Chapter 21 Demand Management

21.1 Introduction

It is now widely accepted that unrestrained demand for travel by car within large urban areas, in the UK and elsewhere, cannot be accommodated. This is due to a combination of financial constraints and concerns about the impacts of traffic on local communities and their environment.

Permitting traffic to grow to levels at which there is extensive and regular severe congestion is economically inefficient. Congested conditions also aggravate the social and environmental impacts of traffic, by exacerbating both noise and polluting emissions, impeding road-based public transport and service vehicles and making conditions unpleasant for walking and cycling. Congestion in the inner parts of towns and cities encourages the relocation of activities, jobs and people out to the urban fringe, resulting in greater dependence on motor vehicles and compounding the environmental impacts. Indeed, increasing awareness and concerns about the potential environmental and health consequences is creating pressure for demand management, independently of that based on congestion.

This chapter sets out the principal measures for the management of traffic demand and outlines the institutional factors which can affect their application.

21.2 Why Manage Demand?

Historically, the main reason for seeking to manage demand for transport has focused on economic efficiency. The most logical tool to improve economic efficiency is a direct form of road-use pricing, as argued by Vickrey in evidence he gave to the US Congress in 1959 (Vickrey, 1959). The economic rationale is that unless the price directly incurred by someone in making a journey covers the full costs of the journey their travel will impose a net cost on the community. The full costs include both the personal costs which the traveller incurs (vehicle running costs, fuel, parking etc) and the social costs which the traveller imposes on the community, through adding to congestion and increasing the potential for accidents, as well as the adverse impacts on the environment, through creating noise, atmospheric pollution and contributing to severance. As the marginal costs imposed on others vary by location and traffic conditions so, it is argued, the charges incurred by vehicle–users should also vary (Downs, 1992). Gomez–Ibanez and Small (1994) provide further insights into the rationale of using road–use pricing to manage urban traffic–demand, while Jones and Hervik (1992) set it in a wider context, with a review of alternative measures; Downs (1992) also includes an extended discussion of other policy measures to manage congestion.

The argument for managing travel–demand has, however, broadened beyond that based on economic efficiency. This reflects increasing concern about the impacts of congestion, in particular on urban communities, but also of traffic more generally and the consequences for communities of increasing highway capacity. Limitation on funds available for investment in urban transport has also contributed to the debate about the extent to which demand should be restrained to match the supply which can be provided.

Evidence from a range of surveys in the UK shows that traffic congestion is widely recognised as a serious problem (University of Westminster, 1996). Fifty percent of respondents in one survey in London cited 'traffic jams and congestion' as one of the main problems of life (NEDO, 1991) and it is perceived to be worsening. Deteriorating air quality and traffic accidents are also viewed as serious problems (Gallup, 1989). Jones (1992) contains a review of a number of sources of such material. Similar views are held throughout Europe, with 59% of respondents to a survey conducted in all EU member–states describing traffic, in their local community, as being either 'unbearable' or 'hardly bearable' (UITP, 1991). The costs of congestion to the nation are very large; the Institution of Civil Engineers estimated the cost to exceed £10bn in 1989 (ICE, 1989), while the Confederation of British Industry calculated that congestion cost the economy about £15bn a year (CBI, 1989).

Awareness of the impacts of traffic on the environment has been growing. The most immediate public concerns are with local effects, in terms of noise and air pollution and their effects on the quality of life, including possible threats to health. The Royal Commission on Environmental Pollution has argued that there is a need to restrain the future use of motor

vehicles, through a combined policy of pricing and measures to promote the use of alternatives to private motor vehicles (RCEP, 1994). The National Air Quality Strategy is intended to provide a framework within which improvements can be achieved especially through local action (DOE, 1996).

There is also a growing recognition of the need to achieve 'sustainability', ie to manage development and transport in such a way "… that meets the needs of today without compromising the ability of future generations to meet their needs" (UN, 1987). The World Bank has distinguished between 'economic and financial' sustainability, which requires the efficient use of resources and the proper maintenance of assets, 'environmental and ecological sustainability', which requires that the external effects of transport are taken into account fully in determining future development, and 'social sustainability', which requires all sections of the community to benefit from improved transport. Each of these is relevant to demand management (World Bank, 1996).

Although the construction of additional or alternative highway capacity can alleviate some of the effects of congestion and of other traffic problems, the benefits may be offset, unless growth in traffic volumes is restrained. However, it is evident that the impacts of such schemes on local communities limit the extent to which they can be implemented, even if funds were available. Constraints on public expenditure and the demands of other sectors of the economy have severely restricted the availability of public funds and private finance is not likely to be a complete alternative general source of funds for urban areas.

Thus, the objectives of demand management policies are:

- ❑ to reduce congestion and thereby improve economic efficiency;
- ❑ to improve the quality of life through improvement of the local environment;
- ❑ to provide a stimulus for the local economy; and
- ❑ to reduce the local and global impacts of atmospheric pollution.

Not all of these objectives are necessarily complementary. Measures designed to satisfy one objective can, in practice, be counter–productive with respect to others. There can also be significant differences between the short– and long–run effects of some measures. Thus, a carefully designed package of measures, which addresses a balance of objectives relating to the particular needs of a local area, will usually be needed.

