AN ANALYSIS OF THE CAUSES AND CURES OF TRAFFIC CONGESTION WITH SPECIAL REFERENCE TO THE CASE OF SINGAPORE

by

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ABSTRACT

Urban traffic congestion is growing rapidly and has become a nagging problem for most cities today. This thesis will address the causes and consequences of road congestion and the various measures that have been developed to curb it. It shall look, with particularly interest, at the experience of Singapore, where an innovative land transport policy has enabled the road system to be congestion free even at peak hours. More specifically, this thesis will probe the need for setting prices for roads as a way of alleviating congestion. It then examines the nature and results of the Singapore Area Licensing Scheme, the world's first comprehensive road pricing system. With the technological revolution, the application of road pricing is becoming both easier and more sophisticated. Today, Electronic Road Pricing (ERP) systems are becoming technically and administratively feasible. The thesis consequently investigate which ERP systems, coupled with a judicious blend of prevailing traffic restraint measures, will be sufficient to break the traffic gridlocks that have become a ubiquitous curse of urban life.

Chapter One

INTRODUCTION

1.1 Road Congestion in Perspective

Anyone who has experienced bumper to bumper congestion will undoubtedly consider the encounter as little better than a visit to the dentist. A typical concrete example of this problem is the case of Bangkok, the City of Angels, which has many devilish bottlenecks. During the morning and evening peak hours, it is often faster to walk a couple of kilometres through the city than to drive. During such times, it can take 30 to 45 minutes to merely travel 600 metres. Over the past year the average speed of traffic at peak hours has been reduced from all of 7 km per hour to 4. To help Thai commuters cope with gridlock, the Thai traffic chief even advised that they apply Lord Buddha's teachings and have patience (Asiaweek, February 28, 1992, p. 57).

The same scenario is true of cities like Manila and Calcutta where the daily ordeal of crawling through heavy traffic snarls has become as much a part of the motorists' daily routine as bathing and eating. It is a common sight to spot businessmen in Manila staying at posh houses in the business district though home is only a short distance away. They are not workaholics but they all are consciously seeking to avoid one thing: traffic (Asiaweek, February 28, 1992, p. 54).

Also clogged up during the rush hours are cities in the developed world such as London, Paris and Italian cities like Rome, Florence and Naples. A typical delivery driver in central London, as recorded by the Greater London Council, goes forward at the pace of a snail. A quarter of his time is spent in second gear while a half of it is in third and he changes gear every 90 yards. When he does eventually get into top gear it is, on average, for only 25 seconds (The Economist, 1979, p. 112)

The term congestion denotes any condition in which demand for a facility exceeds free-flow capacity at the maximum design speed. Though it is applicable to all transportation modes, we shall focus exclusively on urban motor vehicle congestion. Traffic congestion is therefore a consequence of vehicles operating below minimal normal speed levels over a sustained period of time.

The costs of running a vehicle are maximised by driving under conditions of congestion. More buses are needed if they spend half their time in jams, not delivering passengers. Slow driving also hurts the car, contaminates the air and delays passengers.

Some of the costs of such driving fall on the owner, who pays in cash for extra fuel, maintenance and the irritation arising from sitting in traffic jams. Governments would incur the costs of repairing roads and building new highways. Other road users pay for delays caused by congestion while society at large swallows the cost of air pollution, noise and road accidents.

Over the last hundred years, in the developed West and more recently in booming Asia, we have seen astounding growth and prosperity. One of the most visible symbols of this economic progress and vitality is the motor vehicle. The growing need to transport goods and people in busy urban areas has resulted in unprecedented growth in the number of motor vehicles of every size and variety - personal automobiles, buses, taxis, light and heavy commercial trucks and motorcycles. As cities grow and prosper still further, transportation and mobility will play increasing important roles in improving urban residents' quality of life. At the same time there is increasing public concern about the air pollution and congestion that result from increasing vehicle traffic.

The source of this virtue and this vice is the car. It is now as essential to many people as their clothes. Developers reckon that 200 yards is the most that the average American is prepared to walk before getting into a car (The Economist, October 17, 1992, p. 3). By 2000 there will probably be one car for every person aged 20-64 in America (The Economist, October 17, 1992, p. 15). In Britain, for example, the average daily traffic per mile of road grew by 34 per cent between 1978 and 1988, and by 52 per cent on motorways (The Economist, April 27, 1991, p. 67). In Japan, the number of cars has rocketed from 6.3 m in 1965 to almost 60 m now, a figure so large that all municipalities have required cars to carry a sticker showing where their registered parking spot is (The Economist, 1992, October 17, P. 15). In the coming decades, the main growth will come from Asia, Eastern Europe and Latin America. Eventually China, India and Africa will provide millions of new drivers. With such high growth rates, the scene will be disastrous if policy makers do not predetermine efficient solutions to combat the manifold problems of congestion and the overuse of the car.

This urban transport problem is usually perceived as a disequilibrium, at peak time, between the supply of transport infrastructure and the demand for the use of this infrastructure; a demand fuelled by an increasing population and by an increasing desire for more journeys. Given the physical and financial constraints now acting against any substantial increase in road capacity, it has become a necessity to restrain the use of the private car. Policy makers have responded with a range of vehicle restraint measures including fuel taxes, parking controls, traffic management - all of which have contributed to the containment of the problem, but which are recognised as being at best short-term palliatives.

For many years the solution to congested urban streets was seen as residing in the supply side, by constructing more city streets and improving public transportation. These solutions are now being challenged. Just as new highways attract new traffic, so do new city roads often create new congestion. There is the additional question of how many roads can be woven through an urban area before the roads take over and the quality of urban life becomes hugely diminished.

The emphasis is now shifting to the demand side. By pricing congestion, travel on roads at rush hours can be made to cost more. This will encourage motorists to make better use of roads by spreading their journeys throughout the day or using public transport. It would also raise money that could be invested in infrastructure.

In 1975 Singapore became the first city in the world to apply this principle with dramatic effects. Car journeys were drastically cut and traffic speed increased by a fifth. Singapore's success in employing the price mechanism to ration more effectively the use of roads during periods of peak demand is attracting widespread interest among urban planners elsewhere and it is becoming an important agenda item in discussion on road-pricing systems.

With improving technology, it is becoming easier to make improvements on both the demand and supply sides. By linking electronics to the roads and in the car, urban transportation planning is moving into high gear. Traffic volume and speed can now be measured by detectors buried in the road which are linked to computerised traffic-management centres. Instant warnings about traffic jams, accidents and even over-crowded motorways are transmitted to drivers via electronic signs and a radio system. Although this technology is not pioneered by this city state, Singapore, is nevertheless on the forefront in terms of systematic implementation.

1.2 General Structure

In light of the above discussions, the purpose of this thesis is to investigate the causes and consequences of the urban transport problem and the means by which it may be combatted. Special reference will be made to the case of Singapore, for it has the longest operating and most comprehensive system of remedial policies to date. In pursuit of these objectives, this thesis consists of five chapters. Chapter One provides an introduction to traffic congestion and takes a peek at the scheme of work that links together the various chapters. Chapter Two seeks to investigate the causes and consequences of traffic gridlock. A detailed account and an economic analysis pertaining to both issues are discussed. In seeking potential solutions, Chapter Three looks at the roles played by various traffic control schemes and transport policies.

Chapter Four covers Singapore's unique transportation policies and examines, with particular interest, its Area Licensing Scheme and Vehicle Quota System. The effectiveness and weaknesses of both measures in managing the demand for road space are also explored. Chapter Five discusses a newer mechanism to curb congestion known as Electronic Road Pricing. It demonstrates how technology may enable trips to be effectively priced with the use of electronic probes. This thesis concludes with chapter six which draws together all the principal findings of the study.

All said, may the trip ahead be smooth and easy.

Chapter Two

THE CAUSES AND CONSEQUENCES OF CONGESTION

2.1 Introduction

Transport is an integral part of the urban economy. The successful existence of urban society is crucially dependent upon the efficiency and availability of adequate transport facilities. Without them, supplies of the food and raw materials necessary for the maintenance and well-being of the local population and the survival of its industries cannot be channelled into the city nor would the populace be able to move relatively freely between their homes, places of work and recreation. The provision of suitable transport services, both between urban areas as well as within them, is therefore, essential.

However, the issue of mobility and accessibility is getting increasingly complicated. The increasing demand and mounting costs of urban transportation are now depleting resources at a rate that almost reduces city planners and policy-makers to mere resignation. Urban traffic congestion is not new, but its increasing magnitude is notedly alarming. "During a holiday weekend in Spring 1992, thousands of eastern Germans caused a monumental 70 km traffic jam on the Nuremberg-Berlin motorway. With cars stuck for up to 18 hours, police had to wake up sleeping motorists to tell them it was their turn to move" (The Economist, 1992, October 17, 1992, p. 15). In Los Angeles, where a 160 km journey to work is not unusual, by 2010, the average speed of traffic on the highways is expected to fall from 35 mph to just 19 mph, as the number of vehicles on the roads in Southern California increases (The Economist, April 27, 1992, p. 15). Similarly, in Paris, the average speed of traffic is now 9 km/hr. Road construction and broken-down cars can slow traffic even further.[1] The above cases all attest to the fact that the demand for roads has become so overwhelming that traffic spills over the containment limits of transport infrastructure and services. The result: cities are being severely overloaded with traffic.

Given the above, the purpose of this chapter is to explore the causes and consequences of urban congestion. In relation to the former, the evolution of urban society and architecture receive specific attention, while environmental and time costs are shown to be the prototypical examples of the latter. The chapter then develops a methodology for the economic analysis of the benefits and costs of road use which allows us to appreciate the full impact of congestion costs.

2.2 Causes of Traffic Congestion

2.2a The Automobile

The rise of the urban transportation problem can be attributed to several factors. First, there is the development of the automobile. This product, on the one hand, has definitely enhanced certain aspects of community welfare. Specifically, it has speeded up and reduced the costs of delivery and provided personal mobility on a scale previously undreamt of. The development of the automobile allowed the population to live away from

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[1] Qtd. in Chin, ATH, "Role of Transport Policy and Regulations in Correcting for Transport Externalities", Law and Economic Development: Cases and Materials from Southeast Asia, 1992: 211.

the busy and polluted city centres to enjoy the fresh air and greenery of the suburbs. The automobile has become a symbol of freedom for the young. Most people seem to derive pleasure out of their ability to control and to drive long distances cheaply and comfortably in the car. It gives freedom to go where and when one chooses. With a car, one can live in the most remote of areas.

This higher quality of life, however, comes with a cost. As people live further away from the city, it becomes necessary for them to drive to work as sometimes public transport is inaccessible. This brings about the urban transportation problem commonly known as automobile traffic congestion. Instead of adding to convenience, it now becomes a problem. Although the car is a positive asset for leisure travel and for those living in the rural areas, it has become a serious threat to the efficient operation of urban communications, in particular when usage tends to be concentrated in time and geographical space.

2.2b The Invention of Passenger Elevator and Steel Production

The heavy urban density now experienced in most cities has aggravated the traffic situation. Two breakthroughs in technology, the invention of the passenger elevator and the mass production of steel, have led to the exponential growth in tall buildings. These skyscrapers are responsible for the rocketing of urban populations as more people and facilities can now be housed under one roof. In Yokohama, Japan, the 70 story Landmark Tower, boasts 51 elevators, a pneumatic garbage disposal system, countless restaurants, a fitness club, a swimming pool and a viewing deck. During the Earth Summit in Rio, a consortium showcased a blue print for the kilometre high Tokyo - Ecopolis City 100, a conical structure for 75,000 residents (Asiaweek, 1992, p. 35).

For everyone around the world, the bombing of New York's World Trade Centre, workplace of over 100,000, was noteworthy not just as a terrorist act, but also as testimony to the fact that individual buildings can now house populations that once would be equivalent to a small city.

