

Trafficflow

Charging Ahead:
Making Road User Charging Work in the UK

A Trafficflow Project Report

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**Adam Smith Institute &
The Smith Group**

Executive summary

The government is proposing to give local authorities powers to establish road user charging. Trafficflow was set up in response to these plans, with the aim of developing implementation blueprints for practical urban road user charging schemes in the UK. It draws together a wide range of influential organisations with an interest in ensuring that any road user charging schemes introduced in the UK are fair and efficient.

Trafficflow, an initiative of the Adam Smith Institute and The Smith Group, has now reached a key milestone with completion of its feasibility phase. Findings from this work are summarised in this report. It examines the relative scale of possible UK road user charging schemes, whilst narrowing down the options for the way a scheme might operate. It also identifies the financial costs and benefits as the basis for an assessment of the commercial viability of urban road charging schemes.

The feasibility work uses London, Bristol and Leeds as case studies. The technology choice comes down to paper permits or a scheme based on an in-vehicle transponder that communicates electronically with roadside antennae (using dedicated short range communications or DSRC). Trafficflow's analysis has yielded cost-benefit data for these schemes under various conditions. Illustrative net present values (discounted at 10% pa) that can be achieved from each scheme over a 10 year period of operation are:

	Central London	Bristol	Leeds
Paper permit	£740 million	£180 million	£470 million
DSRC (electronic)	£660 million	£140 million	£400 million

These figures represent the funds that would be available for local transport improvements. There are clearly strong commercial cases for both scheme types in each of the cities, using a methodology that can be mapped directly to other centres considering road user charging. The paper permit offers higher returns than a DSRC option, but lacks the ability to charge at the point of use, which will limit its potential for tackling congestion.

The figures above assume a road user charging scheme as a stand-alone operation. However, for the electronic scheme in particular, there is significant potential for cost sharing with other traffic management or customer billing schemes, as well as using the link into the vehicle to offer value added services such as traveller information. These will be built into the refined models during Phase 2.

Further, once the decision is made to step above a stand-alone paper permit scheme, a range of interoperable DSRC in-vehicle equipment is available from entry level units through to multi-functional smart card reading devices, allowing for system evolution as technology and consumer demands develop.

Trafficflow will now build on these findings to develop detailed implementation plans and business cases for the leading cities considering road user charging. These will be expanded in Phases 2 and 3 of the initiative.

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1 Introduction

1.1 General

This report summarises the findings of a feasibility study assessing the merits of implementing road user charging in UK urban areas. It has been prepared by The Smith Group within the Trafficflow study as a public summary of work that is continuing to advance plans for road user charging.

The report sets out the options for urban road user charging and explores further the costs and benefits associated with implementing particular technical solutions in three candidate cities. This data has also been used as part of a broader analysis of the viability – both commercial and political – of road user charging schemes.

1.2 Background

Urban traffic levels continue to rise with associated effects on air pollution, congestion and the economy. There is a consensus within local and national governments that 'do nothing' is no longer an option if urban areas are to provide vibrant venues for business, retail, leisure and residential interests in the future. One way forward is to include road user charging as part of a broader demand management plan.

Trafficflow has assessed the potential of various scenarios for road user charging that could be implemented in UK cities in the short term, addressing both technological and political issues. At a high level, the results and analysis presented here aim to give a first indication of the potential for an urban road user charging scheme.

These have focused on three cities – London, Bristol and Leeds – in order to take account of a range of factors that will affect real scheme design, implementation and operation. The methodology employed means the analysis and conclusions can also be mapped to other urban centres considering road user charging.

1.3 Context of Trafficflow

The government's July 1998 White Paper, 'A New Deal for Transport', paves the way towards the introduction of enabling legislation which stands to add urban road user charging to local authorities' list of available demand management tools. The December 1998 Green Paper, 'Breaking the Logjam', takes these ideas a stage further, proposing legislation items in support of road user charging schemes.

The Trafficflow project takes its cue from the White Paper in so far as it seeks ways in which the charging measures it proposes can be effectively, and fairly, implemented. The first phase of the project, a wide ranging feasibility study, has been completed and is summarised in this report.

Trafficflow is developing blueprints for practical, publicly acceptable urban road user charging schemes in the UK. This is not a lobby for road pricing. Rather, it is exploring road pricing as part of the local and national transport package overall,

and seeks to influence government thinking on delivering a fair and practical deal for road users and non-users alike.

The project offers a mechanism for the business community and transport user groups to understand the implications of road user charging. It brings together major corporations, senior transport academics, road users, transport institutions and local authorities. It involves firms who can provide the necessary resources – covering IT, telecommunications and finance – as well as those who will be affected by road user charging, such as bus and freight operators.

Many of Trafficflow's findings to date have already fed into the government's thinking on road user charging. This process continues with circulation of this summary report and publication of a separate, more detailed set of issues relating to road user charging prepared as Trafficflow's contribution to the Green Paper consultation process. Among the key points Trafficflow makes in its response to 'Breaking the Logjam' are:

- Details need to be clarified on the level of revenues that can be retained by a local authority (irrespective of 'pilot' status) for funding local transport improvements, and the period for which this arrangement will be valid.
- Given the requirements for up-front investment, implementation of road user charging schemes requires a public-private partnership approach to bring together funding of local transport improvements, efficient scheme operation and development of a service package approach.
- Road use charging can serve many objectives. Local authorities need the freedom to use the charge in a way that directly serves local needs.
- The government intends to progress through paper-based pilot schemes and parallel technology trials. But with electronic schemes already operational in some urban areas, it is important that these trials focus on issues beyond the main 5.8 GHz vehicle-to-roadside communications link and do not delay any local authority plans to go straight for electronic solutions.