While conscious of environmental concerns, government, both local and national, tends to place a strong emphasis on maintaining or strengthening the economy. In particular, local government seeks to ensure that their town or city is an attractive place in which to work, to do business and to live. Towns are rarely so isolated that they are not in competition for economic activity with others. For some, the competition is regional, but the development of the Single European Market and global economies means that the competition is also with urban areas elsewhere in Europe and the rest of the world. While fears of competitive disadvantage may inhibit the adoption of radical measures to control traffic, it is also possible that radical measures will stimulate the local economy or, at least, prevent it from deteriorating in the face of competition from other towns and cities which are seen as being more attractive.

Despite concerns about the impacts of congestion, and traffic, there is little evidence that there is a general public willingness to accept the significant reductions in personal mobility implied by many of the measures necessary to the achievement of policy objectives to reduce traffic congestion and to improve both the local and global environment (University of Westminster, 1996).

Any single demand management measure is unlikely, by itself, to be either adequate or acceptable. A successful policy would require a combination of measures (CIT, 1996). Some measures would act as 'sticks', others as 'carrots'. Although there is some evidence that the cumulative effects of a series of small changes could be important, it is probable that any set of measures intended to achieve a substantial change in the use of private motor transport will have to be severe, particularly if they are to be sufficient to meet the targets proposed by The Royal Commission on Environmental Pollution (RCEP, 1994). Considerations of what politicians are prepared to put forward, and what the public will accept, are likely to result in a gradually increasing restraint, allowing transport users and other parties time to adapt.

One of the major challenges is to devise measures which do not unduly restrict personal mobility and which do not put local economies at risk. Ideally, these should also enhance the local quality of life and economy. Possible measures include:

- ❑ congestion charging and road–tolling;
- ❑ road–user charges levied on fuel and vehicle ownership;
- ❑ controls on vehicle–use;
- ❑ controls on vehicle ownership;
- ❑ parking controls and pricing;

- ❑ physical measures of traffic restraint;
- ❑ controls on land–use development;
- ❑ public transport improvement;
- ❑ encouraging more travel by foot and cycle; and
- ❑ encouraging greater use of telecommuting and of transport telematics.

21.3 Congestion Charging and Road–Tolling

Although road–use pricing is the term which has long been used to describe direct charging for the use of roads in urban areas, that term can also apply to other circumstances, such as motorway tolling. The term 'congestion charging' is therefore used here to represent the particular application of road–use pricing to manage demand in congested conditions.

Since, arguably, congestion is the result of imperfect pricing, congestion charging would appear to be the most rational means by which demand can be balanced with supply. Pricing can also be used to reduce the adverse effects of motor vehicles on the environment, both through encouraging the use of more fuel–efficient vehicles and reducing their use overall (RCEP, 1994). The principles of congestion charging have a long history, strongly rooted in economic theory, dating back at least to the advice of Vickrey to the US Congress in 1959 (Vickrey, 1959).

In 1962, the Minister of Transport appointed a committee, under the chairmanship of Reuben Smeed, to investigate the technical feasibility of introducing congestion charging. The Committee concluded that the methods of vehicle taxation then in use (which have changed little since) had deficiencies, "…notably their inability to restrain people from making journeys which impose high costs on other people", and suggested that "…road charges could usefully take more account than they do of the large differences that exist in congestion costs between one journey and another". The Committee examined various forms of taxes and charges, including differential fuel taxation, an employee tax, a parking tax, daily licences and direct pricing. They concluded that "...considerably superior results are potentially obtainable from direct pricing systems" (DOT, 1964). A particular strength of the Smeed Report was the establishment of a set of principles with which any congestion charging system should comply; these have stood the test of time, although extensions have been suggested (May, 1994).

In 1967, the Department of Transport reported on a study of Better Towns with Less Traffic. The report concluded that "…the most promising form of restraint, at least for the shorter term, would be to intensify control over the location, amount and use of parking" and that "…direct road–use pricing, of the type described in the Smeed Report, is potentially the most efficient means of restraint. Although it is by no means certain that a workable system could be devised, its advantages would be so great as to justify further research and development" (DOT, 1967).

In the early 1970s, the Greater London Council examined a wide range of options for restraining traffic demand. The conclusion of this work was that the most effective would be a pricing system for Central London, operating during the working day and based on the use of supplementary licences (May, 1975).

The first urban congestion charging system to be implemented was the Singapore Area Licensing Scheme (ALS), which came into operation in 1975. A paper supplementary licence was required to enter the Central Business District during the morning peak period (Holland *et al*, 1978). This scheme has subsequently been extended, so that it includes the whole working day, with differential peak and inter–peak charges (Turner *et al*, 1993). The paper–based ALS system is being replaced by Electronic Road Pricing (ERP). Initially, this will cover the same area as the ALS but the single, daily, charge will be replaced by a charge each time a vehicle enters the charged area (the Central Business District) (Menon *et al*, 1993). It is intended that ERP will subsequently be extended throughout the Island, transferring some of the current ownership taxes (see Section 21.6) to direct charges for road–use (LTA, 1996).