The consequence of architects channelling urban growth upward instead of outward is a huge increase in population density and absolute population size. The daily migration of this mass of humanity, to and from work, is now severely straining the logistical abilities of road systems designed historically to cope with much smaller population densities.

2.2c Rural Urban Drift

The lure of bright lights and big city life is highly seductive. The last few decades have witnessed an explosion of urban populations often fuelled by the migration of individuals and families from rural areas toward the urban centres. The rapid growth of metropolitan areas and the urbanisation accompanying the development of modern industrial society have been also the result, in no small measure, of the rise of contemporary transport facilities, for these allow migration and further support industry and commerce.

The increase in industry and commerce has emphasised the role played by transport in present day society. In particular, unprecedented rates of urban growth have stimulated a corresponding or even higher increase in the demand for transport. The swing from pedestrian to motorized trips has made motorists more likely to encounter the tensions of driving in crowded freeways and to experience the problems of finding parking places.

But our perception of the urban transportation problem cannot be viewed exclusively in terms of traffic congestion. These are additional negative effects that should not be ignored.

2.3 Consequences of Traffic Congestion

2.3a Traffic Accidents

The increasing use of vehicles has, unhappily, led to many accidents. In several countries in the developing world, fatalities per km are often 20 times higher than in the industrialised countries (Chin, ATH, 1992, p. 211). Although road accidents are most common amongst those using motorised transport, there is an ever present worry for pedestrians and cyclists who utilise the same street. The close proximity and physical presence of heavy traffic flows, combined with the possible death or injury, creates considerable stress for city dwellers.

2.3b Traffic Noise

Traffic noise is also steadily developing into a diabolical nuisance, seriously impairing the general enjoyment of towns, destructive of the amenities afforded by dwellings, and interfering in no small degree with efficiency in offices and other business premises. It is estimated that about 93 per cent of townspeople are affected by undesirably high levels of traffic noise. A study made by a government working group in Britain in 1980 also reported that six out of ten urban dwellers had their sleep disturbed by traffic noises

(Bendixson, 1974, p. 25). In the United States, the Environmental Protection Agency forecasted that land badly affected by noise from freeways would reach 3300 sq miles by the turn of the century, if no action is taken to stop the process (Bendixson, 1974, p. 160).

2.3c Time Costs

With congestion, time is wasted as traffic slows and costs are increased as engines perform inefficiently at lower speeds. A study by the Paris Transport Authority (RATP) revealed it would cost Parisian travellers about $375 m a year if the cost of 12 francs ($2.50) an hour is put on the hours spent in traffic jams by both car and bus travellers (The Economist, Aug 11, 1979, p. 112). That approximates the entire annual bus operating budget of the RATP. Several studies reckon that sitting in traffic jams cost Angelenos around $9 billion a year in lost output (The Economist, 1991, p. 67). Between 1970 and 1976 in Osaka, when the number of traffic jams almost doubled, the amount of travellers' time lost quadrupled. (The Economist, August 1979, p. 112). In Thailand the situation is even worse: the time lost in travelling could add 10% to the Gross National Product of the country (Chin, ATH, 1991, p. 195).

2.3d Air Pollution

The wider impact the automobile has on the environment is also alarming. Worldwide, cars, trucks, buses and other motor vehicles are playing an ever increasing role in global climate change and air pollution. Given that oil is the primary fuel used, motor vehicles are major sources of carbon dioxide, nitrogen oxides and carbon monoxides. All these gases contribute to acid rain, green house effects and the depletion of the ozone layer either directly or indirectly.

Virtually the entire global vehicle fleet runs on fossil fuels, primarily oil. As traffic congestion spreads, increasing amounts of fuel are wasted. More fumes are poured into the air, increasing the likelihood that cities will acquire blankets of smog. As the number of vehicles in use grows and the mileage driven in urban areas increases, and as congestion becomes more frequent, certain signs will become more evident. Sufferers from chest diseases will have their lives endangered, others will find their eyes watering and their nose tickling. More generally, the stink of exhaust fumes will increasingly cover up smells and scents that are part of the pleasures of life. In Bangkok, pollution is so severe that passengers in buses tie pieces of cloth over their faces in a vain effort to ward off traffic fumes (The Economist, December 11, 1993, p. 36). In Jakarta, the once fragrant capital city of Indonesia, the large numbers of vehicles in the city have seriously impacted the environment and caused degradation in the city's air quality (The Economist, December 11, 1993, p. 36). Studies of the pollutants carbon monoxide, hydrocarbon and smoke show that 70 to 90 per cent of air pollution comes from the transportation sector (OECD[2] Environmental Data, Paris, 1988).

All these costs are astronomical. According to the California Assembly Office of Research, the region's cars cause $47 billion in environmental damage. (The Economist,

[2] OECD is the abbreviation for Organisation for Economic Cooperation and Development.

April 27, 1991, p. 67). Another attempt to add up all these kinds of costs externalities, in economist's jargon) has also been made by OECD. Its report revealed the hidden costs imposed by all vehicles on other travellers and pedestrian, in Europe and North America, to be about 4% of Gross Domestic Product (The Economist, August 11, 1979, p. 112).

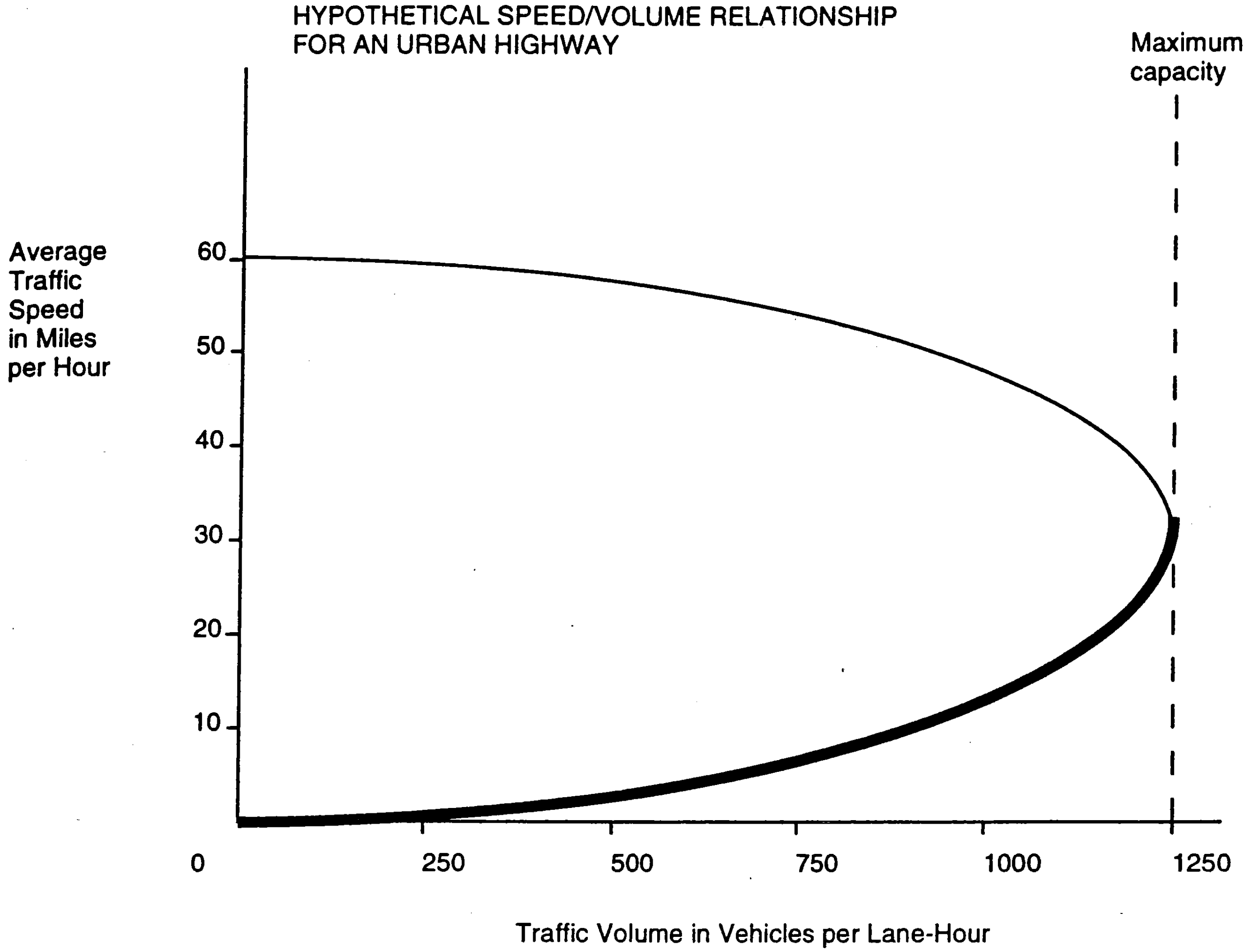
2.4 The Economics of Traffic Congestion

Congestion is normally defined by reference to a speed/volume curve. This curve relates the volume of traffic passing a point on a road (usually on one lane for one hour) to average traffic speed. Highway engineers estimate these speed/volume curves for different types of highways or streets through statistical analyses of observed traffic speeds and volumes.

The speed/volume curve shown in Figure 2.1 is typical of limited-access highways. The solid line shows the relationship between speed and volume when vehicles are entering a highway at rates lower than maximum capacity. The average traffic speed falls slowly as traffic volume increases until the volume approaches maximum capacity, whereafter average speeds drop rapidly. The dashed line illustrates supersaturated conditions, which can occur if automobiles enter the highway in excess of maximum capacity for even a brief period of time. With supersaturation, both volumes and speeds decrease sharply and can lead traffic to a standstill if the entering volume of traffic does not decrease quickly.

Supersaturation is to be avoided, since a highway can carry the same volume at far higher speeds by avoiding such a condition. Even operating near capacity is deemed

FIGURE 2.1


HYPOTHETICAL SPEED/VOLUME RELATIONSHIP
FOR AN URBAN HIGHWAY
Maximum
capacity
Average
Traffic
Speed
in Miles
per Hour
60
50
40
30
20
10
0
250
500
750
1000
1250
Traffic Volume in Vehicles per Lane-Hour

undesirable because small increases in traffic volumes will greatly reduce speeds and enhance the problem of supersaturation.

Normally, no attempt is made to design or operate highways so as to eliminate congestion altogether. Highway construction and every other means of reducing highway congestion involve some costs, and the costs of further reducing congestion by most means usually exceed the benefits of faster travel long before congestion is eliminated entirely. The choice of how many lanes wide to build a highway, for example, involves trading off increased highway construction and maintenance costs against decreases in travel time and operating costs for motorists. The number of lanes is economically optimal if the costs of constructing one more lane are equalled, or barely exceeded, by the gains to motorists from that lane. A highway large enough to allow freely flowing traffic during the height of the rush hours in the centres of large metropolitan areas is seldom optimal; because building such highway capacity is very expensive and the benefits in time savings and operating costs accrue to only a small group of rush hour users. In short, highway engineers and planners accept that some degree of traffic congestion will prevail even in a well-designed highway system.

Given the current pricing system for transport, the urban transport problem is simply the result of a supply/demand disequilibrium at peak times, resulting from the concentration of travel in the morning and evening rush hours. At given prices, rising demand in the face of relatively inelastic capacity always produces congestion for goods and services and, in this respect, urban transport is no exception.