Trafficflow's on-going work programme will continue to develop the detail on the practical options for road user charging. Through its work programme, the project seeks to develop further detail on:

- workable public-private partnerships;
- issues of public acceptability and central government encouragement of local authorities; and
- mechanisms for ensuring the necessary degree of interoperability between urban schemes and forward compatibility with trunk road and motorway schemes at the technical, procedural and contractual levels.

1.4 Report structure

The basic considerations in shortlisting potential features of a road user charging scheme are explored in Section 2. Section 3 focuses on location specific issues such as politics, geography and economics. It also outlines key features of the three cities selected for assessment here.

The cost-benefit analysis is summarised in Section 4. This presents key results of the analysis with a comparison among the cities. The commercial and political viability of road user charging is examined in Section 5. Plans for the remainder of the Trafficflow initiative are then outlined in Section 6.

1.5 Acknowledgement

This report has been made possible by the co-operation of Leeds and Bristol City Councils and numerous equipment manufacturers and system suppliers who have provided quotations and marketing literature, as well as feedback from Trafficflow's sponsors and its review panels.

2 Scheme design issues

2.1 Introduction

The move towards implementing a road user charging scheme is necessarily an iterative one. The decision process should flow along a path from recognition of a traffic-related problem for which road user charging is a viable solution to garnering political support while engineers start to identify potential cordons.

Public opinion and traffic modelling can be used to refine the location of a cordon. It is then that basic technology questions can start to be addressed. But these need to be approached from the city objectives (technology pull) rather than from what systems manufacturers are promoting (technology push). Once this stage is reached, more detailed scheme design concepts can be developed. These can be used as a basis to assess costs and potential revenues more accurately.

2.2 Technology and payment issues

Experiences at similar installations

Systems are in operation across the world for a wide range of tolling, road pricing and restricted access schemes. The technologies used for these schemes range from paper permits through to advanced transponders with card slots and displays of financial balances.

For paper schemes, a common application is for parking permits. Various restricted access schemes are controlled via permits similar to parking permits. The scheme most comparable to a paper permit for road user charging was Singapore's area licensing scheme. This has now been replaced with an electronic road pricing (ERP) scheme.

On the electronic side, there is already a well established electronic toll collection industry using microwave frequencies for what is termed the dedicated short range communications (DSRC) link. Most installations, however, have focused on adding an electronic payment capability to an existing manual/cash payment based toll facility.

There are notable exceptions such as Singapore's ERP system that became operational in 1998, Ontario's Highway 407 and the proposed Melbourne City Link. Highway 407 and City Link provide for 'free flow' electronic tolling (ie. with no physical toll plazas or barriers), but are single highways rather than area schemes. Singapore has the only current free flow electronic scheme covering an urban area.

With these installations, many of the technical challenges faced in implementing a road user charging scheme have already been addressed. Further, there are benefits of an established supplier community and a growing understanding of the maintenance and running costs of such systems. Where there is less existing experience, however, is in the central administration of a major scheme within the road transport sector.

Technology Selection

From an assessment of current installations and systems under development, three broad categories can be identified for the main link to the vehicle. These are:

- a manual system with a paper permit in the vehicle;
- an in-vehicle transponder/tag that communicates to the roadside via a DSRC link;
- an in-vehicle unit that communicates directly to a system management centre.

It is important to note that these are not discrete options. Rather, there is a continuum of possibilities from the basic paper permit through to an integrated multi-functional in-vehicle unit. For Trafficflow, a series of criteria was developed to rank the options for overall design of a road user charging scheme. The criteria, in priority order, are:

- Is it ready to implement today?
- How easy is it to enforce/collect payment?
- What level of visual intrusion does it cause?
- How can occasional users be accommodated?
- What are the in-vehicle, back office costs?
- How easy is the scheme for a driver to use?
- What value-added commercial potential does it offer?

The first criterion effectively excludes the third broad category identified above. Systems based on technologies such as GSM cellular radio and GPS satellite positioning are being trialled but do not yet offer complete commercial solutions.

The second criterion strongly favours DSRC schemes over paper since there is potential for automation of much of the enforcement process with an electronic in-vehicle device. Criterion 3 leans towards paper schemes. Overall, there is a case for further analysis of a paper permit scheme and schemes based on an in-vehicle unit that communicates with roadside antennae. The following emerged in Trafficflow as the leading candidate solutions:

- Paper permits with random manual enforcement.
- Video legible permits with partially automated enforcement.
- DSRC with fully automated enforcement, of which there are three options:
 - low cost tag with user ID linked to account billing;
 - transponder with ID card linked to account billing;
 - transponder with pre-paid stored value card.

