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सचिव भारत सरकार
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D.O. No.K-14011/7/2007-UT-II(Pt.1)
Dated the 15th January, 2013

Dear Chief Secretary,

Sub: Introduction of Congestion Charging in central business areas/ Congested areas in Indian Cities.

It is a well-known fact now that now-a-days mobility in our cities either big or medium, is a huge challenge due to congestion during peak hours which is mainly due to excessive use of private vehicles. There is a need to resolve the congestion issues urgently for improving mobility of the people. The problem of congestion may be partly resolved by adopting Transport Demand Management (TDM) strategies to ensure that the economic development of our cities is decoupled from excessive motorization by encouraging investments in sustainable transports like Public Transport, Cycling and Walking and encouraging TDM policies like Parking Policy and Transit Oriented Development (TOD).

2. However, there may be certain core areas/central business districts(CBDs) in the cities where due to their demographical/ archaeological/business compulsions it is difficult to decongest them. In these core areas/central business districts, the cities may like to look at the option of "congestion charging" to ease out the traffic conditions. Excessive use of private vehicles on limited road space available is inefficient use of precious urban land. There is thus a need to discourage use of private vehicles in the selected core areas of the city to increase the mobility of the people at large so that they can reach their offices, workplaces, business centres, shops etc in time without losing valuable working man hours. This can be achieved by proper Traffic Demand Management and consequent levying of congestion charges on the vehicles entering the specified zone. The congestion pricing is premised on a basic concept; "charge a price in order to allocate a scarce resource to its most valuable use". It is also a human nature that if a good or service is provided free of charge, people tend to demand more of it-more wastefully-than they would if they had to pay a price that reflected its cost. However, providing a good public transport, pedestrianisation, cycling is condition precedent to introduction of congestion charging.

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3. In order that introduction of congestion charging is not opposed by public at large, it is important to seek their cooperation. Such cooperation can be best secured if the objective of any initiative is made clearly known to them. It is, therefore, necessary to launch intensive awareness campaigns that educate people on the benefits of the congestion charges on their health and wellbeing, on overall development of the city etc. It has to be sold as a part of the package of measures to address the transport problems of the city. The public has to be assured in a very transparent way that congestion pricing is not there just to fill Govt Coffers. Rather, money collected will be used to further improve the public transportation of the city, NMT facilities in the core area and to provide other infrastructure for them as road users. While the congestion pricing brings with it a dual advantage i.e. reducing traffic on the roads on one hand and generating funds on the other hand which can go towards improving alternative systems of transport, it may be a politically sensitive issue if not explained well to various stakeholders. Therefore, before introducing such type of schemes in India, it may be desirable to have political consensus and strong political will as well as stakeholders consultation and awareness workshops.

4. Though new to India, globally congestion charging is not a new concept. There are several cities world over where congestion charges in one form or the other are being charged from the private vehicle users since long. They include Singapore, London, Rome, Stockholm, Milan, Santiago-de-Chile, New York City and Seoul on bridges and tunnels for decongesting them. It may be desirable to study the congestion pricing system in these cities in detail, learn from their mistakes and devise our own method of decongesting the core areas/central business districts of our cities because no one-size-fits-all solution can be applicable to all the cities. (The case studies of two cities i.e. Singapore and London are enclosed for ready reference). The results of the congestion pricing in cities like London and Singapore etc has been quite impressive. For example the traffic in Central London went down by about 21% and the traffic speeds went up by about 10%. The scheme has to be simple and convenient to the people and at the same time the congestion charges have to be sufficiently high to work as a deterrent for excessive use of private vehicles.

5. There may be different ways for collection of charges. Most desirable and effective way now a days are electronic solutions including online payment, SMS payment, prepaid and based on vehicle identification either by cameras or boxes equipped into the cars. The cities may adopt any of the technologies depending upon the availability of funds and local conditions. To start with we may have the manual permit/coupon system as was done in Singapore when it introduced congestion pricing for the first time. These can always be upgraded at a later date. For example London has a congestion charge for about 20 sq km area focused on the city centre using automatic number plate recognition cameras at 348 entry sites around the city centre charging zone. Users then pay via website, text message or at specific stores. They incur heavy fines if they do not pay.

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6. Keeping in view the above background, I would request you to issue necessary instructions to all concerned authorities for identifying the most congested areas in their cities, getting a proper study done on various aspects of congestion charges as per city requirement and consider adopting "congestion charging system" as a measure to decongest a particular area/CBD, increasing mode share of cycling as well as public transport and increase the mobility of the people besides controlling pollution.

With regards,

Yours sincerely,

Encl: As above

(Sudhir Krishna)

To

The Chief Secretaries of all States/UTs

Copy to:

1. The Principal Secretaries of all States/UTs, Urban Development Departments.
2. The Principal Secretaries of all States/UTs, Transport Departments.
3. The Principal Secretaries of all States/UTs, Home Departments.
4. The Directors General of Police of all States/UTs.
5. NIC for uploading the advisory on MoUD's web-site.

21/1/13

(S.K. Lohia)
OSD(Urban Transport) &
Ex-Officio Joint Secretary

Central London congestion charging: understanding its impacts

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ABSTRACT

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The origins of a road user charging concept for central London and the development of the central London congestion charging scheme are outlined. The paper then explains the objectives and the main features of Transport for London's programme of impacts monitoring of the scheme. It summarises the main results that were obtained. Drawing on the extensive data from the monitoring programme, the paper then compares the patterns of congestion and traffic flows that were observed in the original scheme and in its western extension. This shows how congestion was initially eased as traffic levels were reduced and how it subsequently increased as the effective capacity of the road network was reduced or reallocated. The paper concludes with some reflections on the achievements of the charging scheme.

Keywords

- government,
- traffic engineering,
- transport planning

1. INTRODUCTION

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The concept of a congestion charge in central London goes back to the Smeed report (Ministry of Transport, 1964), prepared for the then UK Ministry of Transport. Smeed considered the merits of applying pricing to urban road traffic as a means of dealing with congestion.

The report argued that traffic congestion is the result of road users imposing delays on other road users and that excessive traffic congestion results in an inefficient use of the available road space and a loss to the wider community. This arises because the use of road space is not efficiently priced and so road users are 'immune' to the full cost of the delays they impose on other vehicles. Therefore charging drivers to encourage a more selective and appropriate use of available road space should lead to overall efficiency gains.

Nearly 40 years later, in February 2003, a road user charging scheme was introduced in central London by the mayor, Ken Livingstone, providing the UK's first real demonstration of the approach outlined in the Smeed report.

This paper outlines the scheme's development and introduction and explains the impacts monitoring programme devised by Transport for London as charging authority. It then reviews the overall traffic and congestion impacts of the scheme, which are likely to be of relevance to other central urban schemes. The transport, environmental, social and economic impacts of the scheme are also briefly considered, although the impacts here may be more particular to central London.

More information on the central London congestion charging scheme can be obtained from Transport for London's (TfL's) website. (See www.tfl.gov.uk/roadusers/congestioncharging/6722.aspx, in particular the annual Impacts Monitoring Reports that provide more information than can be set out here.) This paper attempts to distil the main implications from all of this background material and from unpublished data and analysis relating to the scheme.

2. DEVELOPING THE PRICING CONCEPT

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Following Smeed, there were explorations during the late 1960s and 1970s of several potential road user charging schemes in London, mostly in combination with wider traffic, transport or urban planning studies by the Greater London Council. The Greater London Council was abolished in 1986, but in the early 1990s the national government carried out the London Congestion Charging Research Programme (Government Office for London, 1995) which explored several potential charging schemes for central and inner London and looked at aspects of scheme operation using cordon charges. It concluded that congestion charging could be both feasible and worthwhile as a traffic management tool in London, but that there would be substantial technology, public acceptability and political risks surrounding the progression of any actual scheme in the medium term.