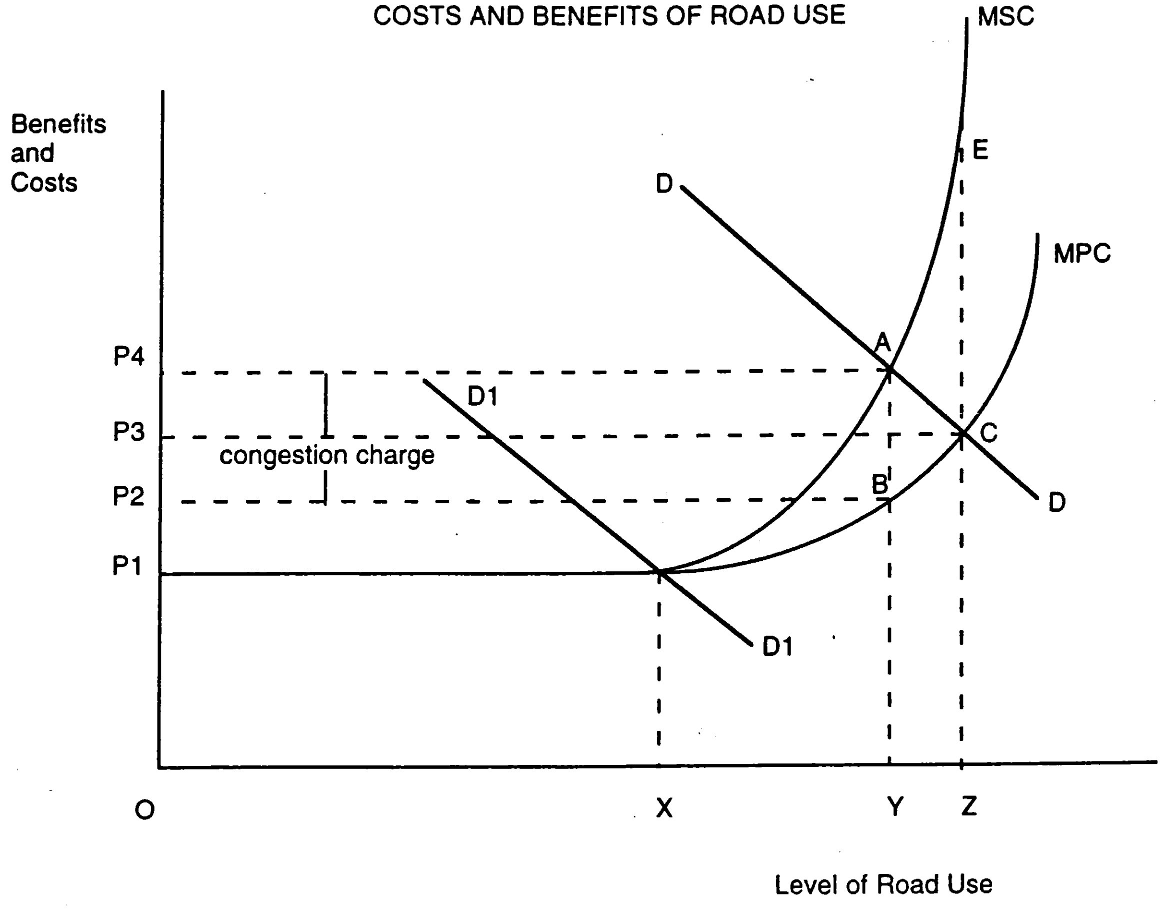
In formal economic analysis, traffic congestion is defined as a level of usage of an existing transportation facility at which the social costs of additional users exceed the private costs incurred by these users. The point is illustrated in Figure 2.2 which shows the social and private costs and benefits associated with the use of a particular stretch of road. The two demand curves represent the horizontal summation of the marginal private benefits of all individuals who want to use the road at two different times of the day, DD representing peak demand and D'D' off-peak demand. DD is greater than D'D' not only because more people want to use the road during peak times, but also because peak-hour trips are invariably journey-to-work trips and these are considerably more valuable. MPC and MSC are the respective marginal private cost and marginal social cost curves.

The costs of fuel, wear and tear, and the wages of the motorist (or his own time) constitute the private costs of the journey which are undertaken by the motorist. Under conditions of congestion, the feeling of anxiety and frustration on non-motorists, the maintenance of roads by the government, and the wider impact congestion has on the environment are contained under the social costs of traffic congestion.

In engineering terms, no congestion exists when the level of usage is less than or equal to X, which can be considered as the design capacity of the road, since cars can maintain a speed consistent with this design capacity. At these flows there is no divergence between private and social costs and X is the "technically efficient" optimum flow. Achieving this traffic level would appear to be a desirable policy objective and is often incorrectly pursued because, in economic terms, it can be shown to represent an under-utilisation of resources.

FIGURE 2.2

COSTS AND BENEFITS OF ROAD USE



Beyond X, additional entrants to the traffic stream are unable to maintain design speeds and, as average speeds fall, they incur additional costs because of increased operating costs and delays which cause MPC to increase. However, each new vehicle is now also causing some delay and risk to others for which it does not bear the cost, hence the even sharper rise in MSC.

The MPC curve represents the supply curve of motorists in using this particular road. It demonstrates the number of vehicles joining the traffic stream at various cost levels. Hence the cost level OP3, which equates privately costed supply and demand, is the price to all motorists when the level of road usage is OZ. The benefits of travel to the motorists can be measured in terms of their consumer and producer surplus, which is defined as the difference between the price a consumer is willing to pay for a good or service (indicated by the demand curve) and the costs he encounters when utilising road services. In the diagram, the OZ - OY motorists are enjoying total surplus of ABC, in excess of the total private costs (BCZY) they are paying. However, the total social cost incurred is far greater, amounting to AEZY. The net social cost of this additional traffic, the difference between its total social cost (AEZY) and the total private costs (BCZY), is ABCE. This net social cost, however, exceeds the total surplus enjoyed by these motorists by ACE. This area therefore represents the true cost associated with excess congestion.

In the absence of intervention, demand will settle at OZ where the marginal private cost and demand curves intersect, whereas the optimum flow is clearly OY. Beyond OY every additional road user costs other road users (measured by the marginal social cost curve) more than the benefit he himself gains from using the road (measured by the demand curve). The important point to note is that at OY there will still be some delays. However, economic theory tells us that this is the level where resources are allocated most efficiently since the marginal social cost the user imposes equals the benefit he obtains. To attain this socially optimal use of roads, the prices confronting motorists should be raised to OP4. In theory, this may be accomplished by improving a congestion charge of P2P4 on the motorist if to make the private costs of road use equal to the social costs at the optimal level of usage OY.

The above analysis highlights the necessity to ration more effectively the use of roads during periods of peak demand. A primary reason for excessive traffic is that users rarely pay the true cost of road use. For example, a private car user usually pays only the direct costs of operating his vehicle, yet when he joins traffic crawling along a congested road he reduces the speed and increases the costs to all other users on that road. In this context, congestion obviously functions inefficiently, raising the real cost of the service and leading to a deterioration in quality. Furthermore, the urban transport dilemma is not just the simple logistical problem of seeking optimal measures to combat congestion under the prevailing pricing system. There are clearly environmental constraints which mean that for established cities, beyond a certain level, it is impractical to provide for the unfettered use of the motor car. It can be seen, therefore, that the problem in cities is to find ways of satisfying the demand for transport within cost, capacity and environmental constraints.

2.5 Conclusion

This chapter has shown that the movement of people and goods in performing various activities (economic or otherwise) gives rise to various forms of externalities. They include traffic accidents, traffic noise, time cost and air pollution. The solution to the spiralling increase in congested traffic is complicated. Issues of cost, capacity and the environment have to be considered. While this may be an uphill task, policy makers and urban planners have not resigned themselves to downright fatalism. Attempts are taken to tackle the congestion problem through deterrent taxation on gasoline, diesel and vehicle ownership. By imposing user taxes on motorists, the higher operating costs may discourage vehicles from entering congested locations. Parking restraints such as the application of special charges and the reduction of space devoted to parking are also being proposed. Others argue in favour of better road structures and traffic management. These include the usage of one-way streets, the timing and control of traffic signals and the encouragement of public transportation. These alternatives are by no means the ultimate solution to traffic sprawls but they are all that have been done in most cities. We shall, accordingly, discuss these measures more explicitly in Chapter Three.

Chapter Three

TRADITIONAL SOLUTIONS TO ROAD CONGESTION

3.1 Introduction

The causes of the urban transportation problem, as covered in the last chapter, can be attributed to several factors: the invention of the automobile, the elevator in contributing to increasing urban densities, and rural urban drift. But over and above these factors, the traffic problem is primarily the result of a supply/demand disequilibrium. Motorists do not pay the full costs of their journey and consequently, the volume of urban traffic is at times in excess of the optimum as defined by the equilibrium of marginal social cost and marginal social benefits.

Since it is unlikely that the motoring community will unite in a concerted effort to alleviate this traffic problem, it will have to be controlled and corrected by policy makers and urban planners. In this chapter we shall look into the various methods implemented to break traffic gridlock and also examine their effectiveness.

3.2 Traffic controls

3.2a Building more Roads and Highways

The seemingly obvious solution to congestion is to build more streets and highways. The early post war thinking was that traffic jams can be cured by providing an extensive and comprehensive network of roads and expressways for good accessibility and smooth travel. In particular, construction of high performance expressways, in, around, and through metropolitan areas was emphasised. However, this capital intensive answer to traffic snarls has become increasingly controversial as costs mounted and as concerns about the environment became more pronounced. In some cases, there were even unneeded investments in infrastructure.

Increasingly, planners are coming to believe that the task of building highways is a never-ending one. Each new highway, they say, generates new traffic: more people take trips they would not have taken before. And each new highway puts new pressure on the roads and the cities it feeds into. "To try to solve the congestion problem exclusively by building more highways is like trying to solve water pollution exclusively by increasing stream flows. It does nothing to ensure that the amount supplied is used intelligently."[1] The result could be stupendous waste. The example of Hong Kong is instructive. Suffering one of the highest vehicle densities in the world, Hong Kong had recently built the Eastern Harbour Crossing to ease congestion at the frenzied Cross-Harbour Tunnel. The new tunnel did help but only temporarily. Before long, the bottleneck situation was again experienced at the Cross-Harbour Tunnel with traffic as high as before: 120,000 vehicles a day. The new tunnel has also attracted substantial new traffic, with numbers doubling after its first year of operation (Asiaweek, February 28, 1992, p. 55). The lesson is that any reduction in road congestion occasioned by new construction may result in an improvement in the transport services. This, in turn, increases the volume of traffic until congestion reverts to its previous levels. Put simply, when something is done that

[1] Qtd. in Stephen L Mehay, et al., Urban Economic Issues, (USA: Scott, Foresman & Company, 1984) 168.

motorists perceive as allowing an easier crossing, it attracts more traffic.

3.2b The Optimisation Of Traffic Signals

There is a need to keep traffic moving with minimum delay. This would ensure that productivity lost through frustrating traffic jams is avoided, thereby creating an incentive for investors to bring financial capital to the city. Thus highway engineers and planners have long sought, through better traffic management, to augment highway capacity without greatly expanding road space or investment. The timing and control of traffic signals was one of the first of these capacity-enhancing techniques to be developed and is the subject of continuing research and refinement. For example, delays at an intersection can sometimes be reduced by altering the proportion of green signals allotted to main and cross streets or by installing devices to vary the signal cycle of rush hour and midday traffic. Closed spaced signals at junctions can be linked to work in tandem to ensure that vehicles are not stopped randomly at junctions. This is achieved by using a central computer to control and synchronise the working of the traffic signals (for example, using information from electronic sensors placed at strategic points).

Significant improvements to the road capacity can be achieved with such measures, and the cost of traffic-signal optimization is usually modest compared with the gains. Most of the benefits are generated by adjusting only a small portion of a metropolitan traffic-signal system, since traffic usually is concentrated on a few major arterial streets. Even with computerised systems, the capital outlay is normally small. Most of the expense is for traffic engineers or computer operators to monitor, repair, and adjust the system.

3.2c On-Street Parking

Another technique to increase street capacity is to reduce the space devoted to on-street parking. Considerable improvements in street capacity were made in many cities during the 1940s and 1950s simply by replacing parallel parking with angle parking. Further useful gains may be made in some cases by eliminating on-street parking during rush hours (or even altogether) as the roadway lost by on-street parking may be much larger than the physical space occupied by the parked cars. On a more drastic note, parking of vehicles can also be banned, with parking being confined to minor roads and off-street car parks. This elimination of on-street parking on congested arterial roads that have parking on both sides may add a lane or more of traffic in each direction.