The Singapore ALS is the simplest form of congestion charging, with users incurring a fixed charge for entering an area during the charged period, regardless of the number of entries they make. Any vehicle within the charged area at the commencement of the charged period incurs no charge, unless it leaves and re–enters the area before the end of the period. This system is classified as an 'entry licence'. A supplementary licence, which is required to be displayed on the vehicle's windscreen within the charged area and time–period, is classified as an 'area licence' (Menon et al, 1993). Thus, strictly defined, the Singapore ALS is an 'entry licence', not an 'area licence', system.

Although the system in Singapore has proved satisfactory for over twenty years, concerns about potential fraud and difficulties of effective enforcement led the London Congestion Charging Research Programme (the London Programme) to

conclude that a paper–based entry licence would not be appropriate for London. Indeed, the London Programme concluded that the only paper–based system which might be used in London would be an area licence required for any vehicle on the public highway, whether parked or moving, during the charged period (DOT, 1995a).

The ERP system which has been selected for Singapore is based on charging vehicles when they pass a charge point and so is classed as a 'point–based charge'. The charge points can be linked to form cordons, cells or screenlines. Alternative charging systems include:

- ❑ 'time–based charging', in which charges are a direct function of the time spent travelling within the charged area and period;
- ❑ 'distance–based charging', in which charges are a direct function of the distance travelled within the charged area and period; and
- ❑ 'congestion metering', in which the charge is based on the amount and degree of congestion encountered during a journey, determined by the moving average speed calculated over a preceding defined distance.

Each of these systems requires the use of automatic fee–collection (AFC) technology, which can also be used for the implementation of both entry and area licensing systems, thus reducing the fraud and enforcement difficulties associated with paper–based systems.

Automatic fee–collection systems need to be integrated with highly–automated enforcement systems, which require that:

- ❑ high levels of both accuracy and reliability are provided, to ensure credibility and thus encourage compliance. In general, failures should favour the user;
- ❑ the system should operate without interrupting the flow of traffic or affecting its speed. It must also operate accurately at speeds well in excess of the highest prevailing speed–limit, as well as under stop/go conditions;
- ❑ the system must operate with vehicles located at random across the full width of the carriageway and at very close spacing both across and along the carriageway;
- ❑ it must be possible to detect and identify all potential violators;
- ❑ privacy must be assured for all individual transaction records;
- ❑ the system must be secure against fraud, tampering, evasion and vandalism;
- ❑ the system should be easy to understand and use, thereby facilitating high levels of compliance;
- ❑ information must be available to users on the charges being incurred, as well as current credit or debit balances on their accounts;
- ❑ the system must easily accommodate occasional users, including visitors, both foreign and domestic;
- ❑ the system should accommodate 'charge privileges', which could take the form of exemptions, credits or upper limits on the charges over a specific period; and
- ❑ if motorway tolling is introduced in the UK, mutual compatibility with urban congestion charging systems is highly desirable, as is compatibility with comparable systems elsewhere in the EU.

With automatic fee–collection for point–based systems, charges can be varied by time of day, location and direction of travel. Charges could also vary by vehicle type provided that the technology for enforcement is adequate.

Automatic fee–collection can be based on the use of either off–vehicle, central, accounting systems or on–vehicle accounting. The former operates with relatively simple, in–vehicle, tag technology. The London Programme concluded that it would be necessary to have a 'read–write' tag, which can convey information to the driver, rather than the simpler 'read–only' tag, which is widely used where manual toll–collection systems have been automated (DOT, 1995a). On–vehicle accounting systems make use of smart cards; these may contain pre–paid travel credits or cash in electronic form. The in–vehicle unit (IVU), described as a transponder, has to have an interface with the smart card and must have the intelligence to manage the charge transaction. The IVU is, therefore, considerably more sophisticated and expensive than a read–write tag but it can also provide for a wide range of in–vehicle information services, as well as automatic road–use pricing.

The Singapore ERP system is based on transponders with electronic cash, using smart cards. The London Programme concluded that to meet the various needs of different users, it would probably be necessary to have a system which offers both on– and off–vehicle accounting, ie, offering both read–write tags and transponders with smart cards.

The London Programme identified that the management of occasional users and visitors would present particular difficulties, unless (or until) there is a common nationwide system. The provision of charge privileges (discounts, exemptions, credits or maximum capped charges) for some users would also complicate the design and management of a congestion charging system (DOT, 1995a).

The enforcement of congestion charging would rely largely on automatic video systems to capture the information required. These systems would retain a video image of the licence plate of all vehicles which might have violated the system, through either not having a valid IVU or for not having sufficient credit for the transaction. The vehicle's keeper would then be traced through licensing records. This system has three key weaknesses. First, it depends on the image being legible; some are not, due to damage, dirt or being obscured by other vehicles. Secondly, it depends on the central licensing records being accurate and up–to–date, which requires a sustained high level of performance by DVLA. Thirdly, it depends on the licence plate being valid; some may be deliberately false. The credibility of the system would depend on the enforcement process being able to identify and pursue a high proportion of violators successfully. It would therefore need to be:

- ❑ accepted by road–users as accurate;
- ❑ regarded by road–users as being administered fairly; and
- ❑ designed to ensure that the probability of being identified as a violator and having to pay the associated penalty, taken together, provides an effective deterrent to non–compliance.

It is likely that violations of a congestion charging system would be treated in much the same manner as parking offences, with most violations being handled under civil law, and only serious offences being subject to criminal law.