In 1998, the government published a white paper (statement of legislative intentions) setting out the proposed powers and responsibilities of a new mayor of London. This included powers to allow the implementation of road user charging schemes in London, and for the revenues to be retained by the charging authority to be expended on transport in London. This 'hypothecation' or retention of the revenues by the charging authority was an innovative aspect of the proposals, intended to make it more acceptable – both politically and publicly.

Meanwhile, the Government Office for London (a regional structure of national government) established a working group of technical experts to explore how a future mayor might use these proposed powers. The group became known as Rocol – road charging options for London. In March 2000 the Rocol group published its report (Government Office for London, 2000), concluding that an area-based charging scheme in central London, with camera-based enforcement, was potentially feasible, effective and likely to be publicly acceptable.

In May 2000, Ken Livingstone was elected mayor of London. His manifesto had included a commitment to consult on a potential road user charging scheme in central London making use of the technical proposals of the Rocol group. Moreover, his advocacy of a road user charging scheme distinguished him from other candidates in the first election for a mayor of London. Following the election and subsequent public consultation the mayor published his transport strategy (Greater London Authority, 2001) in July 2001 with detailed formal proposals for a congestion charging scheme in central London.

As the strategic transport authority created as part of the new governance arrangements for greater London, TfL was then charged with taking forward the development of the scheme. The central London congestion charging scheme was successfully introduced on 17 February 2003, less than 3 years after the mayor's election.

3. ESSENTIALS OF SCHEME OPERATION

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The original central London congestion charging zone covered 22 km^2 in the heart of London, including centres of government, law, business, finance and entertainment. There are relatively few residents in the original zone but it is the employment location for over 1 million people, most of them commuting by public transport. The western extension, introduced in February 2007, is comparable in size to the original zone. The area covered by the extended central London congestion charging zone is shown in Figure 1.

The area covered by the original scheme represents less than 2% of the total area of greater London and, within the area during charging hours, less than 2% of vehicle-kilometres driven within greater London. However, congestion in central London was severe during the working day, caused by high intensities of terminating and through traffic. Comparable characteristics also applied to the western extension, although both traffic volumes and congestion were somewhat less

intense than in the original central zone before the introduction of charging.

Of particular note from Figure 1 are the various boundary and 'free passage' route arrangements – no charge is made for vehicles using these routes. These are existing high-capacity roads that provide good alternatives for drivers making trips through central London who wish to avoid paying the charge. In particular, a 'free passage route' divides the two halves of the enlarged zone, allowing drivers to avoid paying the charge without diverting too widely around the outside of the enlarged zone.

Figure 1.

Click to view

Figure 1.

Extended central London congestion charging zone (not to scale)

The basic area charge was initially set at £5 per day for all chargeable vehicles, applying between 0700 and 1830 h on working weekdays only (revised in 2007 to 1800 h). The basic charge does not vary with distance driven, or the time of day at which individual trips are made.

Certain categories of vehicle, notably taxis, London licensed private hire vehicles, motorcycles, pedal cycles and buses, are wholly exempt from the charge. Residents of the zone can register for a 90% discount from the charge, and disabled persons who are blue badge holders and

drivers of certain alternative-fuelled vehicles are eligible for a 100% discount and pay no charge.

The scheme is kept under continual review by TfL, and various adjustments have been made to the scheme since it was introduced in February 2003. A charge increase from £5 to £8 in July 2005 was intended to maintain the benefits of reduced traffic in central London, although in the event it had relatively little effect on either aggregate traffic volumes or the consequent congestion levels in the original zone.

With the introduction of the western extension in February 2007, the two 'halves' of the enlarged zone function as a single 'extended' scheme, in that one charge payment confers the ability to drive in either of the component zones. Furthermore, residents of each zone benefit from discounted trips in either zone.

More recently, following his election as mayor of London in May 2008, Boris Johnson has proposed removing the western extension, subject to a public consultation and a revision to his transport strategy. The earliest that this could happen is summer 2010.

4. MONITORING THE IMPACTS OF THE SCHEME

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From the outset the mayor and TfL accorded a high priority to effective monitoring of the impacts of the scheme. In part, this reflected the high profile and controversial nature of the scheme at the time of its introduction. In promoting the scheme the mayor made it clear that, if it did not perform satisfactorily, it would be adjusted. Indeed this flexibility is a strength of any charging scheme: the hours of operation, the level of the charge; the definition of the charging zone; the details of exemptions; and the extent and nature of discounts can all be varied to reflect policy and operational considerations.

TfL's impacts monitoring programme also reflected a wish to capture and understand more fully the responses to – and the implications of – the UK's first major urban road user charging scheme. This meant more than simply recording the effects of the scheme, but seeking to understand how they arose, their implications for London more generally, and what would have happened in the absence of the scheme. Furthermore, although the monitoring work had a strong focus on the more immediate traffic volume and congestion impacts, it also included the important areas such as impacts on business, the economy, the environment, personal (social) circumstances and changed travel behaviour.

The result was a monitoring programme of a scale that had probably never before been attempted in relation to a single traffic management scheme. Findings from the monitoring work are set out in six annual monitoring reports - available from the TfL website. These build into a comprehensive appreciation of the main impacts and achievements of the scheme, the contents of each having a different emphasis, reflecting the evolution of the scheme. Table 1 gives more details.

Table 1.

Click to view

Table 1.

Content of TfL's Congestion Charging Impacts Monitoring Reports

Five important considerations underpinned the design of the monitoring work; they are listed here.

- (*a*) The need to balance requirements for an early view of impacts with the longer-term imperative to understand the mechanisms at work. An important – and somewhat surprising – finding was that the main traffic impacts to the scheme occurred and became established almost overnight. There was no prolonged period of 'adjustment', as had been envisaged before implementation.
- (*b*) The need for more than one robust measure of key quantities. Different methods each have particular features and there is rarely 'one simple answer'. In measuring congestion, for example, three different methods gave significantly different estimates of the absolute quantities involved, but very similar estimates of changes and trends.
- (*c*) The need to look outside the charging zone. Much of the benefits from the scheme, such as reduced traffic, road traffic accidents and emissions actually occur outside the charging zone, reflecting the combination of reduced traffic moving to or from the zone with diverted traffic moving around the zone.
- (*d*) Providing for the unexpected. The high media profile of the scheme in its early years meant that TfL had to be in a position to respond at very short notice to specific assertions and claims in the media. This particularly affected the impacts of the scheme on business – where the 'lagged' nature of key business and economy indicators made responding to assertions by those with 'inside information' very difficult.
- (*e*) Finally, a particular difficulty arises with the issue of what would have happened without the scheme. Central London is unique; it cannot be compared directly with anywhere else. Background conditions and influences are difficult to isolate but for many impacts these were ultimately perhaps the major factor in change; some effects are subtle and do not lend themselves to ready observation or measurement; and there was little understanding of the timescales of scheme impacts – how quickly or how slowly would the effects occur.

The results of the monitoring programme have added to knowledge of traffic and transport in London, but perhaps inevitably have also exposed issues that are still being examined and are not yet fully understood. Nevertheless the scheme and its monitoring have contributed significantly to an understanding of the general feasibility, effectiveness and acceptability of urban road user charging schemes.

5. MEASURMENT OF IMPACTS

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5.1. Measuring traffic volumes

Traffic volumes offered the most immediate manifestation of scheme impacts. Although there were several long-established indicators of traffic volumes and trends, traffic monitoring in central London prior to 2002 was surprisingly sparse and not ideal for scheme monitoring purposes. It was therefore necessary to set up an extensive system of new traffic counts, covering the main movements of interest.

The result was an initial system of 20 or so 'key indicators' of traffic volume change, generally organised along strategic counting cordons and screenlines, with some area-based (vehicle-kilometre) counts. Manual classified and permanent automatic counting methods were used in combination, exploiting the relative strengths of both methods. The overall scale of the traffic monitoring effort was unprecedented – involving about 130 permanent automatic sites and in excess of 1000 manual classified counts per year.