3.2d Parking Restraints

Another effective measure to achieve better use of limited road space is the application of special charges for parking. As with other methods of restraint, the aim is to reduce entry of cars into congested locations during peak periods, while avoiding interference with business activities and shopping. This can be achieved by some form of differential parking charge; for example, by setting the charges comparatively low for an initial short period, and applying progressively higher charges for longer periods. Not wanting to pay substantial charges, commuters who are long term parkers will be discouraged from parking in the area. Conversely, people with business appointments and shoppers who need short-term parking are encouraged. The lower charges and the greater availability of places because of more rapid turnover will be beneficial to them.

This approach to parking proved to be successful when adopted in Singapore and is seen as an important contribution to the success of the area licensing scheme (elaborated upon in Chapter Four). Another option might be to offer motorists who paid for the right to drive into town a guaranteed parking space there. Such a scheme is also technically possible.

Parking restraints can give rise to substantial increases in illegal parking and therefore they need to be accompanied by strict enforcement of regulations. Commuters may be encouraged to make additional trips during the peak period (as in the case of people being driven to work in the mornings by other family members, who then return home and repeat the journey in the evening). In addition, many unproductive trips will be made, for example, when drivers circulate in the Central Business District (CBD) waiting for the passengers or looking for parking places due to parking controls. These various side effects may add substantially to congestion if allowed to develop. Furthermore, through-traffic, which is often a primary cause of congestion in city centres, cannot be constrained by parking controls. As a result, parking may be more effective as a restraint measure when it forms part of a more comprehensive demand management scheme, as in the case of Singapore.

3.2e Road Structures

Junctions are usually the spots for bottlenecks and accidents. One of the treatments commonly used includes the use of the special right turn lanes that are set away from the straight through lanes. Alternatively, special left slip roads can allow left turning vehicle to bypass traffic signals.

Roadway capacity can also be increased by channelling traffic flows to reduce vehicular conflicts through such techniques as traffic islands, clearer and more effective lane marking or one-way streets. For example, converting a pair of parallel two-way streets to one-way streets going in opposite directions often increases the combined capacity of the streets by eliminating left turns made against traffic flows. Signal-optimization is also more easily obtained with one-way streets, and reductions in accidents can be achieved due to fewer conflicting vehicle movements.

One-way streets do have disadvantages, however, because they increase the distance that motorists must travel, sometimes enough to offset any gains in speeds. Channelization and one-way streets may also cause congestion problems at other nearby points in the street network and may reduce pedestrian safety and access to businesses. Transit riders may be inconvenienced by bus routes that operate on different streets inbound and outbound. Additionally, by speeding general traffic flow, channelization may also reduce transit speeds by making it more difficult for buses to pull out of curbside stops.

3.2f User Taxes

User taxes can act as a restraining instrument on vehicle use with taxation imposed on fuel, tires and spare parts, thus adding to operating costs in relation to the distance travelled. While potentially restraining total usage, these taxes do not discriminate the place and time vehicles are used. More specifically, they do not differentiate between usage during peak and off-peak periods or in congested or non-congested areas.

However, although lacking in finesse, user taxes, if pitched sufficiently high, provide an overall dampening effect on the growth of vehicle use and, in turn, in the level of congestion.

While a variety of user taxes may be available, some have side effects which mitigate against their use. For example, although a tax on tires may provide a restraint directly related to the amount of vehicle use, it can give rise to the use of unsafe tires. Similarly, a tax on spare parts may lead to poor maintenance, breakdowns and accidents, hence increasing rather than reducing congestion. To be effective, these particular taxes may need to be associated with comprehensive vehicle inspection programs which could prove cumbersome and costly to introduce.

On the other hand, a fuel tax usually is comparatively simple to administer and may be attractive as a means of restraint. However, in areas where the price of fuel is high, for example West Europe, there is little evidence that people do not use their cars. It remains therefore debatable whether such measures have a direct relationship with the amount of vehicle use. Furthermore, some form of exemption needs to be provided for fuel to be used for buses and trucks, lest these forms of transport be also subjected to restraints. To avoid distorting the benefits of different types of fuel, there is also a need to vary the tax rate with the performance of each.

3.2g Encouragement The Use Of Public Transportation And Carpooling

Increased use of mass transit and carpools may also alleviate traffic congestion. The standard automobile takes up the same amount of roadway capacity whether it has only one occupant or as many as six. Similarly, a public bus also occupies the same road space whether it is empty or loaded with 50 passengers. The message is simple: instead of jamming the road with single-occupant automobiles, road capacity would be greatly enhanced if everyone is willing to use public transportation or carpooling, when the same purpose of transportating people from one place to the another is to be achieved. Unfortunately, this measure would likely be unsuccessful as most people are unwilling to give up car ownership for the sake of reducing road congestion.

3.2h Vehicle Ownership Restraints

An even more general restraint device is to inhibit vehicle ownership through high import duties, purchase taxes or registration and annual licensing fees. By raising ownership costs and making cars systematically less available, these measures can be effective in reducing the severity of transport problems. Like user taxes, however, vehicle ownership restraints are insensitive to location and times of use.

In practice, ownership restraints, if income levels rise, are likely to do little more than slow down the growth in vehicles. Moreover, ownership taxes will have to be periodically adjusted upward to remain effective.

Of the various ownership restraints available, high annual licensing fees, by providing periodic charges that are not recovered on the resale of vehicles, are probably the most effective. Purchasing taxes and other acquisition taxes on new cars are inclined to be reflected in resale values and may be seen by a few purchasers as an investment. But for the majority, high purchase taxes will have a considerable effect on their ability to buy new cars. A side effect of this is that the retention and use of older cars may be encouraged; these are likely to be less safe, less fuel efficient, pollute more and break down more frequently, thereby adding to congestion levels. In order to offset these tendencies, special incentives to replace older cars, or inspection procedures, can be implemented. Similarly, high penalties for traffic infringements and obstructions may suppress journeys in congested areas by older, less reliable vehicles and thus lower any adverse impact on safety and traffic flows.

3.3 Conclusion

We saw in this chapter the various measures taken to counter traffic congestion. While they all offer at least a partial solution, none of the alternatives surveyed above is a panacea for congestion. Almost every means is effective in a few limited circumstances, and some, can actually intensify rather than reduce congestion, if not applied carefully. Nevertheless, as discussed, these alternatives can alleviate congestion and consequently are being used increasingly, if not fully successfully. Given the limited success of the measures discussed above, economists have now been emphasising the theory and application of road-pricing schemes. The idea is to set a travel price that follows fluctuations in demand, as is done by airlines, hotels, telephone companies and some power utilities. And for the system to be reasonably effective, charges to individual users would need to be related to the amount of use of congested streets and to the degree of congestion, which vary for different locations.

Singapore has created headlines since the seventies as a country with an enlightened Land Transport Policy. Schemes like the Area Licensing Scheme (ALS), Additional Registration Fees (ARF), Preferential Additional Registration Fee (PARF) Policy for scrapping and recently, the Vehicle Quota System are all unique measures which are attracting world attention.

The island state also has one of the densest vehicle populations per km of road in the world. Its figure of 81 per kilometre is higher than 62 in UK, 43 in Japan and 27 in the USA. (Lee, 1992, p. 1). Despite this, however, Singapore's roads are relatively congestion free compared to larger cities like London, Tokyo and New York. Known for its zero-tolerance policy toward road congestion, it will therefore be instructive to look into its successful road pricing systems, particularly the Area Licensing Scheme. This scheme, which charges vehicle for road usage at peak hours, and the related transportation policies adopted by the island state, will be our next item on the policy agenda, in Chapter Four.

CHAPTER FOUR

SOLVING ROAD CONGESTION: THE SINGAPORE EXPERIENCE

When the motor car was in its infancy, the problem was to find more roads to drive on. Some roads were initially so poorly conditioned that they broke the new machines. While the road has improved through the years, congestion in many parts of the world has kept the speed of the traffic so low that it is still often quicker to walk.

The main reason why roads became congested is that drivers are rarely charged directly for using them. Once the road tax is paid and the duty-laden petrol poured into the tank, the driver always feels he has earned the right to go where he wants and when he wants. However road space is a scarce resource and congestion makes it scarcer. The most efficient way to ration it would be to charge for it directly, and charge more at peak hours. As argued by economists, the congestion problem should be tackled by pricing journeys that result in congestion - hence the terms congestion pricing or road pricing. Although the concept has been theoretically respectable for many years, putting it into practice has, until now, been put off by references to problems of implementation, enforcement, and equity.

Singapore, like many cities around the world, has been threatened with slow strangulation by the increased use of cars. But unlike other cities, the island state has developed tough traffic policies that have proven implementable. This is mainly because it is a small island with a transportation grid almost totally insulated from foreign traffic. Moreover, it has an authoritarian government, and an obedient, law-abiding citizenry.

Singapore is a land-scarce country, with land area of only 641 square kilometres and a population of 2.8 million. Since obtaining independence in 1965, the former British colony has been one of the most rapidly growing economies in the world in real GNP per capita; it is classified by the World Bank in the "high income" group of economies. The concentration of population in a relatively small land space has meant that urban traffic congestion has always been a concern, and this has been reinforced as increasing affluence has brought higher levels of car ownership.

Singapore is also a rapidly growing city state. Seventy per cent of its inhabitants live within a radius of eight kilometres of the central business district. A similar proportion of the city's jobs are located in the same area.

In 1974, there were over a quarter of a million registered motor vehicles, almost 150,000 of them private cars. A large proportion of these vehicles operate in the central area, leading to a significant level of congestion (E.P. Holland et al, 1978, p. 14). Since then, population growth and rising incomes have led to a more than threefold increase in the numbers of cars.

Aware of the extreme levels of congestion implied by such growth, the Singapore Government set out to develop a coordinated transport policy. Two major transport studies were carried out from 1974 to 1976. Both concluded that limitations on the ownership and use of private motor vehicles would be required in Singapore. In the meantime, several plans were put into action. Land-use plans attempted to coordinate the location of new housing, employment, and services in new industrial centres outside the City of Singapore to reduce the need for transport. Some road construction was undertaken. A mass transit system and an area traffic control system were studied. Bus services were improved by the provision of several kilometres of exclusive bus lanes, the use of school buses to expand the peak-hour fleet, and a major administrative reorganisation in the bus company. A policy of restraining the rate of growth of car ownership by taxation was implemented. To raise public awareness of traffic problems, a campaign to promote staggered work hours and car pooling was also launched. It involved an extensive publicity effort and government-business seminars.

While these policies were adequate to deal with the road congestion then, the government was not satisfied that these measures would prevent congestion from becoming a serious problem in the long run. The Singapore government, never one to rest on its laurels when road congestion was concerned, decided to push new plans to deter its occurrence.

The government declared its intention of restraining the use of cars in congested areas. While the short run objective of this policy was to relieve congestion in central Singapore, the long term objective was to persuade motorists to reconsider their attitudes to car ownership and use. The Government believed that modification of travel behaviour over time could be achieved, once the motorist understood and accepted the rationale behind the need for more widespread use of public transport. They further set themselves the goal of designing a scheme to reduce peak-hour traffic by 25 to 30 per cent.

4.1 The Area Licensing Scheme

On June 2, 1975, the Government introduced the Area Licensing Scheme (ALS). The

ALS was first formulated and designed in 1973 by a group of transportation engineers and planners under the direction of a high level inter-ministerial committee, which had been set up to recommend measures to further improve the transportation situation on the island. The primary objective of the ALS was to reduce peak-hour traffic volumes in the city centre through the reduction of entry in the morning, hoping that the morning restrictions would have a "mirror image" effect on the evening return flow. This measure, the most comprehensive of its kind in the world, designated a Restricted Zone (RZ) of 725 hectares in the city centre with 33 overhead gantry signs placed at the entry points on its boundary.