As noted previously, there are other variants of these items that can be considered, ranging from a 'smart' sticker through DSRC read-only tags up to a multi-functional DSRC transponder with smart card. Trafficflow selected these discrete systems in order to assess the viability of road user charging under various configurations.

2.3 Paper permit scheme

Paper permits offer an entry level scenario for road user charging. They lack much of the flexibility of the more advanced scenarios, but with no requirement for roadside equipment the paper permit scheme inherently has lower start up costs than, say, a microwave beacon based system. Once operational, however, enforcement would inevitably be much more labour intensive, increasing the running costs. There are also high security risks associated with a paper permit.

Much of an enforcement plan for a paper permit scheme would have to rely on manual checks. These are most easily carried out while a vehicle is stationary. For this reason, the paper permit is best suited to an area licensing system architecture rather than a cordon based scheme. But even in this configuration, enforcement against a vehicle that enters the restricted zone and then parks where it cannot be seen from the public highway would be extremely difficult.

Area licences would be sold mainly on a monthly/annual subscription basis. This provides an equivalent revenue raising mechanism but disassociates the fee levied from the action of making a journey and so reduces the role of such a licence as a demand management technique.

2.4 Video legible permit scheme

The video legible permit scheme for road user charging is an enhanced version of the paper scheme. It offers the functionality of the paper permit, but with the additional benefit that some enforcement procedures can be automated. It clearly has a more exacting specification than a basic paper permit. As such, it will inherently cost more. So while the ability to automate part of the enforcement will save on some costs, there is an additional infrastructure requirement for camera-based permit readers.

Within the vehicle, the equipment requirement is a valid permit. This has to be legible from a video or infrared (IR) camera. Roadside equipment at each cordon entry point would include a video camera-based enforcement system. There would also need to be links back to a system management centre.

An alternative version of this scenario takes the licence plate itself as the 'permit'. This would need to be read for enforcement in any event and cuts out the requirement for additional in-vehicle equipment. Such a scenario is being considered in the Dutch Rekening Rijden road pricing programme. It could potentially be used for smaller UK cities or to deal with occasional users in one of the electronic system configurations.

2.5 DSRC schemes

Three electronic systems have been assessed within Trafficflow. They all use a DSRC link for communication with an in-vehicle unit (IVU) and enable pricing that is variable with time, vehicle type and pollution levels. Further, they can automate much of the enforcement process. The three configurations considered in Trafficflow are:

- a low cost in-vehicle tag;
- an in-vehicle transponder with account ID card; and
- an in-vehicle transponder with a stored value card.

It is important to stress that these are just three options from a range of configurations. With the same roadside infrastructure, a scheme operator could offer numerous transponder and payment options.

For the *low cost tag* option, the tag has neither a display nor buttons. It would be fixed to the vehicle's windscreen. As it passes a cordon point, it would send its ID to the roadside antenna. This would then start the process of debiting from an account (either pre-paid or for subsequent billing).

Moving up a level in functionality, the in-vehicle unit includes a card in a transponder. Transponders include features such as lights or an LCD to give an indication of card balance. For an *in-vehicle transponder with an account ID card*, the main functionality is similar to the simpler tag. The added benefit is that different drivers can use different cards, thereby charging the driver rather than the vehicle owner. Potentially, the card could also be used for payment for other services, such as parking or public transport.

The final DSRC option has a *stored value card in an in-vehicle transponder*. In this case, accounting is performed in the vehicle with the charge debited from the balance on the card. Communication with the roadside would confirm that a transaction has been performed successfully. Again, the card could be used for payment for other services. There is also a requirement for facilities to load value on to the card.

3 Location specific issues

3.1 Introduction

There are a number of factors peculiar to the individual town or city implementing a road user charging scheme that will affect the order of preference for the technology options. Indeed, the government in its 'Breaking the Logjam' Green Paper stresses that decisions on road user charging viability and scheme design fall to the local authority in the first instance. Trafficflow, as a matter of principle, places considerable store by local issues. These are discussed here under the headings:

- political objectives;
- geography;
- economics.

This section then presents details of the cities considered in the Trafficflow feasibility study, applying the criteria that emerge from the location specific discussions.

3.2 Political objectives

The local politics of road user charging implementation in a particular urban area will dictate a scheme's overall objectives. It is therefore the first point that needs to be addressed in considering such a scheme. Any of the following (partial) list of objectives, or a combination of them, could be the aim of an individual scheme:

- spreading peaks, to improve traffic flow, without discouraging traffic;
- generating additional revenues for transport improvements;
- reducing road accident rates;
- encouraging modal shift to public transport, walking and cycling;
- improving pedestrian/cyclist conditions;
- controlling pollution levels.

It is the choice of objective that will have the greatest influence over the level of charge, the basis for a pattern of daily charging and the schemes funded with the resulting revenues. The stated objective along with the accrued benefits (perceived and real) will be critical in gaining and then retaining public support for the scheme.

3.3 Geography

Geography relates to:

- the physical extent of a road charging zone and of the affected suburbs;
- the complexity of the road layout (can it support additional public transport, are there alternative routes, number of charging zone entry points, etc);
- relative accessibility of alternative urban centres.

The physical extent has the greatest effect on the feasibility of a scheme. The decision tree below gives a crude illustration of how one might identify the types of cities/towns for which road user charging could be suitable.