5.2. Measuring congestion

Measurement of the effect of the scheme on traffic congestion presented greater technical challenges – accentuated by the fact that the anticipated reductions in congestion of between 20 and 30% was the *raison d'être* for the scheme – and early feedback on whether this had been achieved was expected.

The first step was to increase substantially the frequency of the established moving car observer surveys in and around central London. Without changing either the established survey method or network coverage, which would ensure historical comparability, the frequency of the survey was increased 18-fold. Even this increased scale of coverage fell well short of what would ideally have been required. It meant, for example, that initial indications of scheme congestion impacts would not have been available for 3 months or so after implementation, and even then with unknown seasonal biases and a statistical error that could have been up to one-quarter of the expected scheme-related change.

The automatic number plate reading cameras, being used to enforce the scheme, provided another possible way forward. Cameras record the number plates of passing vehicles, making it possible to calculate average speeds based on successive vehicle transits – where both elapsed time and inter-camera distance are known. A camera-based system was, in the event, successfully developed; its role was primarily to provide very early indications of scheme congestion effects, and to be a longer-term backup indicator for the main (moving car) surveys. More recently, data from global positioning system (GPS) satellites have become available.

5.3. Secondary transport impacts

In addition to the traffic volume and congestion impacts, the monitoring work covered a range of 'secondary' traffic and transport impacts. These included understanding the impact of the scheme on public transport in central London – through 'displaced' former car users. In this context the congestion charging scheme needs to be seen alongside other elements of the mayor's transport strategy, which placed great emphasis on the improvement of bus services – both as an essential adjunct to the scheme itself but also reflecting a wider policy priority. Existing TfL data sources provided much of the information required here.

5.4. Wider social, economic and environmental impacts

Beyond the immediate impacts of the scheme on traffic, congestion and travel in and around central London there were a variety of wider potential impacts and issues. These ranged across aspects of the impacts of the scheme on individuals and households, on business and economic activity and on aspects of the environment such as air quality. Concerns over many of these had been raised by stakeholders as part of the scheme development process, and TfL needed to be sure that it was in a position both to understand these impacts and to address any issues that arose.

The main elements of the work included large-scale business and social impacts surveys, covering the behavioural, lifestyle, cost and adaptation aspects of the impact of the scheme on Londoners, with particular emphasis on 'potentially vulnerable' groups, such as 'key' and shift workers. The work also included assembly and secondary analysis of regional economic indicators, such as business turnover and retail sales trends, and analysis of trends in air quality in and around the charging zone, alongside scheme operational and enforcement details, which primarily arose from TfL's contractors for the scheme.

6. RESULTS OF MONITORING

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6.1. Traffic entering and circulating within the zone

In the first year of operation, traffic entering the original charging zone during charging hours was reduced by 18%. Traffic leaving the zone was reduced by 21%. There was a substantial shift in the mix of vehicles circulating inside the zone, with marked reductions of between 30 and 35% in cars (including minicabs or private hire vehicles); smaller reductions in vans and lorries; and increases in buses, taxis and two-wheeled vehicles.

Although remaining impressive figures, it is now clear that since the late 1990s there have been significant 'background' declines to traffic in central London. The introduction of the scheme added, albeit in a very substantial way, to a trend that was already established – and indeed continues.

Figure 2 gives more details of the traffic changes by main vehicle type. Black bars indicate conditions in 2002 before introduction of the original central London scheme; grey bars indicate conditions in 2003 and 2004 following the introduction; white bars indicate conditions following the increase from £5 to £8 for the basic daily charge from July 2005. Conditions reflecting the introduction of the western extension are indicated by hatched bars. Note also that historic data have also been

normalised to account for the change to the end of charging hours, from 1830 to 1800 h, since February 2007.

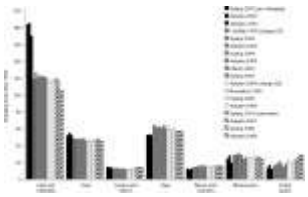

Figure 2.

Click to view

Figure 2.

Traffic entering the original central London congestion charging zone during charging hours (0700–1800 h), 2002–2007

6.2. Boundary traffic

Traffic on the boundary route for the original scheme has remained broadly stable, with an increase in traffic from vehicles diverting around the outside of the charging zone counter-balanced by fewer trips using the ring road for ‘dog leg' movements on radial trips to and from the charging zone. At the junctions around the ring road, which effectively control its performance, local increases in ‘orbiting' traffic are generally offset by decreases in radial traffic. The coordination of traffic signal settings around the boundary routes was improved by expanding the use of adaptive traffic control systems.

There was no evidence of significant adverse traffic volume impacts on roads in the ‘annulus' outside the charging zone, or outside charging hours. In general, traffic volumes in and around central London have tended to fall year-on-year, reflecting a now well-established trend of background decline.

6.3. Congestion inside the original zone

Comparing conditions in 2003 and 2004, immediately after the introduction of the original scheme with 2002 immediately before, as in Figure 3, congestion during charging hours within the charging zone was reduced by an average of about 30%.

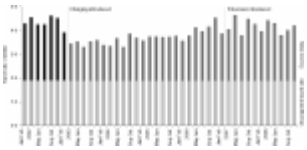

Figure 3.

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Figure 3.

Congestion in the original central London charging zone during charging hours

The decongestion impact was broadly similar across the peak and inter-peak periods, and much of the gains reflected reduced time spent stationary or in queues. This is an important point. Variations in journey times in dense urban road networks are largely determined by the time spent queuing at junctions. The reduced congestion, caused by reduced traffic levels, was mainly reflected in shorter queues at junctions with less time spent by vehicles stationary or in 'stop–start' conditions. Speeds moving between junctions did not materially increase.

Visible from the figure is the trend towards returning congestion in more recent years. This has been a considerable source of concern – as for some time the causes were not immediately obvious. Traffic was not returning to the zone, which would have reflected a diminishing deterrent effect of the charge, but was in fact continuing to decline slowly, reflecting background trends.

Analysis in TfL's sixth annual impacts monitoring report showed that a primary cause of increased daytime congestion was an increase in the

number and severity of road and street works, alongside other 'temporary' disruptions. There was also a more pervasive underlying trend towards reduced effective road network capacity – reflecting more 'permanent' interventions. These included changes to the number and timing of traffic signals, 'urban realm' schemes of various kinds, road safety schemes and changes to the mix of traffic and priority accorded to different vehicles. Although many of these interventions had beneficial effects in other respects, such as reduced road traffic casualties, much of the capacity 'freed up' by congestion charging had ultimately been reallocated, at the cost of returning congestion for charge payers.

This 'return of congestion' was seen in a more dramatic fashion following the introduction of the western extension in February 2007. As Figure 4 shows, congestion in the latter part of 2007 was at similar levels to that prevailing before the introduction of the scheme. Here, analysis suggested that one-third of the 'lost' capacity could be traced to the combination of a major but unfortunately located construction project and changes in the pedestrian facilities at a nearby traffic-signalled junction in Knightsbridge, with another one-third reflecting the replacement of Victorian infrastructure such as water mains – an acknowledged priority for London.

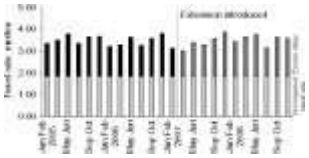

Figure 4.

Click to view

Figure 4.

Congestion in the western extension during charging hours, 2003 to 2008

The impact of congestion charging therefore needs to be assessed in this context. Sustained reductions to the levels of traffic in the central zone mean that, when compared to conditions that would prevail without the scheme, congestion charging is continuing to deliver congestion relief that is broadly in line with the initial percentage reductions experienced in the early years following the introduction of the scheme.