All vehicles, except those in the exempt categories (public and military vehicles, goods vehicles, motor cycles, and buses), were affected. Their drivers are required to buy and display valid area licences to enter the RZ during its operation. Drivers could buy their daily or monthly licences at the Registry of Vehicles, various post offices or from roadside booths located at approach roads to the RZ. The ALS fee was set at US$36 a month; company cars were charged a double rate since their expenses were tax deductible. To encourage car pooling, vehicles carrying four of more passengers were exempted.

Policing was done at the entry point. During the restricted hours, the words "In Operation" and two amber lights were switched on at the gantry sign. Any cars and taxis that had no valid area licences or which did not carry taxi or car pools would have their licence plate number, the colour and the make of the vehicle noted. The offender would receive a summons within two weeks where he could either pay the fine or challenge the summons in a court of law.

During the first few days following the introduction of the scheme, congestion was heavy on the ring road surrounding the city centre as motorists avoided the restricted zone. This problem was however quickly resolved when traffic light timing was modified to favour circumferential movements rather than radial in-bound traffic. Overall, the implementation was carried out very smoothly and no serious problems were observed. The people of Singapore responded well, justifying the Government's confidence that Singaporeans respond favourably to national campaigns and civic projects designed for the benefit of society. The volume of traffic entering the RZ during the scheme's hours of operation was surprisingly reduced by 70 per cent. The situation the statistics represent was most unusual, with extremely light traffic in the Central Business District during the morning rush hour. In this respect, although the ALS was undoubtedly highly successful, there was nevertheless some concern about the underutilisation of street capacity and about the fact that the licence fee which caused this was perhaps excessively high.

However, if not for ALS, the Central Business District would have been choked with traffic both in the morning and evening. The ALS has not only eased the morning jams, it has also helped to some extent to contain the number of vehicles in the Central Business District in the evening. For when fewer people drive in to work, fewer will drive out.

On June 1, 1989, to further improve the congestion level in work-to-home trips in the evening, the Singapore Government extended the operation and imposed traffic restrictions on both morning and evening periods. This time all types of vehicles were affected, other than public scheduled buses and emergency vehicles. The reason behind this policy was a deteriorating situation in the evening when ALS was not in operation, when the traffic slowed to 25 kmh.

Singapore was the first country to implement the ambitious ALS and it attracted world attention. Before 1975 when the ALS was introduced, there was bumper-to-bumper traffic and a stop-go-stop-go situation in the Central Business District. At that time, 42,800 private cars and about 31,000 other vehicles entered the Central Business District every morning. The average speed was under 20 kmh.

Nineteen years after the introduction of ALS, traffic entering the RZ in the morning is still below the pre-1975 levels. In the evening, the traffic volume entering the RZ has also been reduced. The number of private cars entering the city has also dropped to about a quarter (12,100) of the pre ALS level. Although the Central Business District and the number of people employed in the area since ALS was implemented has grown by a third, the growth in private cars going to the city core has far from kept pace and the 30 kmh speed has been maintained.

Figure 4.1 makes a comparison of average travel speed during peak hours in various cities around the world. Travelling speeds, a commonly used measure to gauge the level of congestion, are clearly favourable in the case of Singapore, with an admirable average speed of 30 kmh during the peak periods. By contrast, traffic crawls during the peak periods at Bangkok and New York with only 10 kmh. Manila, London and Hongkong are little better with rates creeping up to 11 kmh, 15 kmh and 16 kmh respectively. The ALS has to a great extent been instrumental in keeping traffic congestion in Singapore under control. The growth in the passenger car population since 1975 is demonstrated

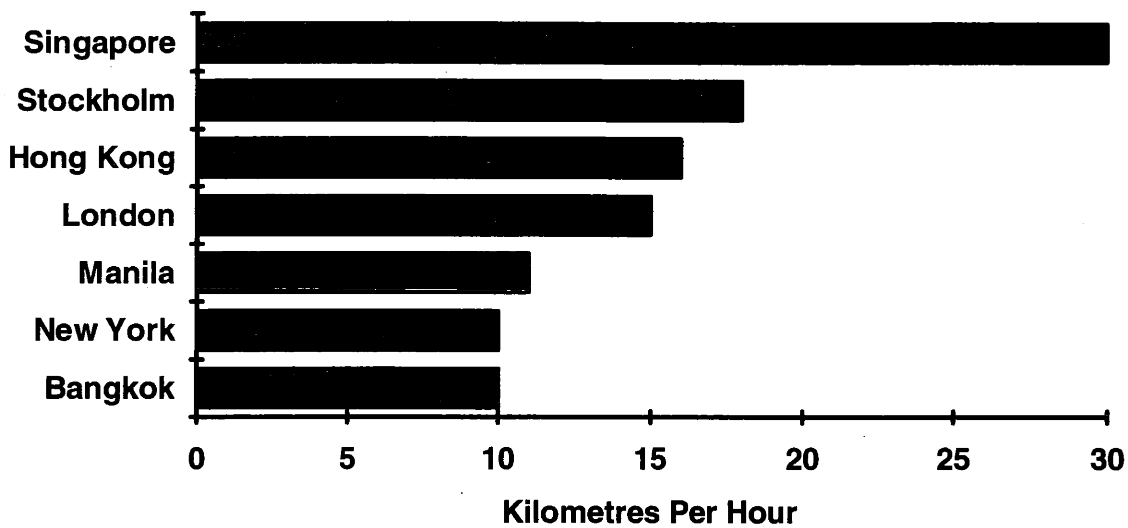


Figure 4.1 Average Peak Hour Road Travel Speed.
(Source: Public Works Department, Singapore, 1993)

in Figure 4.2. The passenger car traffic entering the RZ between 7.30 am and 10.15 am, and the volume exiting during the period 4.30 pm - 6.30 pm are also shown on the same diagram. As can be seen, when the ALS was implemented in 1975, the morning traffic saw a decrease of seventy per cent and has since remained at or below half of the pre-ALS volumes even though car population has almost doubled over the last 16 years. With the implementation of the evening ALS, the outbound traffic during this period decreased by forty per cent. In addition, it caused many people to come into the city area after the evening ALS hours which also alleviated congestion in the RZ.

While the above figures suggest the morning and evening ALS to have been sufficient in reducing road congestion in the island state, the Singapore government was not fully convinced. Thus since January 2, 1994, the Area Licensing Scheme has been extended to cover practically the whole day: from 7.30 am to 6.30 pm on weekdays, and from 7.30 am to 3 pm on Saturdays. This new policy as the Government argues, is due to increasing road congestion during the unrestricted hours. Average vehicle speeds during this period, especially in the afternoon, had dropped substantially from 30 kmh to 19 kmh. Traffic jams were beginning to appear more frequently and over longer periods of time.

The purpose of "the whole-day ALS" is to facilitate smooth traffic flows into the Central Business District throughout the day. It will encourage motorists to use alternative routes, if necessary. Some may also be encouraged to use public transportation instead. The net result will be a smoother and easier ride for all road users, motorists as well as public transport users.

In comparison with the policies of the West, the restriction of road users via high ALS

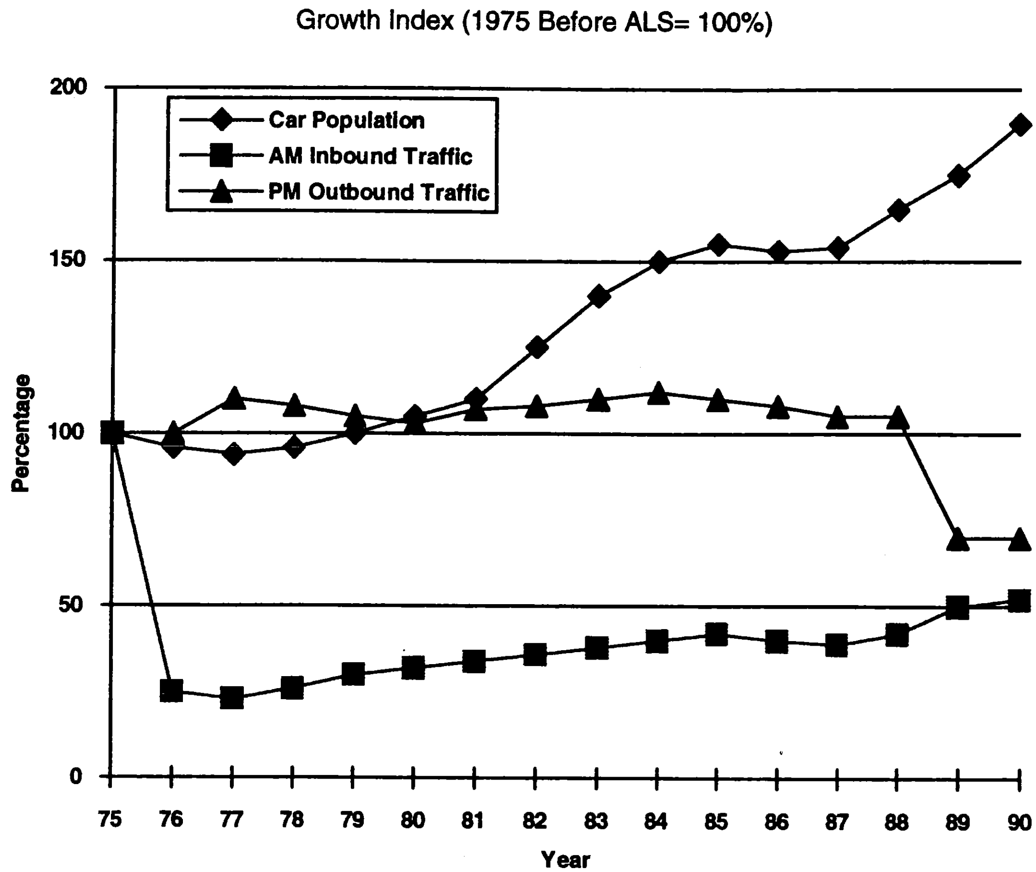


Figure 4.2 Effect of ALS on CBD Traffic in Singapore. (Source: Nanyang Technological University, Singapore, 1991)

prices may suggest an economically-excessive reaction to congestion by the Singapore authorities. It is, however, consistent with a long standing policy to restrict the growth of motor car use in Singapore. Indeed, as early as the 1970s the government had embarked on an aggressive policy of restraining the rapid growth of cars by increasing the cost of ownership, as will be addressed below.

4.2 Additional Registration Fee (ARF) and Preferential Additional Registration Fee (PARF)

Car ownership is a touchy subject in the island state, where a cross country drive takes just over half an hour and car prices can rival those of apartments. The different registration fees added to the price of a car are enough to drive away many potential car buyers.

The basic registration fee for a private car is $1000. Company cars pay five times as much. In addition to this, every car, whether new or old, is subjected to an Additional Registration Fee (ARF). Every motor car will be charged 150% of the open market value. The open market value of the vehicle is assessed by either the Custom Office or the Registry of Vehicles. There is also a Preferential Additional Registration Fee (PARF) system to encourage the replacement of old cars. Concerned that high prices for new cars would encourage motorists to keep their cars longer, thereby increasing the average age of motor vehicles and the frequency of breakdowns on the road, the government offers car owners a discount on the ARF on a new car if the old one is scrapped or re-exported before the end its tenth year. The PARF benefit is equal to eighty per cent of the open market value of car at the time of registration.

All vehicles are also subjected to compulsory motor vehicle inspection by the government. The frequency of the vehicle inspection varies with the type and age of the vehicle.

Paying the price of owing a private car in Singapore does not end with the purchase. The road tax on a 1600cc Mazda 323 is US$864 a year, many times what a typical subcompact car would be assessed in Canada or the United States. Cars that are ten years old or older are required to pay a ten per cent road tax surcharge for every year, again as an inducement to get older cars off the road.