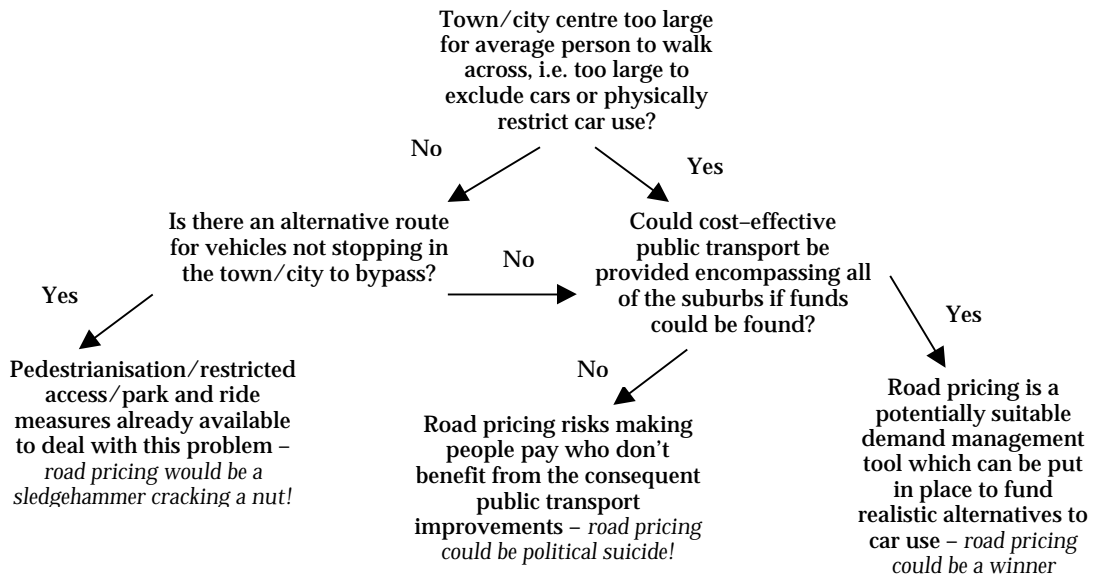


Figure 3-1: Simplified selection process to identify areas where road user charging is best suited

Looking at this in a little more detail, another simplified model below shows how the population density varies as you move out from the centre to the suburbs and to the rural areas or the suburbs of the next town.

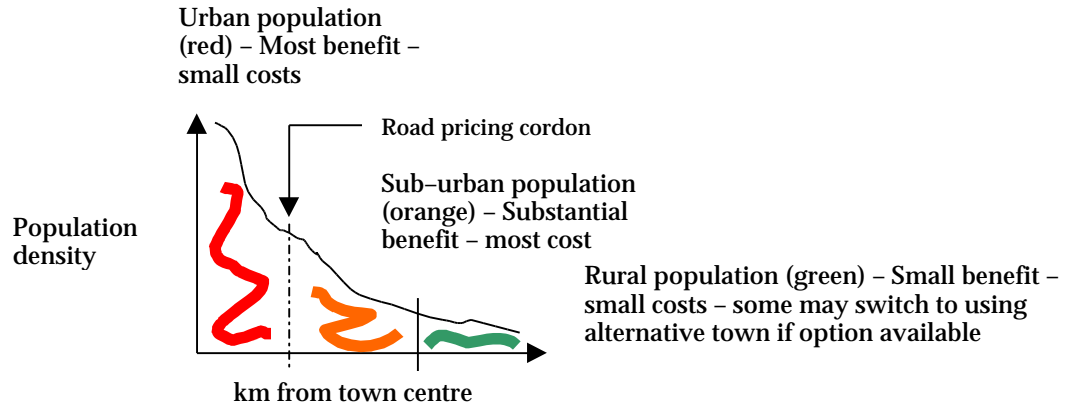


Figure 3-2: Population density based zoning of a town

Notionally, a charging cordon will be sited at the edge of the urban centre. The people that need to cross that cordon most often will be those living in the immediate suburbs. By providing park-and-ride sites at the cordon you offer those people an alternative to paying the charge. However, a change of mode in a relatively short journey is undesirable and merely displaces the problem from the centre to the suburbs.

The next issue, the number of entry points to a road charging zone, relates directly to the cost and complexity of the required technology. If there are many entry points, an area licensing scheme may make more sense than a cordon-based scheme, at least in terms of installation costs.

3.4 Economics

The economic situation of an urban area will dictate the severity of any deterrent effects on the motorist and business. The level of road user charge that would cause this diversionary effect is clearly a matter for careful consideration. This would need to assess the risk of diversion in terms the impact on the local economy as well as traffic.

Stated-preference surveys in this area have been shown to be unreliable. Once a basic scheme design is developed for a city, further market research using focus groups will give a more reliable picture of public opinion. The first real implementations will be used to calibrate models of what might happen if other authorities were to follow suit.

3.5 Implementation areas

Some issues that need to be addressed in implementing a demand management scheme are common to all urban areas. However, at the detailed level, the majority of design issues cannot be resolved by considering a 'concept' city. For Trafficflow's feasibility study, three example cities have been selected. These range in size, levels of traffic congestion and stages of implementing traffic management systems and public transport services. The cities are:

- Central London,
- Bristol, and
- Leeds.