6.4. Use of public transport for travel to, from and within central London

In the first year of the operation of the scheme, passengers entering the original central charging zone by bus increased by around 37% during charging hours. Up to one-half of that growth was estimated to have reflected displaced car users transferring to the bus network because of the charge. The remainder of the growth reflected wider improvements to bus services – a major policy priority of the then Mayor. On the Underground, the economic slowdown of 2002/03 complicated assessments and the aggregate number of passengers at charging zone stations actually fell in the short term.

6.5. Other key impacts

The scheme contributed to safer roads. It is estimated that the lower volume of circulating vehicles in the original zone and its boundary route directly leads to between 40 and 70 fewer reported personal injury road traffic collisions per year. This is against a wider backdrop of substantial year-on-year falls in reported road casualties, at least in part due to wider Mayor's Transport Strategy initiatives. It is too early to judge whether a comparable effect has occurred in the western extension.

The central London economy has performed strongly since the introduction of charging. This was an area of particular concern with the original scheme. Contrary to the expectations of some commentators, the growth in the profitability of the retail sector in central London has been comparable to that seen more widely across London, and recent growth has been roughly twice the national rate. With the benefits of

hindsight and the data from a wide variety of sources, there is no evidence that the £5 or £8 charges have affected the aggregate economy of central London.

Charging has contributed to reduced emissions of pollutants and greenhouse gases. Reduced traffic levels and improved driving conditions led to a relative improvement in ambient air quality against that which would have prevailed in the absence of congestion charging. It was estimated that congestion charging had been directly responsible for reductions of 8% in oxides of nitrogen (NO_x), 7% in fine particulate matter (PM_{10}) and 16% for carbon dioxide (CO_2). These figures related to an annual average 24 h day for all emissions from road traffic only.

The scheme has produced net revenues to support the mayor's transport strategy. These have been of the order of £100 million per year and have been reinvested in furthering other elements of the strategy, predominantly on improvements to London's bus network.

7. DEVELOPMENTS TO THE ORIGINAL SCHEME

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7.1. Increase to the daily charge from £5 to £8

The increase in the daily charge from £5 to £8 from July 2005 was intended to maintain the benefits of reduced traffic, although TfL projected that the incremental change to traffic and congestion resulting from this change would be proportionately less than that arising from the imposition of the original £5 charge in 2003. In the event, the charge increase took place in the same week as the July 2005 bombings in central London, which caused substantial short-term disruption to the transport networks and created difficulties for the monitoring of the impacts of the change.

Longer-term, however, TfL was able to detect only small aggregate reductions to the amount of traffic in the zone – certainly of a smaller magnitude than initially anticipated – and proportionately much smaller

than the initial adaptation to the £5 charge. Two factors appear to explain these effects. The increased charge had a smaller effect on the terminating traffic and virtually no further effect on through traffic; and the consequent more limited congestion reduction appears to have been largely subsumed in the wider trend, prevalent throughout 2006, towards increasing congestion in the charging zone.

7.2. Impacts of the western extension

The western extension was introduced in February 2007, with no significant operational or traffic problems. Traffic entering the extension zone has consistently been between 10 and 15% less than previously, with commensurate reductions in circulating traffic and traffic approaching the zone, as illustrated by Figure 5.

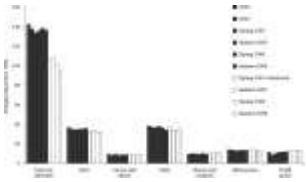

Figure 5.

Click to view

Figure 5.

Traffic entering the western extension zone 2003 to 2007

Table 2, which is primarily based on a combination of traffic model assessments and observed data, represents TfL's 'best assessment' of the changes resulting from the western extension.

Table 2.

Click to view

Table 2.

Summary of traffic changes from the western extension

8. COST OF IMPOSED DELAYS

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In terms of its congestion impacts the scheme has provided a very practical illustration of the economic theory of road user charging. Prior to charging, traffic was moving around the central zone at a typical network speed of about 14 km/h. This equates to a travel rate of around 4·2 min/km. Somewhat more than half of this travel rate was caused by 'congestion' – the additional delay experienced by all vehicles because of the presence of other vehicles.

Network speed can generally be assumed to be linearly related to network flow, with average speed, s, in km/h equal to s_0 at zero flow. Such a straight-line relationship was used in the calculations in appendix 2 of the Smeed report, citing earlier work by Wardrop (1952). A clear observed example of the relationship was demonstrated in central Glasgow (Owens and Holroyd, 1973). Then it can be shown that the delay in hours imposed by a kilometre of travel by a marginal vehicle on all other vehicles is given by

$$\text{Imposed delay} = (s_0 - s)/s^2$$

From this, the marginal vehicle-kilometre in central London before charging was imposing additional delays shared across all other vehicles of about 5 min.

Typically a vehicle might travel 5–10 km within the original charging zone per day, and an average value across all vehicles for losses or savings in travel time might be around 40 pence/min. This implies that before charging, each vehicle imposed costs on the other vehicles inside the charging zone of around £10–20 per day.

When charging was introduced the network travel rate reduced to about 3·5 min/km, so that each vehicle saved around 0·7 min/km of delay. The imposed travel rate of the marginal vehicle fell to less than 3 min/km, equivalent to about £6–12 for vehicle travel of 5–10 km inside the zone.

This value broadly represents the value of the delay that each vehicle using the zone is imposing on other users. A driver unwilling to pay this level of charge would have gained less from using the zone than the delay costs that they would have imposed on others.

9. EFFECTS ON CONGESTION

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Paradoxically perhaps, the more recent trend towards increasing congestion has helpfully demonstrated some underlying characteristics of how the network operates.

Figure 6 shows – to the same scale – the average network speeds in the central zone and the total traffic entering and leaving each zone. This is in effect a combined presentation of the data that inform Figures 2 and 3 for the original central zone, together with the comparable data for the western extension.

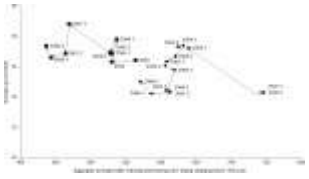

Figure 6.

Click to view

Figure 6.

Evolution of average traffic speeds inside the congestion charge zones and traffic crossing the zone boundaries

Speeds inside each zone have been averaged from the surveys carried out every 2 months to give a total of 12 observations per direction on each surveyed link in each 6-month period. The traffic flow data are derived from the manual classified counts undertaken in the spring and autumn of each year at all entry and exit points to the charging zones over a 6-week period, approximately in the middle of each 6-month round of speed surveys, recording all vehicle movements into and out of the zones. Observations of vehicles have been converted to passenger car units (pcus).

Ideally, the flow inside each zone, measured as vehicle-kilometres, would be used in this analysis. However, this is difficult to measure accurately given the size of the zones. As only a relatively small proportion of traffic is generated within each zone, the boundary crossing traffic is used as a measure of traffic activity.

The annotation 2002-1 refers to the conditions observed in the first six months of 2002 (January–June); 2002-2 means the conditions observed in the second half of 2002 (July–December). The original charge, introduced in the central zone in February 2003, resulted in boundary crossing traffic reducing from around 745 000 pcus in 2002 to 640 000 pcus in the first half of 2003, and traffic in the zone travelling about 20% faster. (January 2003 and early February 2003 data, immediately pre-scheme, have been ignored in assembling data point 2003-1.)

However, between 2004-1 and 2006-2, while boundary flows remained in the region of 620 000 to 650 000 pcus, average speeds declined from over 17 km/h to almost 14 km/h, with deteriorating conditions

particularly evident during 2006-2. From 2006-2 to 2007-2, average conditions were apparently steady, albeit with speeds having returned to pre-charging levels. Between 2007-2 and 2008-2, average boundary flows declined by around 10% with an indication of significantly improved speeds in 2008-2.

The congestion charging scheme was extended westwards in February 2007. Figure 6 again shows the evolution of average speeds inside the zone and boundary crossing flows for the western extension, starting from observations in the years prior to the extension scheme – although not to the same level of precision for 2003 and 2004. The figure then suggests an apparent reduction in effective capacity between 2006-1 and 2006-2, prior to the introduction of charging in the future extension zone, matching a corresponding reduction in the original zone during the same period.