As we have seen, Singapore has aggressively used pricing policies to discourage both the ownership and usage of cars, implementing one unusual experimental measure after another. However, with little tolerance for any sort of traffic congestion, the government did not perceive high prices to be a sufficient deterrent, because the demand for cars in Singapore appears to be more income than price elastic. For instance, in 1989, because of a booming economy, there was a 9.5 per cent increase in the car population over the previous year, a figure well in excess of the long-term average growth rate of 4.2 per cent, and much more than the average annual population growth of 1.4 per cent.

4.3 Vehicle Quota System

In view of the nation's land constraint, the number of motor vehicles on Singapore's roads must be controlled and kept below the level that the existing pricing mechanisms would allow. So on May 1, 1990, a quota system on new cars, the only one of its kind in the world implemented on such a scale, was imposed. All motor vehicles except scheduled and school buses are subjected to fixed allocations. Under this scheme, a vehicle can only be registered with a Certificate of Entitlement (COE), which is obtained through monthly tenders. The COE is valid for ten years from the date of registration.

For the purpose of bidding, vehicles are classified into eight categories. These are:

Category 1 Small cars, (1,000 cc and below).

Category 2 Medium-sized cars, (1,001-1,600 cc) and taxis.

Category 3 Big cars, (1,601 -2,000 cc)

Category 4 Luxury cars, (above 2,000 cc)

Category 5 Goods vehicles and buses.

Category 6 Motorcycles.

Category 7 "Open" (A COE issued for this category can be used to register any vehicle other than a weekend car).

Category 8 Weekend cars.

Successful bidders will pay the lowest successful bid price (quota premium) in the respective categories. COEs are valid for a period of three months after which it has no value. The COEs are also issued in limited quantities and private buying and selling of the COEs are legal. Although this scheme has been successful in controlling car purchases, it also created some problems. One of them was that the price was bid tremendously high, which allowed some people to earn profits at the expense of the others.

4.4 Weekend Car Scheme

On May 1, 1991, Singapore passed yet another unusual law to encourage the use of private cars only during non-congested periods. Called the Weekend Car Scheme, motorists are given financial incentives to use their private cars only from 3.00 pm on Saturday and the whole of Sunday and public holidays, and from 7.00 pm to 7.00 am on weekdays. The idea is for people to own cars, at lower and affordable levels of taxation, if they do not add to traffic congestion. The Scheme also allows better use of the roads during non-rush hours. It is a milder form of usage restraint which also helps to meet the aspirations of people owning cars.

Weekend cars are identified by special red licence plates with a tamper-proof nut and bolt wearing a security code. Their use is allowed at other times by displaying a special daily coupon, five of which are issued free annually. Additional coupons can be purchased at S$20 each. Enforcement is on a random basis. After the first offence, the minimum penalty for using a weekend car during restricted hours is equal to the full annual road tax. For the more serious offence of using a false normal license plate on a weekend car, the minimum fine is twice the annual road tax. To encourage normal cars to be converted to weekend cars to relieve road congestion during rush hours, a discount ranging between five to thirty per cent on the normal road tax (excluding the surcharge on cars 10 years old of older) is offered. Weekend cars can also be reconverted to normal cars, but the owners will be required to refund a pro-rated portion of the financial incentives.

All these experimental measures to slow down the growth of the car population and to control traffic flows have certainly resulted in relative clean air and fewer traffic jams in the island state. However, the Singapore experience, although quite successful in curbing the problem of road congestion, can still not be considered the best of all models.

The merit of the Weekend Concept is highly questionable. Most of the weekend cars, newly purchased and registered or converted from normal use, are either luxury cars now enjoying a 95 per cent rebate on the otherwise high road taxes, or the second or third cars belonging to affluent households. The distributional impact has therefore been widely perceived as unfair by the general public.

The Area Licensing Scheme may incur implicit scheduling costs for inconveniences caused when people retime their entry into the restricted zone because of the high fees. More troubling, congestion has shifted to just before and after the restricted hours, and has adversely affected those who chose to travel at the off-peak periods prior to the implementation of the ALS, and those who switched to buses contributed to increased travel times for all bus riders.

It may also be difficult to accept the argument that a whole-day ALS will improve the traffic flow. While it may even out traffic just prior or after ALS hours, it would attract traffic during peak hours. With whole-day ALS, the option and incentive to avoid peak hours would be removed. While the current system enables motorist with no urgent business in the Restricted Zone to rearrange their schedule outside ALS hours, a whole-day ALS would have them travel at their most convenient time: peak hours. They are peak hours precisely because many people find them a convenient time to travel, to get to work, open shops and to do business.

The quota system is an effective method of controlling levels of car ownership as the government can control the numbers of new cars purchased. But the more difficult question remains whether this control of ownership will be effective in limiting congestion given that the relationship between ownership and usage is uncertain. It is conceivable that owning a car does not create problems by itself, it is the use of a car on busy roads that adds to congestion. With time, the quota allocations will also increasingly lag behind the pent up demand for cars, bidding up the quota premiums. In fact, in less than 3 years since the implementation of the Vehicle Quota Scheme, the increase in COE prices has been astonishing, as shown in Figure 4.3. For the first 2 categories of vehicles, the COE prices have increased five fold since the scheme's introduction while the third category, prices quadrupled.

The weakness of the system is that it encourages people to bid more than they are actually willing to pay. They do so in order to make doubly sure that they succeed in getting the COE. Genuine car buyers would also suffer because the scheme could be abused either by car dealers forming cartels to corner the COE market, or by speculators out to make a quick buck, thus pushing up COE prices.

The attitudes of car buyers are slowly turning from disappointments to resentment with the increasingly unaffordable cost of car ownership in the country. Although examples abound with regard to the rationale of the quota system, how many Singaporeans actually understood concepts such as optimum land use, market forces or demand and supply? Public perception is not usually founded on rational economic grounds. While no one can fault this, it is a reasonable guess that the large majority of the motoring public cares not a hoot about the logic of it. In the end, what matters to them

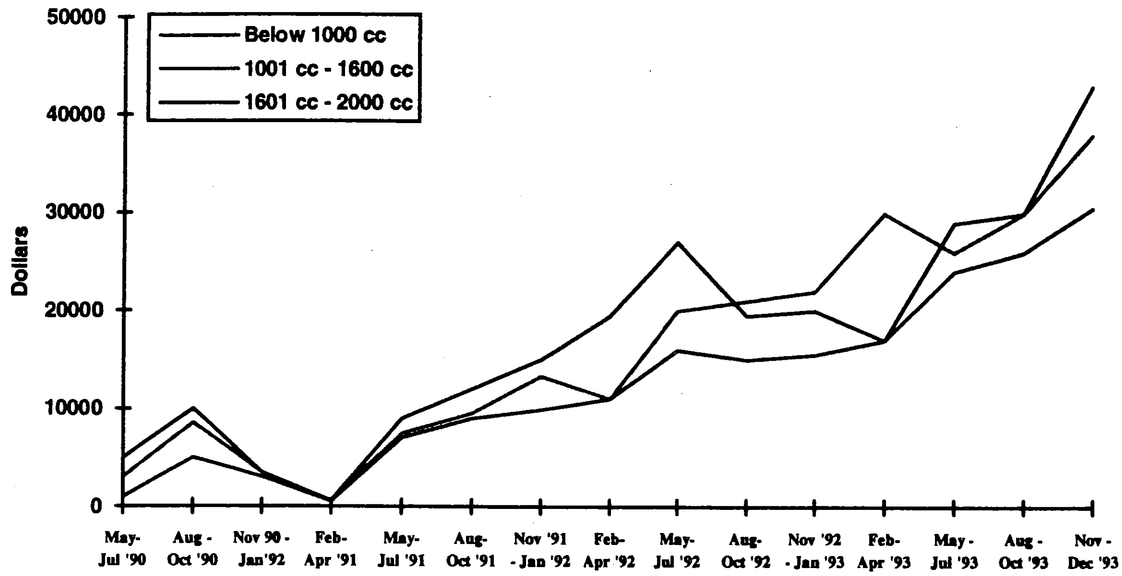


Figure 4.3 Growth of COE Prices in Singapore.
(Source: The New Paper, 1993)

is how much they have to pay. And if that is the yard stick, then the COE Scheme has been one bad experience.

In the Quota System, the free market principle is equally invalid as the supply factor in the supply - demand equation is not in its natural form since it is not controlled at the source, namely the car manufacturers, but arbitrarily by the government. It seems therefore inconceivable that genuine demand can change so quickly from month to month for COE prices to grow in double- digit percentages. The equity in distributing COE is equally suspicious because while the rich minority may be bidding higher prices, the majority of bidders or genuine buyers may be clustering below the lowest successful bid. The quota system is also cumbersome administratively for the government and inconvenient to the car owing public. It is also a drastic curtailment of legitimate middle class aspirations for car ownership.

The alternative to the Quota System, as the Government argues, like "hours caught in traffic jam, lost business opportunities and higher operation costs when goods get delayed or taxis make fewer and ferry less people" are hardly justifiable.[1]

Rental fees from transport firms have risen with the increase in COE prices. What is paid today is double what was paid two years ago. With the COE increases, some companies are postponing their plans to replace their aging vehicles. Furthermore, the construction, container and air cargo sectors have all been growing at up to 20 per cent annually, but the annual increase in the numbers of COEs has been only 3 per cent, not even enough to allow for replacement of old vehicles. With the high COE prices, transport

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[1] Source: The Strait Times, July 25, 1992.

firms will run their vehicles into the ground, and breakdowns will be more frequent.

What the high COE prices show, above anything else, is that the relative ease by which Singaporeans are able to travel on the roads, whether as car owners or bus commuters, comes at a very high price. The COE system makes the price transparent for all to see. What is not clear, however, is what the political price will be from disaffected motorists.

4.5 Conclusion

Singapore is an international commercial centre with an important and growing tourist industry. It cannot afford to have chaotic traffic conditions, as are found in Bangkok. The road congestion problem in the capital city of Thailand is so severe that in 1992 it had to declare a two-day public holiday during a World Bank/IMF meeting so that conference delegates would not miss their meeting due to traffic jams.

Unlike Bangkok, Malaysia or Indonesia where traffic jams are still tolerable because the capital cities contribute only 13 per cent to their Gross Domestic Product, in Singapore, the city is the whole economy and if the island has traffic congestion, the whole economy gets seized up and the state's productivity and competitiveness will also suffer.

There is a growing recognition in many countries that the problems associated with relentless traffic growth will get worse, and there is an increasing urgency for more effective solutions. Road pricing is one such solution.

The philosophy behind road pricing is simple - the user pays. This is fair and effective.

If we want something, we have to pay for it, and in this case, we pay for the cost of driving. This includes the cost of using a scarce resource like road space.

Many countries have charged this cost to general taxes. That is, everyone pays, motorists and non-motorists. This is undoubtedly unfair to non-motorists, and even to motorists, it makes no distinction as to who uses more roads.

There is no direct and transparent linkage between the motorist and the cost of driving. If we applied the same principle to the usage of, say, electricity or water and made everyone pay a flat rate, it would be disastrous. Nobody would conserve electricity because regardless of the amount they use, the cost is the same. The same argument holds for road space. Without proper pricing, motorists will not be encouraged to use the road sparingly. The repercussion will be gridlock and traffic jams.

What Singapore uses is the "user pays" approach. Non-motorists should not be made to pay for the cost of driving. Thus the Additional Registration Fee (ARF) and the Certificate Of Entitlement (COE) are taxes for vehicle ownership. Usage restraints such as the Area Licensing Scheme and Weekend Car Scheme are measures to restrain car use at peak hours, thus creating free flowing traffic.

In closer analysis, these measures, though effective in managing the demand for road space are still blunt instruments. For example the Vehicle Quota Scheme has no particular impact on motorists who contribute to congestion. Every motorist would pay the same price for a COE at monthly bids. The Area Licensing Scheme, though a better price mechanism, is still not the best model to ease traffic congestion. In particular, it is not flexible enough to be able to be extended to other areas of congestion.