In each case, a single cordon has been assumed. Other studies and, indeed, an eventual implementation may involve multiple cordons or zones. However, the indicative figures and analysis from the feasibility study form a solid starting point from which detailed design and technology selection processes can commence.

Central London

Central London (defined here as the area inside the Inner Ring Road which effectively links London's main rail terminal stations) is the largest of the three areas selected. Following the decision tree set out in Figure 3-1, London is a strong candidate for a road user charging scheme on geographic grounds. Its centre is too large for an 'average person' to walk across. A comprehensive public transport service already reaches out to the suburbs, and the bus service in particular could be extended cost effectively to respond to increased demand.

The population distribution for Greater London and beyond is also conducive to a road user charge, with a relatively even population density stretching out well beyond the proposed charging area. With traffic management measures, some 130

crossing points would need to be equipped on the Inner Ring Road for a road user charging scheme to be implemented.

London is unique in the UK in the size and scale of business/retail facilities it supports. As such, there is only a limited risk of other nearby centres gaining from a charge for entering London by road. Finally, the political will in the capital has moved in favour of a road user charge, although this will need to be reassessed once the Greater London Authority is established.

Bristol

Bristol is a smaller city with local congestion problems that are now stretching out to nearby motorways. The Bristol city centre is partially pedestrianised already and is bounded by a ring road, which forms the cordon for Trafficflow's assessments.

Using the decision tree to assess road user charging in Bristol, almost any of the permutations are possible depending on the proposed location of a cordon. Certainly, traffic volumes are sufficiently high to warrant action.

Furthermore, the neighbouring urban centre, Bath, is not of sufficient size to offer a major threat to the longer term urban vitality of Bristol. Finally, Bristol City Council has been advancing its demand management plans on environmental grounds for several years now. The local population is therefore well informed of the merits of a road user charge.

Leeds

Leeds falls between the London and Bristol cases. It has more severe traffic congestion problems than Bristol and looking at Leeds in isolation there are strong indicators that a road user charging scheme would be viable. A key issue to be addressed here concerns the risk of displacement to neighbouring urban centres.

The Leeds city centre already has significant pedestrianisation. It is bounded by the Inner Ring Road, which Trafficflow's assessment used as the cordon. Using the decision tree for Leeds, again most scenarios are conceivable. Traffic volumes into the city are too high to make significant additional pedestrianisation viable. Additional public transport services are already planned, indicating that road user charging could be viable.

The extended Leeds urban area means there would need to be detailed analyses carried out on the risk of business and retail interests moving to a nearby centre. While this is a concern, the starting position should be that Leeds has a sufficiently strong national reputation for it to retain the great majority of its current businesses.

3.6 Systems architectures

The specifics of a particular city pose significant challenges for aspects of any given road user charging technology. The diagram below illustrates the range of scenarios being considered compared with Singapore's electronic road pricing scheme.

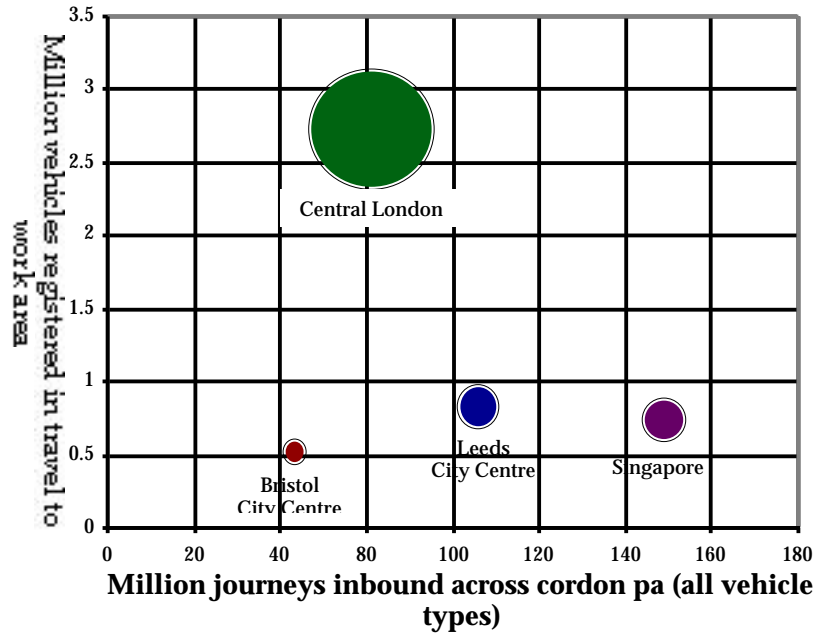


Figure 3-4: Scheme size comparison (width of bubbles relates to number of cordon points)

The figure above shows the scheme size of three UK scenarios in comparison with the well known (already implemented) Singapore example.

- Journey numbers relate to the rate of transactions and so to the scale of the enforcement and billing operations.
- Numbers of vehicles involved relates to the number of individual accounts that will need to be managed within the scheme and the scale of in-vehicle equipment costs.
- Numbers of cordon points relates to the complexity of roadside infrastructure.

4 Costs and benefits

4.1 Introduction

The three cities and three main technology options provide the basis for nine scenarios that have been assessed within Trafficflow. In addition, as noted earlier, the DSRC option has been further broken down into the three configurations based on different tag types and payment arrangements.