The implementation and operation of a congestion charging system with automatic charge collection would be relatively costly. For London, it was estimated that the implementation costs of an inbound cordon for Central London with read–write tags would be of the order of £85m. This increased to some £140m for a system of transponders with smart cards. These latter costs would be lower with a system using an established electronic cash card, since some of the costs would be borne by the electronic cash card operator. The annual operating costs were estimated at some £55m per annum, for both the tag and smart card based systems. These costs are largely independent of the level of charge. However, even with a point–based charge of two pounds, the financial payback period would be less than four years (DOT, 1995a).

Although not designed as congestion charging systems, the experience of implementing 'toll rings' in Bergen, Oslo and Trondheim would usefully inform preparation for any planned urban congestion charging system (Gomez–Ibanez *et al*, 1994).

In addition to the reports on the London Programme, documents which provide further insights include CIT (1990 and 1992), Downs (1992), Gomez–Ibanez *et al* (1994), Hewitt *et al*, (1995) and TRB (1994). Blair (1994) provides an extensive annotated bibliography.

Although congestion charging and road–tolling are well supported by economic theory, their implementation has not been easy or popular; nor is direct road–use pricing necessarily the optimum measure for every circumstance. Other principal demand management measures are described in the subsequent sections.

21.4 Demand Management through Fuel Prices

The economic rationale for congestion charging is that the users of motor vehicles do not perceive the true costs of using their vehicle, either at the point of use or at the time they make individual travel decisions. Given the impacts of vehicle–use on the community, even when traffic is flowing reasonably freely, this rationale applies more generally. There is, therefore, a case for increasing the generalised cost of car–use closer to the point of use by increasing the price of fuel through taxation. Indeed, Government policy in the 1990s has been to increase the real level of motor fuel duty by five percent per annum, for environmental reasons. However, it is thought that the effects of this increase on vehicle operating costs are being offset by increased fuel efficiency or by trading down to smaller engines and that there may be little lasting effect on the use of motor vehicles, as long as the scope for downsizing and increased fuel efficiency remains. Indeed, the Royal Commission on Environmental Pollution concluded that, to be effective, much greater price increases would be required and recommended that motor fuel duty be increased year by year, so as to double the price of motor fuel, relative to the price of other goods, by the year 2005 (RCEP, 1994).

Unfortunately, policies based on increasing the price of fuel are indiscriminate in their effect. Thus, the remote rural dweller, who has no real alternative to the use of a car for essential travel, is affected much more than the city resident, who may well have reasonable alternatives. Differential pricing is not feasible, since fuel bought in lower price zones can be used in those where prices are higher. Furthermore, it is likely that the primary impact of increased fuel prices would be a reduction in 'optional' travel, such as leisure journeys in the evenings and at weekends, and that the impact on congestion in urban centres

may be quite limited (Dasgupta *et al*, 1994).

Thus, although fuel prices could well be an element of a national demand management policy, they are not an appropriate measure for local demand management, when the objective is to reduce motor vehicle use in particular localities and at peak times.

It can be argued that, without fiscal and other measures which encourage or require reductions in the more harmful vehicular emissions, there will be neither the incentive for industry to design less polluting vehicles nor for the public to buy them, particularly if there is any price or performance penalty. Yet, there is technical scope for reducing the main pollutants by at least 50% (Bly *et al*, 1995) and also reducing the specific fuel–consumption of both petrol– and diesel–engined vehicles.

21.5 Regulating the Use of Vehicles

Demand can be managed by using regulations to control the use of vehicles. In Bologna, and some other Italian cities, permits to use motor vehicles within the city centre are issued to essential users only; others have to park outside the restricted area or travel by some other mode. The Bologna scheme forms part of a comprehensive policy to reduce traffic in the city centre, the old town. The policy includes public transport improvements, parking controls and pedestrianisation. The traffic–limited zone was introduced in 1989 and extends from 0700 hours to 2000 hours. Although there is a large number of exemption permits (for residents, delivery vehicles and those with private off–street parking), the overall policy reduced the number of vehicles entering and leaving the city centre by about 50%. However, this has since been eroded by increases in the number of exemption permits issued (Topp *et al*, 1994).

An alternative to permits is the 'odds and evens' scheme, in which use of vehicles is permitted on alternate days for registrations ending in odd and even numbers. Athens is one city which has applied this scheme. Sao Paulo has implemented a variant, whereby vehicles with registrations ending in certain digits are prohibited on certain days. One risk of the 'odds and evens' policy is that it encourages an increase in the number of vehicles owned, to provide households with both odd– and even–numbered vehicles.

Evidence suggests that, although permits and related schemes can, in principle, achieve a reduction in car–use, effective and tight control is required to avoid diminution of the effects through fraud and evasion. Indeed, a permit scheme is a variant on the entry or area licence schemes with user privileges (see Section 21.3).

In California, measures have been introduced which require larger employers to introduce ride–sharing and other schemes, to reduce the volume of 'drive alone' commuting journeys to their employment sites. However, it is not clear that these measures have any significant effect across a region (Wachs, 1990). Nottinghamshire County Council is promoting a similar concept, through a travel–reduction programme, but without the legislative support applying in California. Other UK authorities are sponsoring 'travel awareness' campaigns, to increase appreciation of the unfavourable impacts of traffic, and travel more generally, and of the actions which can help to mitigate those impacts.

