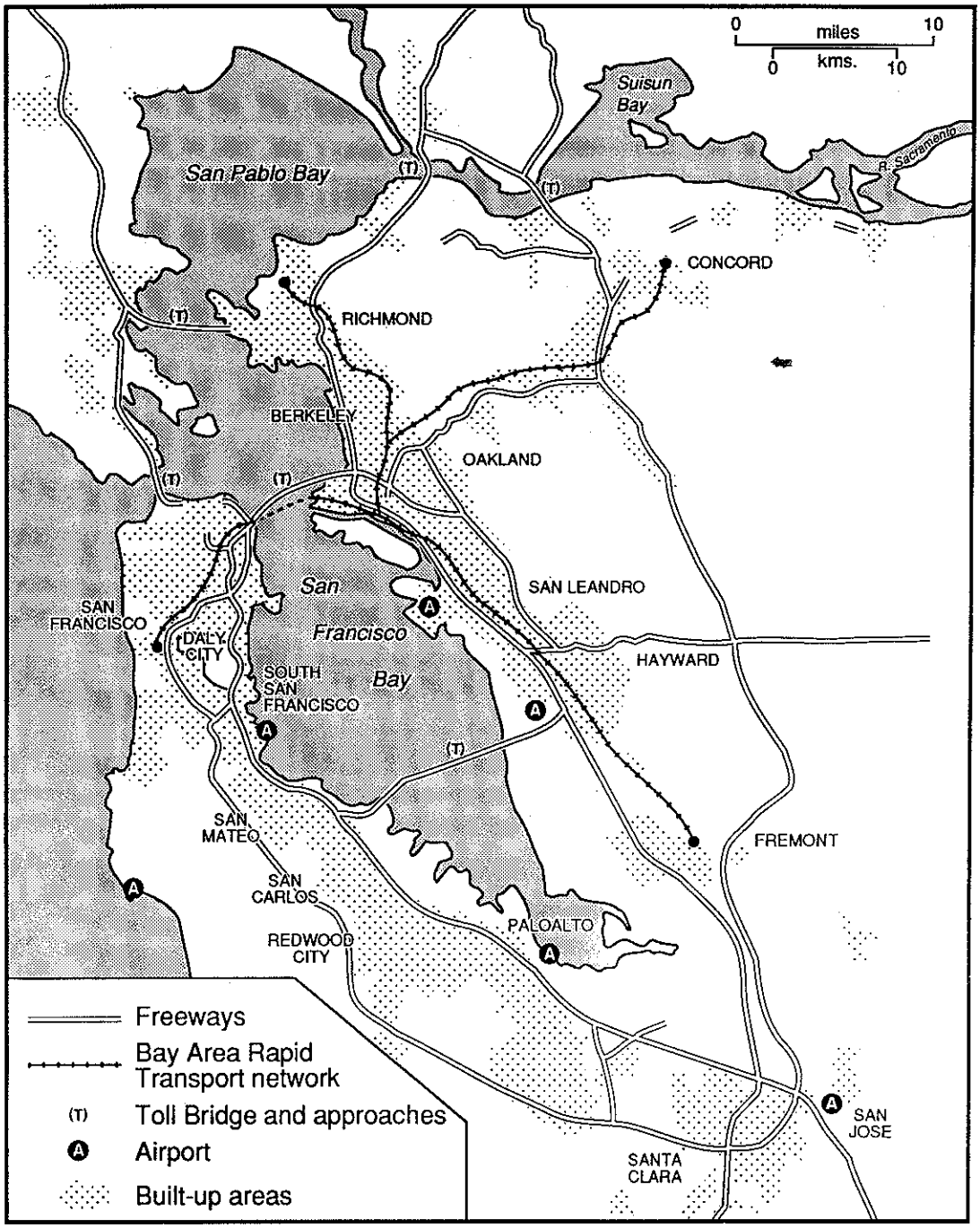

Figure 6.5 San Francisco: the freeway network and the Bay Area Rapid Transit system.

1982; Fielding, 1983). Although the latter have succeeded in capturing a proportion of the car-borne market, the enormous investments involved have been questioned. During the 1980s more emphasis was placed upon securing a more efficient use of existing facilities at lower costs.

Conclusions

Transport planners face an ever-increasing array of problems. Although a wide range of solutions have been devised and applied with various levels of success, an acceptable resolution of many of the basic difficulties has yet to be achieved. The reconstruction of existing roads and the building of additional expressways has alleviated congestion in many urban areas; but it has brought in its wake additional difficulties created by the inevitable generation of further volumes of traffic. The eventual realization that the demands for road space created by steadily growing private-car traffic could never be adequately met except at enormous cost to the urban environment stimulated a reappraisal by transport planners of the potential of the public sector where, it was hoped, new investment could revitalize existing rail and bus systems, increase their attractiveness to the motorist and thus raise their share of the total urban travel market.

This process of public sector modernization is still a feature of many contemporary urban-transport plans in cities of leading industrial nations although the proportion of the total market which new mass-transit and similar schemes acquire is rarely at the forecast level. Compromise proposals involving physical and fiscal restraint of private motoring coupled with improvements in the efficiency of existing public transport services, and, where appropriate, the provision of additional capacity in the form of light-rail transport are now increasingly being incorporated within transport-planning programmes.

Cities in the Third World have yet to face the problems posed by excessive volumes of cars and here the principal concern is to ensure that public transport, represented almost entirely by buses, can be improved in order to offer a sufficient level of mobility to populations which still depend to a large extent upon this mode of travel for all basic-journey purposes. Whereas bus services in the industrialized world, until recent moves towards deregulation, have been subject to rigid licensing procedures, the position in the developing nations is of a much more informal nature, with conventional buses sharing the traffic with paratransit services. An inability to secure financial resources generally prevents the larger Third World cities from installing the elaborate mass-transit systems common in Europe or North America. Many analysts believe that a lower level of technology based upon established bus transport would be the more effective way of solving the present imbalance between public transport demand and supply.

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