This section sets out the main results from modelling and assessment work carried out as part of Trafficflow's feasibility stage. It begins by outlining some of the underlying assumptions used in the modelling.

4.2 Baseline assumptions

The costs to a local authority of introducing road user charging include main system implementation and operation. They also need to cover the provision of incentives, the value of lost parking revenues and, potentially, compensation for affected business or individuals. The corresponding benefits are financial as well as economic and social.

Trafficflow's modelling to date has assumed all schemes require pre-payment. This is likely for a paper permit scheme as well as the DSRC stored value card scheme option. But the account-based DSRC schemes can operate as pre- or post-pay. The modelling assumed a post-pay option would be offered at a premium, to offset cash flow implications of interest payment and potential bad debts.

The default charging regime was that used in the 1995 London Congestion Charging study, which also reflects the regime used for Singapore's road pricing scheme. There was a peak charge applied in peak periods (7 am through 10 am and 4 pm through 7 pm), and half that charge applied in two daily 'shoulder' hours. At all other times road use continued to be free. The charge was applied on a one-way (inbound) cordon basis. For London, the peak charge was set at £4, with £2 used for Bristol and Leeds. Other rates were also assessed for comparison.

This is a charging regime designed specifically to reduce commuting car traffic and so ease congestion at peak times by encouraging the spreading of journey times. In the preliminary modelling undertaken in the feasibility phase, it was assumed that revenue was raised equal to the number of journeys made, as if there were 0% fraud, error or charge evasion. In this case, it was assumed that non-payers would be charged a fine sufficiently high to ensure that scheme revenue was maintained at a level it could have obtained with 100% payment, but without covering enforcement costs.

Emergency vehicles, powered two wheelers, the disabled vehicle owners (and/or the 1.6 million orange badge holders nationwide) were ignored for the purposes of this modelling. It was assumed in the first instance that it is immaterial to the overall commercial viability of the scheme whether or not these individuals are included.

4.3 Results

DSRC scenarios

City		Low cost tag	Transponder with ID card	Transponder with stored value card
Central London				
	Implementation	£55 million	£99 million	£112 million
	Operation	£26 million pa	£34 million pa	£32 million pa
Bristol				
	Implementation	£10 million	£17 million	£19 million
	Operation	£11 million pa	£12.5 million pa	£9 million pa
Leeds				
	Implementation	£17 million	£30 million	£33 million
	operation	£24 million pa	£27 million pa	£18 million pa

Table 4-1: Minimum implementation and operation costs for DSRC schemes

With a £4 peak charge, the London scheme with the low cost tag provides the best return on investment of the three DSRC options. It could be worth £662 million NPV over 10 years of operation (after an initial one year for implementation and assuming a 10% pa discount rate). This would be available for reinvestment in public transport or other local transport improvements. For Bristol, the best return is £142 million, while in Leeds a DSRC scheme could generate £404 million. In both of these cases, the best NPV figures are for the stored value card option.

In-vehicle costs dominate implementation and operational costs of the stored value card DSRC system, representing around 85% of the total cost of implementation and around a half of the operational cost. The operational costs assume the in-vehicle unit would need replacing after 6 years, with cards replaced more frequently.

With the account holder ID card, in-vehicle costs continue to dominate, although back office operational costs increase significantly. The simple ID tag option shows a clear drop in the in-vehicle costs compared with the other DSRC options. Roadside costs remain unchanged. Back office costs are lower for implementation since there is no requirement for card vending or recharging. But back office operational costs are unchanged from the account holder ID card version.

Video legible permit scenarios

City	Implementation	Operation
Central London	£6 million	£19 million pa
Bristol	£1 million	£7 million pa
Leeds	£2 million	£14 million pa

Table 4-2: Minimum implementation and operation costs for video legible permit schemes

The video legible permit schemes can potentially be implemented at considerably lower cost than the DSRC options. But there is less of a difference between operating costs for video legible permits versus DSRC. It is important to consider here that there are still some unresolved technical issues for the video legible permit, with no schemes currently in operation. Accuracy of permit reading while a vehicle is on the move has yet to be fully tested, for example, raising concerns that affect overall public acceptance and the enforcement process.

Video legible permit scheme costs are dominated by roadside infrastructure in implementation, but by the back office in operation.

Paper permit scenarios

City	Implementation	Operation
Central London	£1.5 million	£18 million pa
Bristol	£0.5 million	£6 million pa
Leeds	£0.6 million	£12 million pa

Table 4-3: Minimum implementation and operation costs for paper permit schemes

Clearly paper permit schemes have the lowest in-vehicle costs. But administering the permits and the enforcement function mean the back office costs drive the cost of setting up and running such an operational scheme. These account for some 75% of set-up costs and 98% of operational costs.

As noted above, there needs to be further assessment of the costs and levels of effort involved for the enforcement regime in a paper permit scheme. Parking facilities in the urban area and the split of parking between residential and business property are among the factors that will affect the potential for viable enforcement of a permit based area licensing scheme.

4.4 Financial case for road user charging

The following table compares the level of financial benefits arising from a road user charging scheme in each of the selected cities. For the DSRC values, the option giving the highest NPV has been quoted. This is the low cost tag for London and the stored value card reading transponder for Bristol and Leeds.