The effect of charging in the western zone is evident from the decline in traffic levels from 2006-2 to 2007-1, the corresponding increase in traffic speeds from around 17 km/h to around 19 km/h. In the second half of 2007, however, most of the benefits gained from charging were effectively lost with speeds returning to pre-charging levels even with the reduced level of traffic entering and leaving the zone having been maintained. In 2008-1 and 2008-2 comparable effects to those observed in the central zone are evident from the observations in the western extension. A further decline in the volume of traffic entering and leaving the zone was followed by a small increase in speeds.

The striking similarity in the patterns suggests that the underlying trends are being reliably demonstrated: that the initial reduction in traffic flow inside each zone brings about an improvement in speeds; that this improvement gradually deteriorates; and that a period of broad stability was reached around 2007-2, with average speeds back to pre-charging levels, followed by something of an upturn in speeds with flows declining from 2007-2 to 2008-2.

9.1. Interpretation

Figure 6 illustrates the interaction between 'supply' effects (the speed of traffic, as a function of the demand) and 'demand' effects (the change in demand, as a function of the speed of traffic).

- (*a*) Supply effects depend on the network. If the network capacity stays constant, then as demand reduces due to charging then speeds increase.
- (*b*) Demand effects depend on the underlying demand to drive. It is affected by congestion charging. If the underlying demand to travel stays constant, then as the network gets slower, fewer people will want to drive on it.

In Figure 6, the initial effect of charging is to reduce demand. Road supply is unchanged. So the jump between 2002-2 and 2003-1 for the central zone demonstrates the supply elasticity: the change in speed of traffic with respect to the flow. The arc elasticity of speed with respect to flow is −1·2. The corresponding value for the western extension, from 2006-2 to 2007-1, is −0·9. These values are close to the value of about −1·0 that other studies of traffic in central London have indicated.

Once charging has been introduced, the fall in speed and flow for both areas indicates a fall in the network capacity. If the underlying demand is assumed to be constant, the fall in speed indicates a change in the supply. This indicates an arc elasticity of demand with respect to speed of 0·8 in the central zone and of 0·9 in the western extension. Again, these values agree with a value of about 0·8 indicated in other studies in London. The agreement supports the assumption that the change in conditions since the introduction of charging is due to a change in supply – that is, a fall in network capacity.

The fall in both speed and flow since the start of charging has, as Figure 6 shows, shown a tendency for speed to fall more than flow in the first year or two, and for the fall in flow to occur later. This may be at least partly because supply effects are instant, but demand effects take time

as drivers gradually change travel behaviour in the light of the slower speeds.

The fall in network capacity since the introduction of charging can be expressed as the change in flow that can be carried by the network for a given speed. In the central zone, the line joining the point at 2002-2 (prior to charging) to the point at 2003-1 (after charging was introduced) enables an estimate to be made of the flow that could have been carried prior to charging at, for example, the 2008-2 speed of 15 km/h. This would be in the region of 720 000 pcus/day. The actual flow at 2008-2 was 570 000 pcus/day: 20% lower. So there has been a net loss of about 20% in effective network capacity for road vehicles in the period between 2004 and 2008. Similarly the western extension saw a loss of 15% of effective network capacity in the 18 months after charging started.

The potential causes of additional delay on the two networks have been considered in the Congestion Charging Annual Monitoring Reports, and mentioned in Section 6 above.

10. REFLECTIONS ON THE ORIGINAL SCHEME

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More recent TfL monitoring reports have been able to give a longer-term evaluative perspective on the experience with charging in central London, such that it is possible to offer several reflections that will be of wider relevance.

First, the London scheme, with its various developments, has confirmed that charging is practically feasible. It has also generally confirmed the methodologies and theoretical basis behind the concept of road user charging. Initial fears of gridlock outside the zone, mass public confusion and economic desolation have been proven to be unfounded. Taking a longer-term perspective, the advent of charging can be seen as simply another evolutionary step in urban transport planning.

Second in terms of the potential wider applicability of charging, central London was in some respects a particularly suitable candidate. Congestion levels were very high. It is very well served by public transport, and travellers displaced from car to public transport would not overwhelm the capacity of the public transport system. It had a manageable proportion of through traffic. The political decision process, under an elected mayor, was straightforward. Other cities will have different characteristics, notably in terms of public transport provision and political structures, and these will be critical in determining the application and the more detailed nature of any future local schemes.

Third, while the charging arrangements in central London may have been a significant development for transport planners, and for certain individuals who may be directly or disproportionately affected, ultimately it operates in a wider backdrop of potentially more pervasive trends and influences. Most Londoners are not significantly affected by the scheme, and the economic prosperity of central London clearly owes much more to global events and the vagaries of the wider economy than to an incremental change to the relative costs of private vehicle travel which is used by less than 10% of visitors.

In retrospect the impacts attributable to congestion charging have tended to accentuate positive trends, such as reduced emissions or fewer accidents; or to reverse a negative trend, congestion; or, arguably, to have had a neutral impact on a cyclical trend, economic activity. Meanwhile, the experience with returning congestion in both the original central London charging zone and the western extension shows that scheme benefits need to be closely managed – and that the priorities for the allocation of scarce road space need to be both thought through and clearly articulated.

Fourth, Mayor Livingstone recognised the importance of monitoring – and the transport planning community is now much better off for it. TfL's published information, comprehensive as it is, is nevertheless merely a

summary of a much wider body of knowledge and experience, which will be of long-term value. Charging in central London not only represents one of the biggest and most ambitious transport monitoring programmes but also one that has been actively used to refine and develop policy – and one that has been seen through to a logical conclusion, and its results published.

Finally, the technology for operating the scheme is well ahead of what could have been considered by Smeed and his panel – but somewhat behind what is now technically possible. But the principles that they described governing traffic flows and the economics of road traffic congestion are unchanged, and have now been applied in the centre of one of the world's leading cities. This is perhaps the greatest impact of the original scheme: it has shown that the principles of congestion charging are sound and that practical schemes are possible.

DISCLAIMER

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The views expressed here are not necessarily those of Transport for London.

ACKNOWLEDGEMENTS

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REFERENCES

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1. Government Office for London. *The London Congestion Charging Research Programme.* London: Her Majesty's Stationery Office; 1995.

2. Government Office for London. *Road Charging Options for London: A Technical Assessment.* London: Her Majesty's Stationery Office; 2000.
3. Greater London Authority. *The Mayor's Transport Strategy.* London: Greater London Authority; 2001.
4. Ministry of Transport. *Road Pricing: the Economic and Technical Possibilities.* London: Her Majesty's Stationery Office; 1964. Report of a Panel led by Dr R J Smeed.
5. Owens D, Holroyd J. *The Glasgow Experiment: Assessments under Light and Very Low Flow Conditions.* Transport and Road Research Laboratory; 1973. Report LR522.1973.
6. Wardrop JG. Some theoretical aspects of road traffic research. *Proceedings of the Institution of Civil Engineers, Engineering Divisions.* 1952;**1((3))**:325–62.

Two decades of congestion pricing in Singapore

(Presented at the 8th Conference of the Road Engineering Association of Asia and Australasia in Wellington New Zealand 1995)

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1. AIM

Singapore was the first city to introduce road congestion pricing in 1975. It works on the principle that motorists pay for the use of road space at times and at places when and where they cause congestion. It has been modified many times over the course of two decades, to cater for the changes in traffic patterns. This paper describes the congestion pricing scheme called the Area Licensing Scheme (ALS), the reasons for the many modifications, lessons learned, and its future.

2. HOW CONGESTION PRICING FITS IN

Singapore has an overall transportation strategy which consists of :

* Integrated landuse and transportation planning;

* Provision of a good road network complemented by good traffic management;

* Improvement to public transport; and

* Traffic Demand management

Congestion pricing falls under "demand management".