An automatic alternative may be the final solution for the road pricing system. Electric Road Pricing is theoretically the most effective transport planning and traffic management tool available. Technology is evolving fast and it is now possible to install in each car an electronic device the size of a matchbox that will act as a road-meter. This clocks up a charge each time the car crosses an electronic strip in the road. So road-users can be made to pay according to the roads they use, the time at which they travel, and even the density of traffic around them. Technology has also swept aside many of the long standing objections to this option, such as practical feasibility and invasion of privacy. To see how it works, we shall discuss the topic in greater detail in the next chapter.

Chapter Five

TOWARDS THE FUTURE: ELECTRONIC ROAD PRICING AND RELATED TECHNOLOGIES

The Singapore experience in operating the Area Licensing Scheme has provided practical support for advocates of road pricing. The results of introducing entry licences have been an alleviation of road congestion and an increase in average traffic speed. London, fearing that its traffic might grind to a halt, is looking into several measures, among them a scheme similar to Singapore's ALS. The idea calls for cars with fewer than four people to require a licence before entering the city core. The closest any city has come to Singapore's ALS is found in the toll "ring" in Bergen, Norway (Traffic Engineering and Control, 1986, p. 83). Six toll gates are situated as strategic locations around its central business district. The 62,000 vehicles that pass through each way pay the toll. The reason for pricing its city, however, differs from Singapore's need to contain traffic congestion. It was the County Road Administration's way of getting more funds, for the funds allocated for the main roads have not kept pace with the growth in road traffic.

Cities are in a jam because there are too many cars. Countries are running out of roads. The building of more bypasses, underpasses, overpasses, roads, tunnels and flyovers are insufficient. The limitations of money, land and environmental considerations make it impractical to keep building roads at the same rate as the growth in traffic. In Seoul, traffic congestion woes persist with the car population growing by 12 per cent a year, far outpacing road expansion of 2 per cent a year. Land is a scarce commodity. The availability of land will act as a constraint on how many more roads we can provide. Furthermore, by building more roads and flyovers, we are postponing the problem. Experience has shown that when new roads are built, demand will quickly increase to fill up the newer capacity available. Building flyovers will only transfer the problem from one intersection to another. Finding ways to make more efficient use of our roads is a cheaper solution to road congestion than building more roads.

The long term solution is to manage demand through pricing our roads. We have seen from last chapter that the Area Licensing Scheme (ALS), though efficient, is not the best of models. It is labour intensive and not flexible enough to extend to other areas of congestion. It can be useful in Singapore's context but it cannot be easily transferred to other cities in the world. The geography of Singapore combined with the specific nature of its political system and social structure make transportation difficult. For other cities which are less compact than Singapore, the boundaries of the city centre may not be as easily defined. What Singapore revealed, however, is that road pricing can be transferred from theory to practice. The next option is can it be improved and enhanced in a way that is implementable in all cities? The answer, fortunately, is affirmative: it lies in Electronic Road Pricing (ERP), a practice that has already been used experimentally in another city state - Hong Kong.

5.1a Electronic Road Pricing in Hong Kong

Experimentation with ERP was first tackled by the Hong Kong Government in 1983. For many years, Hong Kong had experienced rapid growth in the use of motor vehicles and a serious spread of congestion. With a total area of 1065 square kilometres and a rapid population growth (from 3.1 million in 1961 to 5.34 million at the end of 1983), Hong Kong's population density is amongst the highest in the world. A subway was built in the hope that it would help solve the congestion problem. However, the mass transit railway, which carries 1.7 million passengers a day, did not stop the long queues of vehicles on the roads. Acknowledging the fact that further expansion of the transportation network was physically difficult, and considering fiscal measures like vehicle ownership restraints and registration taxes to be too crude, the government pioneered ERP, initiating a 21-month pilot study lasting from July 1983 to March 1985.

Compared to other methods of restricting vehicle use of congested roads (such as area licensing and parking charges), ERP is much more selective and flexible in achieving the objectives of limiting traffic in a specific area at a particular time. It forces motorists to adopt strategies in their travel behaviour by inducing them to choose other alternatives such as combining trips, changing routes, shifting travel time, or taking public transport. Commuters, for example, often know a variety of routes to travel to work and are alert to any changes that might give one route a slight advantage over another. Thus traffic congestion in a central area may be reduced at peak periods.

ERP systems avoid the problem of a blanket charge, a charge imposed without considering the frequency and time of usage, on vehicles entering the city centre, as in the case with area licensing scheme as used in Singapore. Under ERP, motorists will be charged according to the time and places where congestion needs to be curtailed. Commuters have the prerogative to evaluate their time and place of their trips to check if the journey is worthwhile taking. By this, the marginal trips will be reduced and the congestion level lowered, leaving other high-value and high priority vehicles running more smoothly. The charges on vehicles vary with respect to different congestion levels. As the system is automatically computerised, there will not be any physical toll booths which can hinder smooth traffic flows. In addition, the labour required in this system is small due to the system's automation.

The ERP system in Hong Kong used a form of automatic vehicle identification (AVI), in which each vehicle had an electronic number plate (the size of a video-cassette tape) which was mounted underneath the vehicle. Whenever a vehicle travelled past a toll site, an electronic loop buried beneath the road surface would collect encoded information about passing vehicles via the electronic number plates and transmit the date, together with the time and place, to a central computer. Charges, which were displayed at each charging point, could vary depending on the time and location of the toll site. The system sent a monthly bill to the motorist, giving a breakdown of the toll sites crossed, similar to a long distance telephone bill (see Figure 5.1). In addition, roadside closed-circuit television cameras automatically took pictures of vehicles with faulty or tampered number plated. The technical and economic feasibility of the ERP system, based on a true subset of the full system, was found to be above the performance requirement, attaining well over 99 per cent effectiveness and reliability.

To summarise, the ERP experiment in Hong Kong proved to be effective in reducing congestion by time of the day and location, because of its inherent flexibility. Private car travel was initially forecasted to be reduced by around 20 per cent in the peak hours and

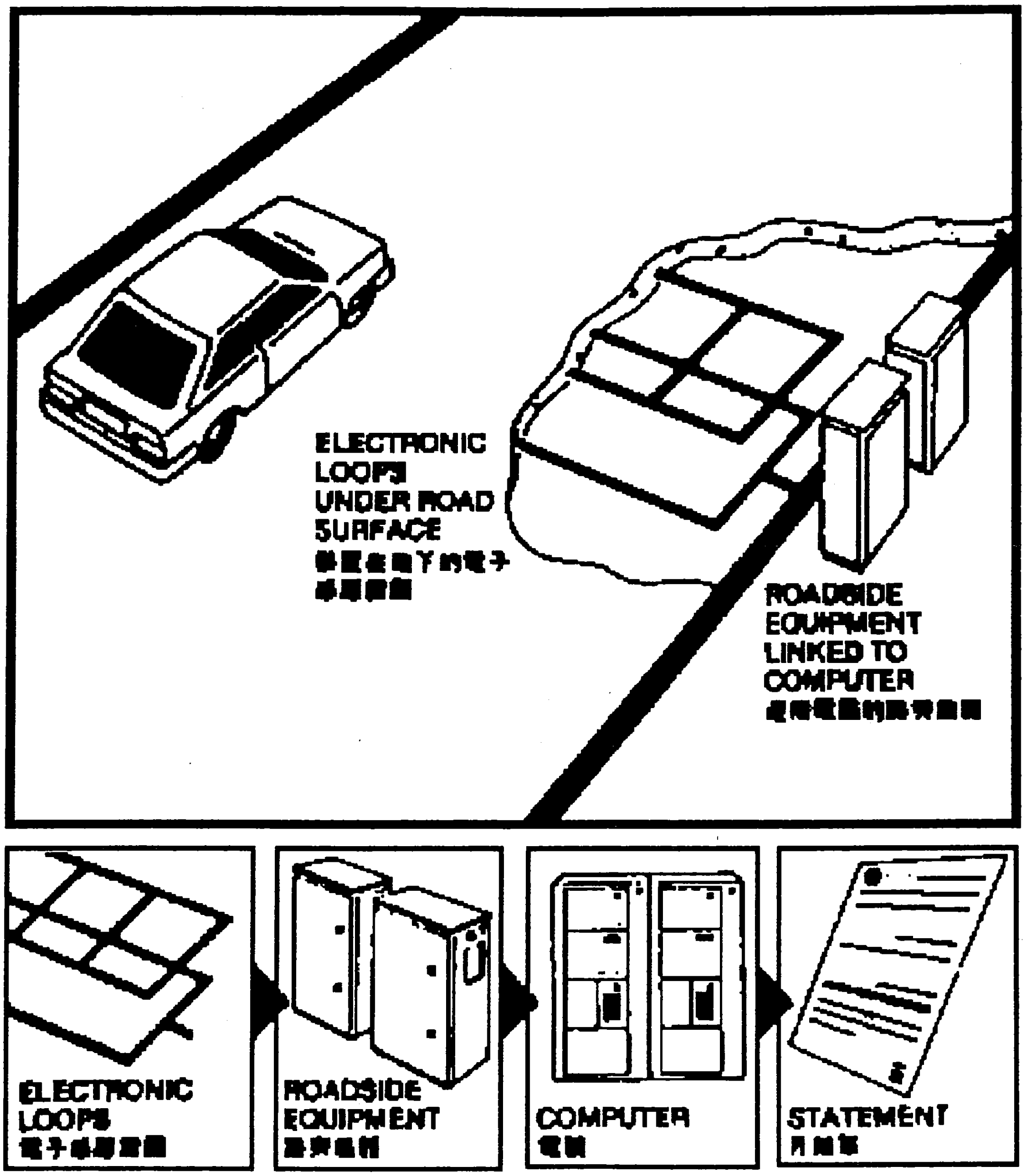

Figure 5.1 Electronic Road Pricing System Outline (Hong Kong)
(Source: Traffic Engineering and Control, December 1985)

9-13 per cent over the day. It was later found that traffic speed had increased significantly, particularly in the downtown areas. The considerable economic benefits largely accrued to public transport users and operators, and also to the high-value goods vehicle traffic and business traffic.

Though the impact of the scheme was positive, there were some political snags. Expensive roads hit drivers with low incomes much harder than rich ones. Sophisticated computer systems to track the movement of cars also posed a threat to the privacy of the individual. Because of strong political opposition, the Hong Kong government decided to postpone full implementation of the system until it was convinced that ERP was the only possible resort to solving the city state's congestion problem.

5.1b Electronic Road Pricing in Singapore

Despite Hong Kong's decision to abandon its experimental ERP system, the Singapore Government has shown immense interest in trying out ERP. Work is well underway to develop a custom-made system for the country. In April 1994, prototypes set up by several competing consortia will be thoroughly tested over a three-month period by the authorities to decide on who should be awarded the contract for a full system. The system finally chosen will employ a smart card to charge for road use. A stored-value card about the size of a credit card is slotted into a device attached to the vehicle. As the vehicle passes through a gantry point, a detector automatically deducts the cost of using the road from the card. If the vehicle does not have a card or if the card has insufficient value, this will activate a camera which snaps a photograph of the car (see Figure 5.2).