	Central London	Bristol City Centre	Leeds City Centre
Max investment in local transport (10 years of operation, discounted at 10%)	£662 million DSRC to £737 million paper	£142 million DSRC to £179 million paper	£404 million DSRC to £474 million paper

Table 4-4: Comparison of financial benefits of road user charging across cities (max values)

In each of the illustrative cases noted in the table, operation of a paper-based scheme seems more cost-effective than a DSRC scheme, in terms of the money available for investment in transport improvements. However, this will only hold true if the numbers paying the charge can be maintained at similar levels when permits are sold on a 'season ticket' rather than daily basis. There is also greater uncertainty in the enforcement costs for the paper scheme.

However, road user charging cannot be considered in isolation. Implementation and operation can cost-effectively build on other facilities and services (from traffic detection to credit card billing). These links will offset some of the costs, particularly for the electronic scenarios. Also in support of the DSRC options, there is potential for value added services. As well as traffic or other information services provided to the vehicle through the DSRC link, there are other facilities where the same in-vehicle unit could be used for payment (for fuel or car parking, for example).

Further analysis is required to establish if these value added services would be sufficient to tip the financial case in favour of DSRC over paper. Such analysis will have to address additional, less quantifiable issues such as a driver's reluctance to fix a sticker to his/her windscreen and to have to deal with regular sticker replacements. There are also other upgrade paths that could be open with a DSRC scenario, such as the possible replacement of tax disks, that are not possible with the paper scenario.

Returning to the data presented in the table, the highest DSRC NPV value for London comes from the simple tag-based scheme, while for the other two cities the stored value card option offers the better NPV. In short, among the DSRC options the simple tag has the benefit of lowering the in-vehicle cost. The advantage of the stored value card is that no central accounting is required.

So for a scheme with a high proportion of registered vehicles compared with the number of transactions (London), the simple tag offers the higher NPV. Conversely, a high proportion of transactions compared with the number of equipped vehicles (Bristol and Leeds) points to stored value cards as the favoured electronic approach.

The implication of this is that the London simple tag DSRC option is 11% short of the NPV achievable with a paper permit. For Bristol, with the stored value card option as the leading DSRC contender, it comes up 26% short of the paper permit's NPV. In Leeds, the difference is 17%. As noted above, further investigation is required to assess how the value of additional services linked to the DSRC configuration might affect the financial case for an electronic road user charging scheme.

4.5 Conclusions

This analysis has shown that:

- In-vehicle costs dominate in stored value card-based DSRC schemes.
- Tag-based scheme costs are split more evenly between in-vehicle and back office.
- Roadside infrastructure costs dominate in video legible permit based schemes.
- Back office costs dominate in paper-based permit schemes.

The comparison of benefits across cities suggests that the best opportunities (from a pure cost-benefit perspective) lie with the largest (most congested) cities. For the cities considered here, this means Central London, followed by Leeds then Bristol. But a clear cost-benefit case has been made here for each of the three cities, with results that can be transferred to other urban areas considering implementing a road user charge.

Clearly a positive NPV is not the only consideration. There needs to be an assessment of the scope for transport improvements that could be funded from the road user charge, for example. Indeed, viability of a scheme depends on the sums available for local transport investment being significant compared with the scale of improvements required.

5 Viability of road user charging

5.1 Introduction

Financial cost–benefit modelling provides the starting point for the assessment of commercial viability. The analysis of political viability draws on information about implementation areas, and combines this with information about the winners and losers identified through the cost–benefit work.

These two aspects of viability assessment have been addressed in Trafficflow. Both would be affected significantly by the potential for cost–sharing with other services and/or facilities, so these options have also been explored.

5.2 Commercial viability

At a basic level a scheme cannot be considered commercially viable unless the capital costs are lower than the return on that capital from scheme revenues. This is the case for all schemes considered in Trafficflow if allowed to operate for at least two years. Table 5–1, below, summarises the cost and revenue earning risks associated with the 9 scenarios considered in the Trafficflow feasibility work.

	Scenario								
	DSRC in London	DSRC in Bristol	DSRC in Leeds	VLP in London	VLP in Bristol	VLP in Leeds	Permits in London	Permits in Bristol	Permits in Leeds
Risk	1	2	3	4	5	6	7	8	9
Revenue earning potential	✓✓		✓	✓✓			✓✓		✓
Minimum cost	✓*	✓*	✓*		✓	✓	✓✓	✓✓	✓✓

Table 5–1: Costs and potential revenues in road pricing scenarios (more ticks means more desirable scheme)
(*for low cost tag variant of this scheme)

Some of the key risks to the anticipated revenues and costs of a road user charging project have been analysed within Trafficflow in terms of changes to the external business environment and payment administration. These and other related points are summarised in Table 5–2 based on the effect of these issues on the scenarios considered in the project.

Changes in the external environment

Paper–based schemes in particular carry a high risk of mass avoidance of payment since they rely only on random manual enforcement. This could be controlled to some degree by setting a high level of penalty charges as a deterrent, but this risks aggravating public opinion.