The US Federal Clean Air Act, as amended in 1990, requires communities in the USA with serious air pollution to take measures to reduce vehicular emissions and not to pursue infrastructure and development policies which could exacerbate vehicular emissions (Shrouds, 1995). In practice, this requires measures which reduce car–use or, at least, discourage increases in vehicle–kilometres in the region.

21.6 Restraint on Vehicle Ownership

It is possible to contain growth in car–use by restraining growth in vehicle ownership. For many years, this has been a key feature of Singapore's transport policy, which has also included increasing the capacity and the quality of the Island's public transport and highway systems, as well as the management of demand through road–use pricing and parking controls. A similar policy on restraining car–ownership has also been pursued in Hong Kong, where first registration costs and annual taxes are high.

Initially, Singapore exercised control on car ownership through high import duties and high annual charges, with a charge–structure designed to encourage the scrapping of older cars and to discriminate against company car–ownership. However, continued rapid growth of vehicle ownership led to a decision, in 1990, to introduce absolute limits on the number of vehicles which could be registered. Buses for use on scheduled services and emergency vehicles were the only classes excluded. The target was to reduce the annual increase in

vehicles owned to three percent. Prospective buyers of new vehicles have to bid for a 'Certificate of Entitlement' (COE) in a monthly tendering process. Depending on the category of vehicle, the premium has been between some £4000 and £9250 per vehicle, adding between 12% and 25% to the total price paid (Olszewski *et al*, 1993; and Koh *et al*, 1994).

While fiscal measures, such as those adopted by Hong Kong and Singapore, may be effective in controlling car–ownership, there is a view that, as disposable income increases, pressure will arise for a change in the balance between charges for vehicle–ownership and charges for vehicle–use. In Singapore, it is anticipated that the introduction of Electronic Road Pricing will facilitate this (LTA, 1996). Significantly, there are no local vehicle manufacturing interests in either Hong Kong or Singapore. They are also city states, in which the economy of rural areas is not an issue. The impacts of such fiscal policies in countries with strong manufacturing interests and/or extensive rural economies would be markedly different and their pursuit more difficult.

However, other demand management measures could be used to deter car–ownership in congested urban areas. In parts of Japan, for example, it is necessary to prove that a parking space is available before a car can be purchased. Car–clubs, through which access to a car is provided when required rather than direct ownership, can serve to reduce demand, by curtailing immediate access to a car. For example, Auto Teilet Genossenschaft (ATG), based in Lucerne, Switzerland, has over 5,000 members, including a number of businesses, and Stadt–Auto, a similar organisation based in Bremen, has over 3,000 members (see Section 29.10). Research suggests that ATG members have reduced their annual mileage from, typically, 15,000km to about 5,000km and also made significant savings in total transport expenditure.

To restrain car–ownership and use, the City of Edinburgh Council has sponsored an inner city housing development, in which the purchasers of houses covenant not to own a car and arrangements are being made for ready access to rented vehicles on favourable terms, based on the 'Stadt–Auto' car–club concept. Indeed, lack of convenient, or secure, parking space (particularly in inner urban ares) can be a deterrent to car–ownership and space problems can also influence the sizes of cars owned.

21.7 Parking Controls and Pricing

The control of parking is principally addressed in Chapter 19; it is relevant here to consider parking in the context of managing traffic demand.

Parking controls, including pricing, can be used to influence vehicle ownership but their primary use as a demand management measure is to regulate parking capacity and to allocate the available space between different groups of user. However, the control of parking affects only trips with a destination within the area subject to the controls. Used by itself, therefore, parking control can reduce congestion for those vehicles passing through the controlled area, with the result that 'through' traffic flows can increase. This can be because of diversion from longer but previously quicker routes, which avoided the congested area, or from other times of day or because trips which were previously unattractive become feasible.

The use of parking controls as a demand management measure is weakened by the fact that, in almost all urban areas, a high proportion of parking spaces are in private non–residential (PNR) car parks not under public (local authority) control. Recognising that parking controls could only be effective if PNR could also be managed in accordance with an area–wide parking and transport policy, studies were undertaken in the 1970s (DOE, 1976) to determine whether it would be feasible to extend public control to such spaces. The problems were found to be considerable, not only in the definition of a PNR space but also in enforcing regulations on their use. The conclusion was that such policies would be difficult both to introduce and to operate. However, there is scope for the use of parking controls as an element of urban transport policy and re–examining the case for public control of PNR car parking.

Much of the PNR stock of parking spaces is used for employees' parking, normally free of charge. It can be argued that anyone with a free, and guaranteed, parking space provided at work does not bear the full costs of their journey to work. In consequence, those travelling to work in major urban areas may well make modal choices and, possibly, residential location choices which, in a community context, are economically inefficient (Shoup *et al*, 1992). If it is not possible to control such parking directly, through PNR controls, a case can be made for treating it as a 'benefit in kind' on which income tax is payable, as with cars provided by employers.

At some employment locations in the United States, the use of parking space is controlled to give preference to those commuting by car–pool or van–pool. These vehicle–pools are sometimes organised by the employers themselves, to save the cost of providing parking accommodation.

21.8 Physical Restraint Measures

Traffic can be managed through the use of physical measures, designed to make the use of motor vehicles less attractive. These may reduce speeds or extend travel distances, as described in Chapter 20.