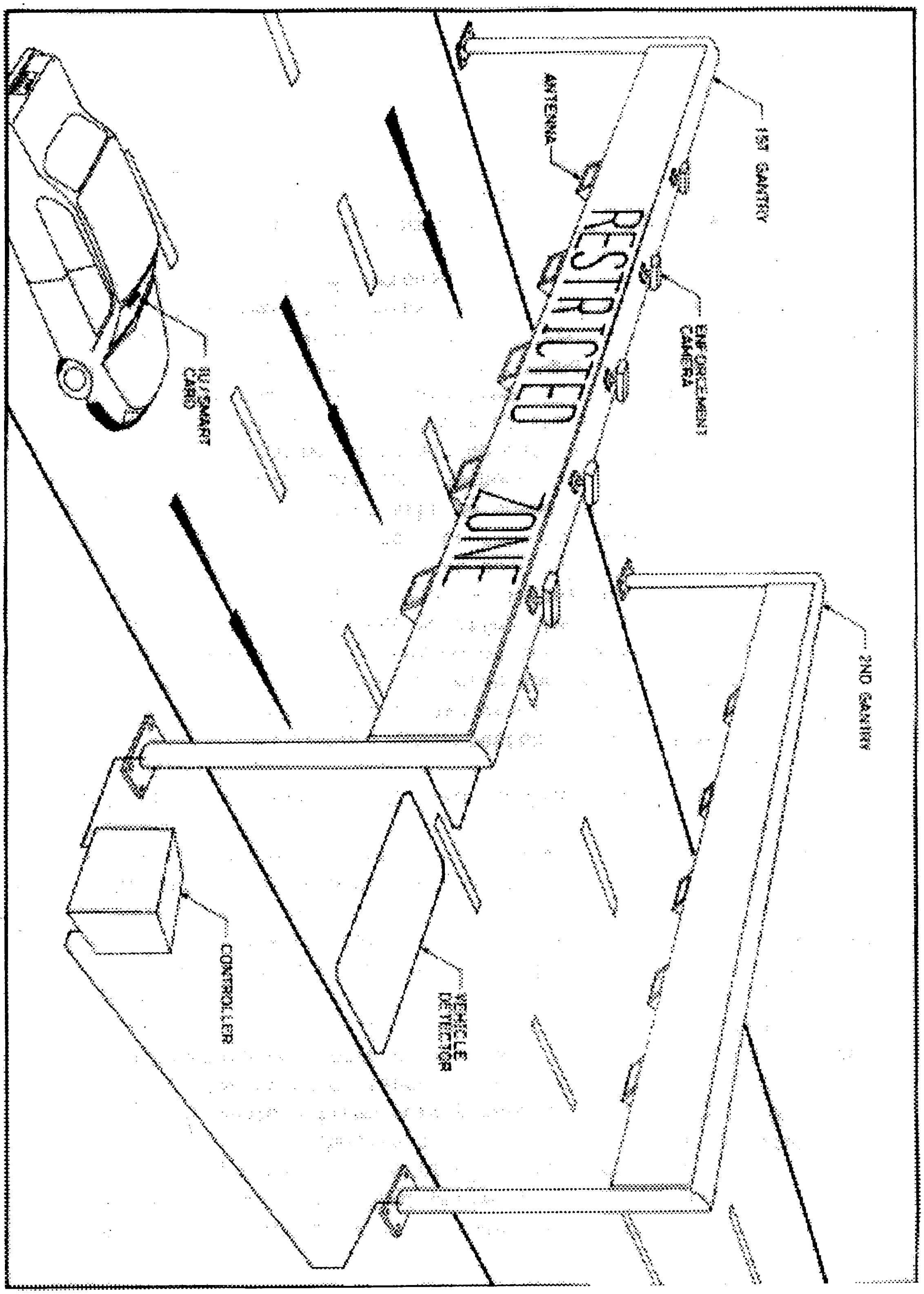

Figure 5.2 Electronic Road Pricing Entry Point (Singapore)
(Source: Public Works Department, Singapore, May 1993)

For any government that has the will and resources to deal with traffic problems, congestion free travel seems to be becoming possible. Many modes of travel control have now progressed beyond the drawing board as a result of the technological revolution and are being slowly implemented. The most developed of these technologies and their place of implementation will now be discussed.

5.2 New Technology in Traffic Control

5.2a JAPAN

The Japanese government and automobile industry are jointly testing several road automobile systems in which a monitor in the car tells the driver what route to take to any particular destination and what the traffic conditions are like. Experiments in some Japanese cities, moreover, have shown that car park guidance information alone has resulted in about 20 per cent more use of car parks and less illegal street parking, leading to less congestion and smoother traffic flow (PWD Report, 1993, p. 27).[1] On the Tomei Expressway, Japan's busiest motorway, the volume of traffic and its speed are monitored electronically in order to give drivers instant warnings about traffic jams and accidents. These are displayed on electronic signs which also advise on other things, such as when motorway service stations are crowded (The Economist, August 7, 1993, p. 71).

[1] Public Works Department (PWD) is a statutory board in Singapore.

5.2b UNITED STATES

Sensing technology has also made law enforcement easier when it is currently used in automatic speed-traps. On the I-95 interstate highway in the United States, between Pennsylvania and Delaware, trucks are checked to ensure they are not overloaded. Sensors are placed near the road to weigh the lorries automatically as they drive along and the overweight are photographed using the speed-trap cameras. (The Economist, August 7, 1993, p. 71).

5.2c BRITAIN

Here advanced roadside sensors are being developed which can obtain information directly from a vehicle's electronic tag, or automatic vehicle-identification (AVI) system. This device is so small that it may not even require a battery. Once a roadside beacon receive a radio signal, it can return a simple code that contains the identification of the vehicle. The system has proven to be affordable and effective. The Dartford bridge and tunnel complex, a toll-crossing of the Thames east of London, introduced such a scheme two years ago. Upon payment to open an account, motorists are given a credit card size AVI tag which they place on the windscreen. This tag allows a driver to zoom through special lanes without having to queue at a booth. The car is quickly identified by a radio which subsequently automatically deducts the toll from the driver's account (The Economist, August 7, 1993, p. 72).

5.2d Teleworking and Related Technologies

Teleworking has considerable potential to reduce traffic. The term "telework" means the substitution of telecommunications for the physical travel to one's conventional workplace. It is simply teleworking at home and communicating with the office through the telephone, facsimile machine, computer modem and electronic and voice mail systems. It is also called "telecommuting" because by working at home, teleworkers avoid making trips to work (or "commuting"). This leads to a reduction of peak hour traffic, thus relieving some of the urban congestion problem.

Teleworking has gained popularity recently, much credited to advances made in telecommunications and to the use of personal computers. In the United States, it is estimated that teleworking may reduce peak hour vehicle trips by about 5 per cent in less than 10 years (The Strait Times, September 18, 1993, p. 13). If the teleworking population keeps increasing at the current rate, this reduction of trips, especially the peak hour work trips, would bring a significant degree of improvement in the traffic situation.

For those condemned by circumstances to travel, another vision of the future is image processing technology. It promises to be so accurate that a camera will stimulate the human eye and make intelligent deductions on traffic movement. A control centre will collate all the data on traffic situations from the roads to give information to the driver, fed directly to a monitor in the vehicle. These advanced traffic management systems (ATMS) and advanced traveller information systems (ATIS) should be available for general use by the turn of the century.

Technology is also being developed to provide an automatic vehicle control system

(AVCS). This will not only automatically alert drivers of impending collisions, but would put a vehicle on auto-drive. As well as increasing levels of safety, the auto-drive will also increase traffic flow on heavily used roads because vehicles will be able to keep shorter spacings between themselves when moving (PWD report, 1993, p. 27).

Despite the promising of advances in the ATMS, ATIS and AVCS, it should be emphasised that electronic road pricing (ERP), which is shortly to be introduced in Singapore, is still a far more effective tool in curbing traffic congestion since it directly hits the motorist in the pocket. If you want to use the car, it will cost you, and this, in turn, constitutes a more powerful deterrent than does the mere provision of information.

5.3 Conclusion

Since the 1960s, economists have begun to revive the idea of pricing as a way of controlling traffic congestion. Its theoretical attributes have been well documented in the literature, but more recent developments to make it both technically and administratively feasible have placed it, once again, at the forefront of the transport planning agenda. The introduction of an electronic road pricing was pioneered by Hong Kong, and is now being copied by Singapore. Elsewhere, few governments yet seem at ease in copying either Hong Kong's or Singapore's traffic busting tactics. But easy options are running out. Sooner or later, officials will have to go beyond short term solutions and tackle traffic on all fronts. What Hong Kong's and Singapore's experience demonstrates is that given an appropriate institutional setting, such schemes can be made operational. And with the development of new electronic technologies, the traffic control menu from which government can choose is getting more varied and sophisticated by the day. Accordingly, some of the more easily digested are already being sampled.

Chapter Six

CONCLUSIONS

The last few decades have seen an astonishing growth in road traffic almost everywhere. Some cities have been afflicted by traffic choking their street for so long that they have reached "the point of absolute capacity". For most major cities, car population growth has always far outpaced road expansion. This has resulted in gridlock, frustration and money down the drain for the victims and administrators of traffic bottlenecks.

What governments did, for many years, to curtail congestion were to raise general taxes, and improve traffic management operations, such as by the optimisation of traffic signals and the encouragement of public transportation. These measures, though useful, can still not be considered as the most efficient instruments in ensuring smooth traffic flow at a consistent level. Furthermore, the price mechanisms in general tax increases are blunt instruments. They makes no distinction between those who use the roads more and those who use them less. Motorists who contribute often to congestion pay the same taxes as motorists who do not. These price mechanisms plainly fall short of providing either the optimum or even an equitable solution to congestion.

Despite the financial disincentives of car-related taxes, the car population is still growing. After a home, it is the second-largest purchase for many people (The Economist, October 17, 1992, p. 3). Cars are now as essential to many people as are their clothes. Traditionally, dog may be Man's best friend, but the car certainly seems to be competing more strongly for his affection. Today, our car markets are saturated with two-, three- and four- car families. In the coming decades, the main growth will come from Asia, Eastern Europe and Latin America. Eventually China, India and Africa will provide millions of new drivers (The Economist, October 17, 1992, p. 4). Increasingly heavy urban densities and a large inflow of labour to urban settings, in search of better job opportunities, will doubtlessly further aggravate the traffic situation here, lifting it to the intolerable conditions currently experienced in richer countries. Traffic congestion has also brought about negative externalities such as accidents, visual intrusion, pedestrian delay, and air and noise pollution.

Experience shows that building more roads simply encourages traffic growth leading to eventual congestion at absolutely higher levels of vehicles. In countries with good public transport, extra roads also suck people away from buses and trains, so more public spending on roads raises total travel costs. Finding ways to use our roads efficiently would therefore be a wiser solution to road congestion than building more roads. Governments and cities are now starting to listen to the economists, who have been, for years, advocating that road space is not a free gift to motorists which creates or adds to congestion. Road space is scare and valuable, and motorists should have to pay for what they are using. The idea is to charge all motorists who enter the city for the congestion their cars cause. This would discourage unessential journeys, increase traffic speeds and also raise money which could be used for improving public transport. The only city with a long term charging scheme is Singapore, which has received dramatic results in successfully preventing traffic jam and smog. The Area Licensing Scheme, however, does have drawbacks. It is labour intensive and may not be flexible enough to be transferred to other cities suffering congestion.

But electronic technology is making road pricing more sophisticated. Today, a more flexible system that can be easily modified as circumstances dictate, and that can accommodate the complexities of more differential pricing at various points in the road network, is technologically possible. Termed the Electronic Road Pricing (ERP) system, this is today's transport planning and traffic management at its best. The ERP system will help us finetune the pricing mechanism. Motorists who contribute to congestion often will pay more than commuters who do not. This way, we can shift the emphasis of our congestion control measures from ownership restraints to usage restraints. It will enable us to influence the usage of road over time and space. Electronic road pricing is now a technologically possible and an efficient tool for congestion management. Some inexpensive palliatives such as traffic engineering, parking restraints and the encouragement of public transportation can be beneficial in many situations. If necessary, selective additional highway building might be economically justified in some urban areas. However, if we want to continue to attract investment and to develop our economy, we must use our roads more efficiently and be more aggressive in mitigating increasing traffic congestion. For roads are like arteries. They carry blood to the vital organs. Cars are like cholesterol in the blood. One needs cholesterol for the proper functioning of the body. But too much cholesterol is bad. If there is a blockage, one may die of a heart attack.

The city state of Singapore has shown how to help the roads remain healthy and how to encourage an urban economy to flourish. For these reasons, its example is a concrete demonstration to the rest of the world that modern technology and economic theory, coupled with a resolute political will, can handily combat the congestion that elsewhere is often perceived as incurable.

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