Summary of changes of ALS for the period 1975-95

Date	Changes			
	Restricted vehicles	**Restricted hours**	**Restricted Zone area**	**Licence Fee**
2nd June 1975 (Morning ALS)	Cars, Company cars	7.30am-9.30am On weekdays and Saturdays	610 ha	Cars $3 daily $ 60 monthly Company cars at double the price Carpools and all other vehicles exempted
23rd June 1975		7.30am-10.15am on weekdays and Saturdays		
1st August 1975	Taxis included			Same fee as cars Taxi pools exempted
1st January 1976				Cars and taxis $4 daily $80 monthly Company cars double the price
1st April 1977				Taxis $2 daily $40 monthly
1st March 1980				Cars $5 daily $100 monthly Company cars double the price
1st February 1984			630 ha (Cairnhill Road area included)	
1st November 1986			715 ha (Marina Centre included)	
1st June 1989 (Morning and Evening ALS)	All vehicles (other than motorcycles, public scheduled buses and emergency vehicles included)	7.30am-10.15am on weekdays and Saturdays and 4.30pm-7.00 pm on weekdays		Car and taxi pool exemption removed $3 daily for all vehicles $60 monthly for all vehicles Company cars at double the price
1st July 1989	Motorcycles			Motorcycles

	included			$ 1 daily $ 20 monthly
1st December 1989		7.30am -10.15 am on weekdays and Saturdays and 4.30pm-6.30pm on weekdays		
1st September 1991			720 ha	

1st January 1994 (whole day ALS)	All vehicles (other than public scheduled buses and emergency vehicles)	Peak period 7.30am-10.15am on weekdays and Saturdays 4.30pm-6.30pm on weekdays Off-peak period 10.15am-4.30pm on weekdays 10.15am-3.00 pm on Saturdays		Whole day licence Motorcycles $1 daily $20 monthly Other vehicles $3 daily $60 monthly Company cars double the price of other vehicles Part day licence Motorcycles 70c daily $14 monthly Other vehicles $2 daily $40 monthly Company cars double the price of other vehicles
1st May 1995		Peak period 7.30am-10.15am on weekdays and Saturdays 4.30pm-6.30pm on weekdays Off-peak period 10.15am-4.30pm on weekdays 10.15am-2.00 pm on Saturdays		

3. DESCRIPTION OF THE AREA LICENSING SYSTEM (in 1995)

The congestion pricing system is called the Area Licensing Scheme (ALS). An imaginary cordon has been placed around the most congested parts of the city, termed the Restricted Zone (RZ), an area of 720 ha. Each of the 33 entry points to the RZ has an overhead gantry sign with the word "Restricted Zone". To enter this area during the period of 7.30am to 7.00pm on weekdays and 7.30am to 2.00pm on Saturdays, vehicles other that public scheduled buses and emergency vehicles need to purchase and display an area licence. These paper licences which come in daily and monthly forms have to be displayed clearly on the vehicle windscreens, or on special holders on the motorcycle handle bars. There are two types of licences, the wholeday and the partday (off-peak) and for three categories, namely motorcycles, company cars and others. The licences are distinguishable from each other by shape and colour. Licences are available at post offices, convenience stores, petrol stations and at special licence sales booths set up along the approach roads to the RZ. They cannot be purchased at the entry points. Police personnel are stationed in sentry huts at the entry points. They observe whether the vehicles are displaying the correct area licences as they pass the entry points. Offending vehicles are not stopped, but their particulars are taken down and they will receive a summons sent to their addresses for entering the RZ without a valid licence. The penalty is $70. Escape routes are provided at the main entry points to ensure that vehicles are not forced unwittingly to enter the RZ. There is no policing within the RZ. Vehicles are free to move around and leave the RZ.

Wholeday licence can be used for entry during the whole of the restricted period between 7.30am and 7.00pm on weekdays and 7.30am and 2.00pm on Saturdays. Partday licence can only be used for entry between 9.30am and 4.30pm on weekdays and 9.30am onwards on Saturday.

4. WHAT HAS ALS ACHIEVED?

Since 1975, the city area has grown by about 30% in terms of area with increases in employment and commercial activity. The vehicle population has increased by 245% from 276,866 at beginning of 1974 to 677,818 in mid-1997 over the same period. Yet traffic conditions in the city roads are better than what it was in 1975. The current average traffic speeds in the city during the working day varies from 26 kph to 35 kph, as compared with about 15 kph to 20 kph prior to implementation of ALS.

In 1975, the public transport share of the work trips to the city was 46%. Today it is estimated at 67%. With the gradually increasing patronage, public transport operators have been able to improve their services.

There has been a fundamental shift in the attitude to the car. True, that the car is still a much-sought after commodity by many, but public transport has become a respectable and acceptable alternative.

5. LESSONS LEARNED FROM THE OPERATION OF THE SYSTEM

The ALS has brought many benefits to the transportation system in Singapore. But there are many lessons that we have learned from its operation. I will now discuss the main lessons learned from hands-on experience in the operation of the ALS.

5.1 Need To Shape Public Opinion

While people expect to pay for the use of water and electricity, paying for the use of road space is anathema to them. Traditionally, roads have always been seen to be public places where everyone has the right of free usage. Therefore, much work had to be done in the beginning to explain the rationale for charging for road use (or congestion pricing). It had to be sold as a part of a package of measures to address the transport problems. The public had to be assured that congestion pricing was not there to fill government coffers, but that alternatives would be offered for those affected. These include the improvement to public transport and some provision of alternative acceptable unpriced roads. After having announced these, the public had also to be convinced by seeing that the alternatives would be provided.

5.2 Make The Scheme Simple And Convenient

The motorist had to find the scheme to be easy to understand and use. The use of paper licences that were readily available at many sales outlets made it convenient for the motorists. All that the motorists had to do was to affix the licence by a sticker to the windscreen or to a holder on the motorbike. There was nothing else for him to do.

The control points were clearly demarcated and sufficient advance warning signs put up. At all major points, escape routes were provided to ensure that motorists were not forced unwittingly to enter the RZ. Signs were also put up to warn motorists that they were leaving the RZ.

5.3 Enforcement To Be Simple, Fair And Effective

Any scheme is only as effective as how well it can be enforced. Police personnel did the enforcement merely by watching for offenders, not a difficult task by itself. Nevertheless, it was a boring and mundane job.

It was necessary to ensure that the licences were easily visible and recognisable. Different colours were used for different months. The required size of licences to be clearly seen, was

determined from field trials. There were a total of 3 categories of vehicles for differential charging i.e. motorcycles, company cars and others. Therefore, each licence came in a different shape. They were further distinguished by shape for monthly and daily licences - all monthly licences were partly circular and daily licences partly rectangular. Licences that catered for the wholeday had full colours, while those that catered to off-peak hours had half white-half colour.

The police were placed in a vantage and comfortable position for them to look out for these licences in special well-positioned sentry huts .

It was also necessary to ensure that enforcement and appeals were not cumbersome. Therefore, offending vehicles were not stopped, but received a summons to pay a fine of $70 for entering the RZ without a valid area licence. There were ample avenues for the motorists to appeal and to show proof that they had valid licences, that were not spotted by the police officers. Lastly and most importantly, there were no exemptions from the scheme, except for emergency vehicles and public scheduled buses. The "no special privilege" made the scheme more palatable.

5.4 Need To Guard Against Fraud

Licences are not transferable between vehicles. The registration number of the vehicle is written on the licence during the purchase. This is necessary for ease of enforcement. Otherwise, offending motorists could challenge the notice of summons for the offence by producing any area licence.

There have been some cases of motorists being caught transferring licences between vehicles. No cases of forged area licences have been reported.