While the creation of traffic–free areas in urban centres may remove traffic from some streets, they do not necessarily reduce demand overall, unless coupled with other measures. Some cities have implemented more comprehensive measures (Topp *et al*, 1994). For example, York has a policy of reducing the use of motor vehicles across a wide part of the City. This is achieved through a combination of physical and regulatory measures and by positively encouraging non–motorised modes. Gothenburg has sought to limit traffic within the city centre, by creating a system of cells between which there is no direct access for cars. To move between cells, drivers have to return to a ring road which encircles the controlled area.

Roadspace can be reallocated, either to disadvantage car–users explicitly, for example, by allocating space to public transport and multiple–occupancy vehicles, or to deter short distance travel by car. An experiment in Nottingham, in 1975, is an early example of the former that proved unsuccessful and was withdrawn (Vincent *et al*, 1978). However, Zurich has been particularly successful in using traffic management and control measures to secure reliable and quick travel times for public transport, with positive discrimination against other motor vehicles.

While the primary objective of bus–priority schemes in many cities is to enhance public transport services, there is frequently a secondary objective of seeking to discourage car–use. Positive discrimination against 'inefficient' use of roadspace by vehicles with only a driver, or only a driver and one passenger, is extensive in the US through the use of 'HOV' (high occupancy vehicle) facilities, both on the highway and at employer's parking lots. Critical to the success of HOV facilities is that users can travel more quickly and easily door–to–door than those driving solo. The system is reinforced if they can be seen by–passing long queues of those not permitted to use the facility. In the UK, extensive bus priorities can achieve some of the benefits of HOV lanes, through giving priority to those in buses, but they do nothing to encourage reduction in demand through 'ride–sharing' in cars or through the formation of car– and van–pools.

21.9 Land–Use and Development Controls

Since travel is a derived demand, it should be possible to reduce demand, overall, through changes in land–use location policies. Indeed, it can be argued that much of the increase in the use of cars is a direct result of policies which have permitted, even encouraged, the dispersion of major activity centres to the fringes of urban areas and beyond. Many of these locations are not readily accessible by public transport and, with concentration into larger units for retail, education, healthcare and recreation, few people live near enough to access them by foot or bicycle.

The need, at least, to curtail, if not reverse, some of these trends has now been recognised through the publication of revisions to the Department of the Environment's Planning Policy Guidance documents, one of the most important of which is PPG13 (DOE/DOT, 1994) [NIa] [Sa]. A key principle of these policies is to locate new developments so as to facilitate access by public transport, bicycle and on foot, with a preference for locating developments in existing town and city centres. There is also a presumption in favour of more mixed development.

Development policies can be used to control the extent of parking in new developments. One possibility is to increase the proportion of parking capacity, under public rather than private control, through the provision by the developer of commuted payments to the Local Authority in lieu of providing spaces within the development. The Local Authority is required to use such revenues to provide parking spaces in a public facility. By this means, it is possible to set limits on the number of spaces provided within developments (Sanderson, 1994) (see also Chapter 28).

Important though land–use and development policies are, the general pace of development and redevelopment is such that significant benefits across a large urban area are only likely to be achieved over the medium to long term. Furthermore, there is little evidence that mixed development can have a significant effect in reducing travel demand. With increasing affluence, choice has become important to consumers and greater job mobility means that, although an initial housing location decision may be based on a convenient journey to work, few people are willing to change their house every time they change their job. The effectiveness of land–use policies in reducing travel demand will depend, to a significant extent, on the pursuit and effectiveness of other complementary policies (Barrett, 1995).

As with many other demand management measures, competition between adjacent localities for economic strength can seriously reduce the effectiveness of well–intended policies. Given the choice between accommodating the requirements of a major project, which will enhance the local economy, by relaxing their more stringent policies or maintaining those policies and seeing the project go elsewhere, many authorities will opt for the former. While a firm national, or regional, policy framework might help to avoid such 'bidding' situations, it would be at some cost to local autonomy on key decisions.

21.10 The Roles of Public Transport, Taxis, Cycling and Walking as Alternatives to Travel by Car

For many of those with access to a car, public transport is now seen as the choice of last resort. The reasons for this include perceptions (whether true or not) of poor information, uncertainty and unreliability, unacceptable travel times, discomfort and inconvenience, concerns about threats to personal security and price. For many people, their car is an extension of their private space. Yet, in some urban areas, public transport still carries a significant proportion of commuters, as well as travel for other purposes, notably into and out of central London.

Demand management can cause some trips to be made at different times of day or to different locations, some not to be made at all and others to be combined. Some people will switch to public transport, if there is a sufficiently convenient service, and others may switch to taxis, cycling or walking. Evidence from various studies (Dasgupta *et al*, 1994; MVA, 1991 and DOT, 1995a) suggests that the extent to which demand for travel by car can be reduced, by feasible restraint policies, is limited. However, these and other studies suggest that restraint measures in combination with improved public transport can increase the shift away from car–use.

The combination of public transport improvement with traffic restraint, acting as 'carrot and stick', is particularly important if restraint policies are not to affect local economies adversely, particularly those of town and city centres which development policies are intended to strengthen. Seeking to make an entire journey 'seamless', with easy transfer between different modes and operators, is of particular importance. This should include arrangements for common (smart–card) ticketing between all the local public transport operators, as well as for park–and–ride charges (CIT, 1996).