5.5 Care In Demarcating Boundaries Of The Restricted Zone

This has always been a contentious issue. The original boundary of the RZ was demarcated to include the most congested parts of the city including car parks, office and commercial buildings. Nevertheless, during the demarcation, it was not totally possible to exclude all peripheral residential areas. Some affected residents who worked within the RZ welcomed this move, but those who worked outside, resented it. This was especially so when the restrictions were extended to include the whole day in 1994. These affected residents had now to buy an area licence to return home.

Over the two decades, some of the peripheral residential areas became commercial areas, owing to changes in landuse zoning; and these areas had to be brought into the RZ, which was in line with the original concept of including congested areas in the RZ. This was also a point of contention to some of the new owners.

There were some schools in the RZ and parents who came to pick up their children in the evening were unhappy when the restrictions were introduced to include the evening in 1989.

Fortunately many of the schools have been resited as part of an on-going programme to move them out of the city centre.

5.6 Need For Adequate Area Licence Sales Outlets

The area licences are bought beforehand i.e. unlike a toll system, it is not possible to get the licence at the entry points. It is thus necessary to provide adequate sales outlets. Monthly licences were bought well in advance of the month. Therefore, they were made available at all post offices which are conveniently located throughout the country from the 15th day of the preceding month.

Although post offices also sell daily licences, they are not popular outlets because they only open in the late morning. The most popular point of sale is the daily licence sales booths located along the approach roads to the RZ, which account for 65% of such sales. There are 26 such booths in all. To make them more convenient, many of them have been converted to drive-in booths, whereby the motorist can buy the licence without getting out of his vehicle. At some of the popular booths, it has become necessary to lengthen the driveways to serve two vehicles simultaneously. As the ALS was extended to cover more hours, there was a need for more outlets. Petrol stations and convenience stores have been brought into the fold.

5.7 Need For Continuous Monitoring Of The Scheme

The ALS has been monitored regularly over the past twenty-two years. These involved information on traffic counts, sale of licences, violations and regular surveys on attitudes and behaviour of motorists. The constant monitoring of the ALS gave early indications on trends and on when to make changes.

6. HIGHLIGHTS OF MONITORING

I will now discuss some of the highlights that became evident as a result of the monitoring.

6.1 The Mirror Image

The ALS started in 1975 with restrictions only applicable to cars, company cars and taxis during the morning peak hours of 7.30am to 10.15am. There was an underlying assumption that if we kept out some of these predominant vehicles from the RZ in the morning, then the evening problem will take care of itself because less vehicles had entered the RZ. Containing the morning problem did not completely solve the evening problem, but alleviated it only to a small extent. This improvement was much less than that expected i.e. the mirror image did not appear. The reasons were:-

* Some of the restricted vehicles came into the RZ before or after the restricted periods, but joined the evening peak hour traffic out of the RZ to return home.

* The morning restrictions kept out the cross-town traffic that went through the RZ to outside destinations. In the evening, the cross-town traffic returned through the RZ in the absence of restrictions. It was estimated that they constituted 22% of the traffic in the city in the evening.

6.2 Restrictions On Cars

The ALS started in 1975 with restrictions on cars and company cars. The original objective was to discourage the widespread use of the car for the journey to work. A few weeks later, taxis were included, with the same restrictions as for cars. This was because they were seen milling around the entry points to the RZ causing congestion. However, their special status was recognised when the licence fees for them were reduced in 1977. As a result of these selective restrictions, the other categories of vehicles started using the RZ in large numbers. Goods vehicles took advantage of the uncongested conditions in the RZ to use it as a cross-town route. 50% of goods vehicles using the RZ were just passing through and 54% of them ran empty. There were also indications that some started using goods vehicles as surrogate for the car.

Moreover, over the years, it was felt that the objective of a road pricing was more appropriately to charge all vehicles for the use of road space, at times and at places when and where they cause congestion; and there were no more valid reasons to target only at the cars and taxis.

6.3 Carpools

With the original scheme, carpools (1 driver + at least 3 passengers) were given free entry. This was to counter the criticism that the ALS favoured the rich. Carpools became popular and at the height of its popularity, 52% of car traffic entering the RZ during the restricted hours were by way of carpools. What was happening was not carpooling, but hitchhiking. Motorists wishing to gain free entry into the RZ went to a bus stop and picked up 3 bus commuters to make up the carpool. This was a widespread practice. It lessened the demand on the overstretched public buses and the bus companies did not complain. For a short while, there was also a small racket of street urchins offering to form the carpool for a small fee, but this soon died out, as motorists realised that there were bus commuters who were willing to form these carpools in return for a free ride to the RZ. Cars were being used in a more effective manner with the average occupancy increasing to 2.2 from 1.7 during the morning. In the evening, there were no incentives for the drivers to form these carpools and the average occupancy remained at 1.7.

As the trains(mass rapid transit LRT) started running in 1987 and the bus services became better, it was obvious that the carpool scheme had outlived its usefulness. It was also viewed as a method to get around the ALS.

6.4 The Restricted Hours

The ALS started with morning restrictions. Whilst, there were considerable improvements in traffic in RZ in the morning, the evening situation started getting worse as the city grew in size and the vehicle population increased. Towards the end of the 1980s, it became clear that some sort of evening restrictions was necessary. Two options were open; either to exercise inbound control to the RZ at the same control points as in the morning, or to bring in exit control by forming another imaginary cordon in the RZ to charge vehicles going out during the evening peak hours. The former course was taken because it was more convenient for the motorist. Firstly, he would not have to remember that there were two sets of overhead gantries operating at different times. Secondly, it was not possible to set up convenient roadside sales booths in the city for motorists to buy evening licences.

In 1989, the scheme was thus revised with the following changes:

* The scheme was extended to evening peak hours; of 4.30pm-7.00pm

* The restrictions were also extended to include all other vehicles, except public scheduled buses and emergency vehicles;

* Free entry for carpools were withdrawn; and

* Area licence fees were reduced and a new fee amounting to one-third of car fees was introduced for motorcycles

As expected, there were complaints from motorists. Car drivers felt that the evening ALS would only divert traffic congestion to other locations. Motorcyclists claimed that they should be exempted because they did not contribute to congestion. Drivers of goods vehicles said that they would avoid the RZ, unless absolutely necessary, in which case, the companies would pay for their area licence. Companies, in turn claimed that the cost of business would go up because of the new restrictions on goods vehicles. Some residents in the RZ felt that they were victimised because now they were subject to the restrictions even when returning home.

Much effort had gone into publicity before and after the changes to explain the rationale and the advantages of the revisions, and on the ramifications if we did not stick to the tried package of transportation measures. There was even a hearing by the Parliamentary Select Committee on Land Transport Policies to discuss the changes, where many members of the public aired their views. There were many advantages of these public hearings because it gave the opportunity for us to better explain the need for changes and take measures to address some of their concerns.

After the initial furore, motorists took the evening restrictions in their stride and resumed life as usual.

6.5 Traffic Surge Before And After The Restricted Hours

Right from the beginning, we were confronted with the tremendous traffic volume surges before and after the restricted hours. Motorists who did not wish to pay rushed to the RZ in fairly large numbers just before 7.30am or 4.30pm. These did not create much problems. The post-restricted hour surge at 10.15am and at 6.30pm were higher and did create problems. Compounding the problem were the habit of vehicles queuing up at the approach roads waiting for the scheme to end.

Furthermore, the ALS had created anomalies in the traffic system. Although, the critical morning peak hour traffic volume to the RZ was about 32% lower than what it was before the scheme, the off-peak hour traffic volume to the RZ during certain hours could be as much as 17% higher than these peak hour traffic volumes. Some localised traffic problems were being experienced in the RZ during these off-peak hours.

The final changes to the ALS came about in 1994 as follows:

* the ALS was extended to the whole working day;

* the fullday and partday area licences were introduced;

* the new partday licence was for entry into RZ during off-peak hours at a lower rate; and

* the whole day licence could be used for both peak and off-peak hours

The public reaction was muted than before. Many viewed it as the inevitable finally coming. The reduced off-peak charge was generally welcomed. Shops in the RZ feared that they would lose business. Some shops even offered to refund the cost of the area licence fee to patrons spending a preset amount.

There were general improvements to traffic in the RZ throughout the working day. The peak hours reverted back to the normal times. The general increase in speeds also benefited buses, especially during the off-peak periods.

6.6 Public Transport Usage

Other than the improved traffic conditions within the RZ, the main benefit has been the increase in public transport ridership for work trips into it. In 1974, before the ALS was introduced, 46% of the work trips were made by public transport, in 1994, this figure had climbed up to 67%. Although public transport system had improved by leaps and bounds during the past two decades, there is no denying the fact that the ALS has also helped to push people to public transport.

7. PUBLIC PERCEPTION OF AREA LICENSING SCHEME

Road pricing has become a norm in Singapore for the past two decades. When it was introduced, the pledge was that it was a part of a total package to solve the transportation problems in a city with a very limited land area, where the unlimited building of roads was not possible. It was never sold or meant as a revenue-oriented scheme, such as a toll road system, but as a scheme to discourage the widespread use of the car and to shape the attitude to it. Many may dispute this claim, but there is a reluctant acceptance of the scheme because of the benefits in traffic flow that it has brought about. Furthermore, the public have seen many other transport projects such as road projects, a new urban railway and improved bus services catering to different categories of users. This has added credibility to the initial assertion that ALS was part of a total package.

Those motorists who are prepared to pay, drive to the RZ enjoy good traffic conditions with speed of up to and above 30 kph during the restricted hours. Others have convenient alternatives at reasonable cost. Nobody would dispute that the accessibility to the RZ and the city area has improved. In other words, mobility has not been reduced.

There are critics who feel that congestion pricing leads to under utilisation of the roads and hence of economic resources. There is also the other valid observation that some car trips have diverted to other peripheral roads and caused congestion elsewhere. But such congestion is more localised in nature and is spread over a shorter period than what was experienced in the city before ALS was introduced.

8. THE STRENGTHS AND WEAKNESSES OF ALS

The strengths of the ALS are:

* easily implemented

* easily understood by motorists

* relatively cheap to operate

The weaknesses are:

* very labour intensive

* enforcement is boring and mundane

* each change brings about more complexity i.e. inflexible

9. THE FUTURE OF AREA LICENSING SCHEME

The ALS will undergo a change. In 1998, it is expected that it would be replaced by an electronic road pricing scheme. This is meant to automate the scheme. The RZ will be demarcated by overhead gantry signs which carry radio antennae and enforcement cameras. Vehicles wishing to enter the RZ need to fix a small gadget called the invehicle unit (IU). The payment will be by a stored value smart card, which needs to be slotted into the invehicle unit as the vehicle passes under the gantry. Radio waves from the gantry will instruct the IU to deduct an appropriate charge from the smart card. If the transaction is successful, there would be no action. If the vehicle has no IU, no smart card or insufficient balance in the smart card, the enforcement cameras will take a photograph of the rear licence plate of the vehicle for subsequent enforcement.

The ERP will address some of the shortcomings of the ALS. For example, it will be possible to vary the charges easily, which would help to feather down the traffic surges that occur just before and just after the restricted hours. It is easier to allocate different charges to different categories of vehicles. ERP can also charge different rates at different gantries to effect preferred diversions of traffic flow.

10 COST BENEFIT BASED ON THE FIRST SCHEME (1975-89)

The capital costs	
Fringe car parks	$5.5 million
(built for a park-and ride scheme for	
Motorists affected by ALS- did not	
Become popular and was abandeoned)	
Infrastructure for ALS	$1.0 million
Miscellaneous	$0.1 million

	$6.6 million

Operating costs (14 years)	
Policing	$4.1 million
Manpower for licence sales	$1.8 million
Manpower for fringe car parks	$0.2 million
Printing of licences	$1.9million
Maintenance of infrastructure	$ 2.0 million

	$10 million

i.e about $59,000 per month

Revenue

Sale of licences	$151.0 million
Revenue from fringe car parks (alternative uses for lorry, bus and Private hire car parking)	$ 5.5 million
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	$156.5 million

The ALS was never meant as a revenue scheme but rather as a traffic management scheme

11. CONCLUSION

The ALS has been a success story for Singapore. It has proven that congestion pricing is an effective tool to keep transportation problems within manageable levels, when applied in conjunction with other time-tested strategies. Nevertheless, constant monitoring has been necessary to amend the scheme to reflect changing conditions, so that it still remained relevant and ensured that we did not lose sight of the original objectives of the scheme. We have learned many lessons, that are relevant to any city planning to embark on congestion pricing.

. REFERENCES

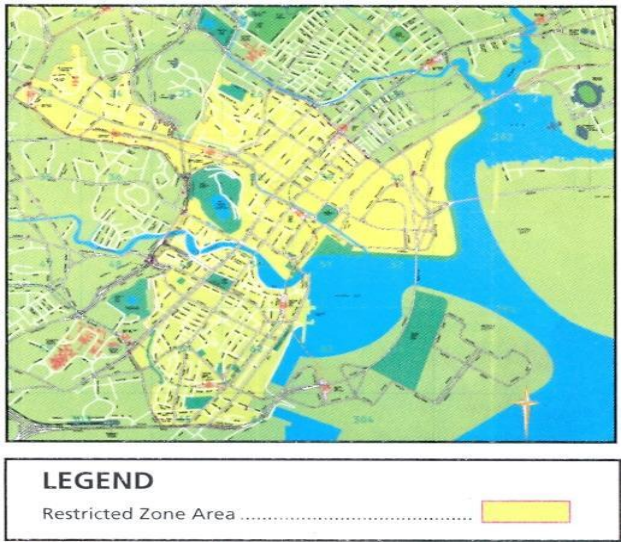
1. Various Public Works Department and Land Transport Authority Reports (1974-1997) (unpublished)

2. Centre for Transportation Studies, Nanyang Technological University, Singapore

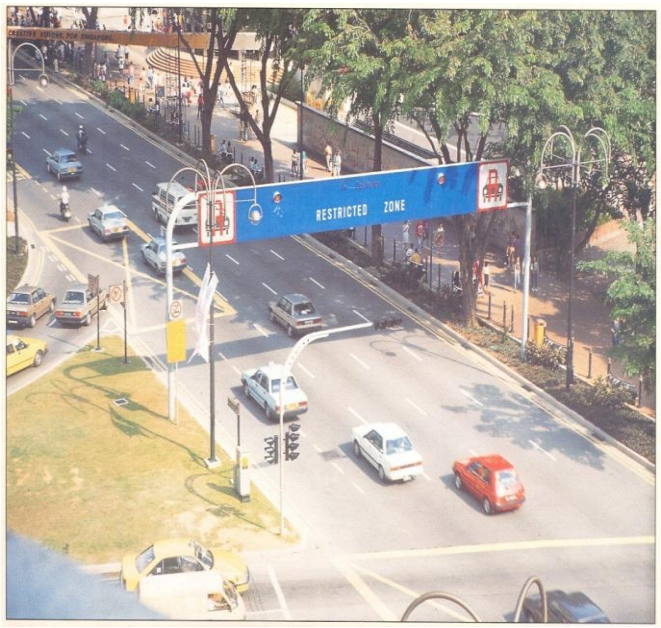
a) Report NTU/CTS/92-2

b) Report NTU/CTS/93-2

IMAGES OF ALS



Restricted Zone(RZ) in the city



ALS gantry signs at 28 entry points to RZ

Daily and Monthly Area Licences for June 1992

Area Licence to be displayed as vehicle goes past the entry point

Sales booth for daily area licences (in advance and away from entry points)

Enforcement at entry point (no stopping of vehicles, only taking note of violating vehicles)

Good traffic conditions during operation of ALS (1995)