In addition to ensuring that the public transport system is of sufficient quality to complement any restraint on the use of private vehicles, it is important to recognise that, because some car–users are willing to switch to taxis, adequate and convenient facilities for taxis will be required at major activity centres.

Many urban journeys are short, well suited to walking or cycling, which can be quicker than motorised alternatives. To encourage greater use of these modes, better facilities are necessary, designed to meet their specific needs, providing safe, direct and easy routes to activity centres. The provision of improved facilities for cyclists and pedestrians is likely to be a particularly important element of any policy designed to restrain the use of cars in urban areas (see Chapters 22 and 23).

21.11 Telecommuting

The information revolution will undoubtedly lead to fundamental changes in both the ways in which people work and where they work, transforming the relationship between work and home locations and, thus, the need for travel. By working from home, or from local telecommuting centres, travel to and from work will be reduced. It has been estimated that by the year 2010 up to 10 million workers in the UK will be teleworking (Gray *et al*, 1993).

Research in California (where telecommuting is probably most highly developed) and the Netherlands indicates that telecommuting can lead to a net reduction in travel (Pendyala *et al*, 1991 and Hamer *et al*, 1991). Research also suggests that the information revolution will reduce the need to travel for some purposes but that this could be complemented by increases in travel for other purposes, although net reductions were found by Koenig *et al* (1996).

Although not intended as a demand management measure, it would seem that traffic reduction benefits could be obtained by encouraging the development of telecommuting and through exploiting the potential of information technology to reduce the need to travel for a variety of purposes.

21.12 The Potential for Transport Telematics

As noted in Chapters 15 and 18, the development of advanced transport telematics (ATT) to promote intelligent transport systems (ITS) is expected to contribute to increasing efficiency in travel and

transport, not least through the provision of real–time information. For those using roads, this should enable them to plan their journeys to avoid congested times and places. For those travelling by public transport, transport telematics will provide access to up–to–date routeing, timetable and fare information, coupled with real–time information on service operations to allow for late running. Ideally, the system should provide optimal advice for the traveller, regardless of the mode of travel or the operator of the system, but the achievement of this will depend on arrangements for funding of the development and implementation of ATT systems.

The basic systems to permit travel–planning and real–time journey information have been implemented through demonstration projects, such as London Transport's 'Count–Down 'for real–time information at bus stops, and the more extensive, EC–supported projects in Birmingham and Southampton (see Chapter 24). Traffic*master* provides network–wide real–time information on motorway traffic conditions and variable message signs serve this purpose more locally (see Chapter 15).

The introduction of smart–card based payment systems could contribute towards the creation of the seamless journey, in which a traveller may use different systems, provided by different operators, with all fares and charges paid by use of a common smart–card. This could be a pre–payment card or an electronic cash card. For maximum convenience on public transport, it should be a contactless card. However, for automatic road–use pricing systems (tolling and congestion charging), a contact card is likely to prove more suitable, to provide the speed of data–transfer required (Blythe *et al*, 1995).

21.13 Legislation

Many elements of a demand management plan can be implemented within existing legislation but others would require new legislation. These include the introduction of any form of road–user charging (including congestion charging) and local authority control of PNR parking. Existing regulations can be used to control entry, although there are doubts about their suitability for area–wide control schemes, such as the permits used in Bologna.

21.14 Financial Considerations

As explained in Chapter 4, most finance for local road schemes and transport measures depends ultimately upon Treasury funding. Although the Package Bid approach in England and, in some respects, Challenge Funding in Scotland, offer local authorities greater freedom in determining local priorities, their scope and options are constrained by the total funding provided. Major investment in public transport infrastructure is still very largely dependent upon central government. The actual arrangements vary between England, Scotland and Wales (IHT, 1996) [Wa].

As described in Chapter 19, one relaxation of central government's control of finances has been the facility to transfer responsibility for parking enforcement from the police to local authorities, together with arrangements under which revenues from charges relating to civil offences are retained by the local authority [NIb]. This is important, not only in the context of funding but also because it gives local authorities greater control over parking, as a crucial element of demand management policy. However, the use of revenues from any form of road–use pricing remains a vexed issue. In evidence to the Select Committee on Transport, the then Secretary of State for Transport advised that, since such a charge "…would be a levy as opposed to a charge for a service rendered" it would "…fall under public expenditure and would be treated accordingly" (Transport Committee, 1995). With this interpretation, the revenues would accrue to the Treasury and, hence, become part of general revenue.

This contrasts with the advice that motorway tolls would constitute charges for a service, which would permit retention of at least part of the revenues for re–investment in motorway construction and maintenance (Transport Committee, 1994). However, in his evidence on congestion charging, the Secretary of State also said "…it would be open for a policy to be developed, which would allow money to return to those who had contributed it." (Transport Committee, 1995). This position was explained in the Government response to the Transport Committee's report, which stated '…the view that urban road tolls would be general government revenue, rather than negative expenditure, is not a policy decision but derives from the application of national accounting conventions that are internationally recognised." It went on ".. the Government accepts the general principle that financial arrangements should ensure that communities which implemented congestion charging should be economically better off as a result. The Government will consider the detail of the necessary arrangements further as and when necessary" (DOT, 1995b).

This raises the critical issue of the non–hypothecation of tax–revenues, a key element of Treasury policy. This is that no revenues derived from taxation can be

committed to specific items, or programmes, of expenditure. This contrasts with other countries, such as the United States, where funds raised through a specific tax, such as the Federal Gas Tax, can be used to pay for particular activities, including highway funding through the Federal Highway Trust Fund. So long as net revenues from urban congestion charging are deemed to be Treasury revenues, it is unlikely that any local authority will choose to implement a congestion charging policy, unless there are complementary improvements to public transport, for which investment funds will be required.

This raises another important issue, that of 'additionality'. Even if it were possible to devise arrangements under which the net revenues from congestion charging were retained or returned for expenditure locally (whether directly or, for example, through increased Government funding), it would be necessary to ensure that these funds were in addition to, rather than in substitution for, those which Government would otherwise have allocated through its various channels. Ensuring additionality of funding is likely to prove a crucial test, locally, in determining the acceptability of congestion charging. The City of London Corporation commissioned a series of studies which have examined innovative approaches to the funding of transport projects, including the use of congestion charging revenues (LBS, 1993).

Goodwin has proposed that the revenues from congestion charging should be allocated according to a 'rule of three', with one third being allocated to highway improvements, one third to public transport and one third to either general tax relief or increased general expenditure (Goodwin, 1989). Subsequently, Small has suggested an alternative allocation, with one third allocated to reimburse travellers as a group, one third for new transport services and one third to substitute for general taxes currently used to pay for transport services (Small, 1992).

21.15 The Political Dimension

While the principles of demand management may be sound, and the need amply warranted, the implementation of measures to achieve a significant reduction in vehicular traffic levels is fraught with risk. There are risks about the degree of success of such measures; risks about the nature and extent of the impacts on the local economy, particularly in relation to other competing towns and cities; and risks about the responses of the electorate to measures which will limit the extent to which they can use their cars.

Politicians tend to avoid potentially risky policies. If significant demand management programmes are to be implemented, political leaders (both national and local) will need to be satisfied that there is sufficiently strong public support and to have confidence in the effectiveness of the plans. To achieve these requirements, they would need to be satisfied that a programme can be implemented in such a way as to minimise the risks, either of failure or of impacts which prove unacceptable to the electorate.

21.16 Public Attitudes

Research suggests that there is a growing awareness of the adverse effects of motor traffic in general, and congestion in particular, on the quality of life and on the environment in urban areas. However, although an increasing proportion of car–users would be prepared to consider switching some trips to public transport, there is little evidence of a widespread willingness to forego the perceived mobility benefits of the private car. Measures designed to reduce the use of cars, through improvements to public transport or restricting the use of cars in city centres, appear to have more popular support than fiscal measures such as congestion charging or increases in fuel duty, although some of the concerns about congestion charging can probably be mitigated, if it forms part of an integrated package of measures (Jones, 1995).

Even if congestion charging can be shown to have beneficial effects on congestion and the environment, successful implementation would require its acceptance by the public as a reasonable measure. This is likely to require the provision of good information and extensive consultation. But, most importantly, the role of congestion charging must be within a broad, well–founded, urban transport policy coupled with a long–term commitment to use a substantial part of the net revenues to improve public transport and the environment, over and above normal public expenditure.

21.17 The Assessment of Demand Management

The assessment of plans and policies is addressed in Chapter 9. Although the basic principles apply equally to the assessment of demand management measures, some particular aspects require more detailed consideration. The first is assessment of the equity of impacts arising from the incidence of benefits and costs. There are two forms of equity, 'horizontal' and 'vertical'.

Horizontal equity is concerned with the distribution of the costs and the benefits between different groups of transport users; for example, whether city centre car–commuters incur net disbenefits due to traffic restraint, while other commuters benefit, or whether peak–hour travellers suffer net disbenefits while travellers at other times of day enjoy net benefits, and so on.

Vertical equity is concerned with the distribution of the costs and benefits between different sectors of the community, for example, by income class or some measure of ability to absorb the consequences. There is concern that congestion charging would be 'regressive', with the less well–off incurring net disbenefits while the better–off enjoy net benefits. In fact, both the Hong Kong studies and the London Congestion Charging Research Programme (DOT, 1995a) showed that, on average, the less well–off benefited, mainly because of the consequential improvements to bus services. But that conclusion would not necessarily apply in all locations or with all types of charging structure. Vertical equity is also concerned with the impacts on particular social groups, such as people with impaired mobility and those with particular travel needs.

Demand management is likely to have differing impacts in the short– and longer–term. In the short–term, an individual response might be to accommodate the charge in some way, continuing with the same basic travel patterns, albeit by another mode or at a different time of day. However, as opportunities arise for more radical change, such as changing one's job or relocating a business, so more extensive changes might take place. Ideally, both should be assessed, although the tools for assessing longer term change, including location decisions, are not as well developed as those for assessing shorter term change.

This issue of short– and long–term change is particularly pertinent in the context of understanding the possible impacts of demand management on the local (urban) economy and the distribution of those impacts by locality and by sector. These are likely to prove of importance in decision–making. As there is little real understanding about the detailed workings of urban economies, this is a particularly difficult topic, in which judgement, informed by research, must play a key role.

21.18 References

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