Risk	Scenario								
	DSRC in London	DSRC in Bristol	DSRC in Leeds	VLP in London	VLP in Bristol	VLP in Leeds	Permits in London	Permits in Bristol	Permits in Leeds
	1	2	3	4	5	6	7	8	9
Mass civil disobedience	✓✓	✓✓	✓✓	✓	✓	✓			
Control over pricing levels	Control through contractual framework								
Competitive behaviour of public transport operators				"			"		
No control over supply side				"			"		
Variable tax take	Reliant on government decision								
No comparably sized schemes in operation elsewhere		✓	✓		✓	✓		✓	✓
Payment administration	None of the baseline schemes as defined are post-pay, so the risk is limited to unenforceable non-payment								

Table 5-2: Commercial risks applying to road pricing scenarios
(more ticks means lower risk so more desirable scheme)

A scheme is likely to be installed and possibly operated by a public-private consortium. But few, if any, local authorities will wish to give up control over pricing levels to any external consortium. Pricing risk could be mitigated by agreeing bounds within which the charge can be varied and establishing a joint board of local authority representatives and scheme operators to negotiate charge levels.

Most public transport provision is in the hands of private operators. So the risk of competitive moves from public transport operators is one of the most difficult to mitigate. However, an approach could be envisaged which ensures that scheme operators are rewarded (at least in part) according to performance indicators which are independent of the risk from public transport operators cutting fares.

Payment administration

A key operational issue is how payments (and therefore debt) will be treated. If payments are construed as mandatory 'taxes', debt will be against the state and enforced through the courts and criminal law. If they are construed as charges for services, debt will be against the service provider and enforced through civil law. Trafficflow favours the latter approach. The private sector has vast experience and well developed processes for the management of credit and debt for service payments.

The way payment is administered is also central to the consumer proposition. Offered as a 'service', a road user charging scheme would be experienced by the user as being more like owning a mobile phone. The scheme could be branded. The user would have a defined customer relationship with the service provider. Promotional offers could be established ('road user miles', discounts on public transport tickets, etc).

The analogy with purchasing a service breaks down to the extent that road charging would be mandatory for any driver entering the charge zone. A road user charging service provider would have public service obligations and could not, for example, refuse to take on a driver as a new account holder because he was not credit-worthy, unless there were a pre-pay alternative.

The consumer proposition will be developed and examined in detail in later phases of Trafficflow. What the sensitivity analysis work to date in the project to date shows is that schemes would support a lower level of enforcement than would be sustainable on political/public acceptance grounds. Thus, the scheme operator has considerable headroom in determining the appropriate balance between enforcement effort, the pursuit of non-payers, debt management and revenue protection.

A first pass combined ranking in terms of purely commercial desirability (maximum return, minimum risk excluding political factors) would deliver:

- 1st. DSRC or a paper permit scheme in Central London or Leeds;
- 2nd. DSRC or paper permits in Bristol City Centre.

Cost-sharing options

Most of the DSRC options were demonstrated to be dominated by in-vehicle costs. Much discussion of DSRC over the last few years has centred on providing value added-services to the driver, such as additional travel information. If sufficiently attractive services can be offered, some vehicle owners could be persuaded to buy their own in-vehicle units rather than taking a free 'basic' model.

Much consideration was given to account billing alternatives to the DSRC stored-value card option. An account billing service might be able to offer a segment (even the majority) of the driver population an attractive alternative to the inconvenience of purchasing and/or recharging pre-pay cards. This option also offers a choice between pre- and post-payment.

Trafficflow set out with the assumption that a public-private partnership would be the best way to deliver fair and efficient road user charging. This is so for more reasons than simply the need for a local authority to borrow against future revenues to fund large scale public transport improvements at the outset. Public-private partnerships can bring to bear the best capabilities of the private sector in areas such as:

- call centre/customer management services;
- card retailing/vending operations;
- account billing and debt management;
- marketing.

There are considerable cost savings and risk reductions to be made by building from existing operations rather than developing new transaction processing and billing software, setting up a new customer management operation from scratch and so on. Further, it may be that companies want to 'buy-in' to this market, causing further cost reductions, because of synergies with existing services.

Risks exist for a road user charging scheme operator because of supply-side aspects of local transport which affect performance of the road user charging scheme, but are outside the control of that operator. Given that increased risk translates into increased costs, it is likely to be more cost-effective to try to construct a single public-private partnership covering all aspects of local transport management, rather than award separate contracts for road user charging scheme operation, parking provision, etc.

5.3 Political viability

The political viability of a scheme will be driven primarily by local issues. At a political level the proposal to implement a scheme will be sold on the basis that it represents the best overall solution to growing local traffic/transport problems. Voters will need to be convinced that they stand to benefit or that the cost and inconvenience to them is outweighed by improved traffic conditions and wider public benefits. These issues are being explored in detail with participating cities in the next phase of Trafficflow.

Some of the dimensions of political viability are:

- Public acceptance:
 - the scheme's objectives properly reflect local priorities and aspirations;
 - it imposes minimal personal inconvenience;
 - it offers at least the option to maintain personal privacy;
 - the size of revenue stream is sufficient to fund public transport improvements;
 - the overall consumer proposition is attractive or at least acceptable.
- Local government issues:
 - the scheme can deliver some benefits on the timescales of a local election cycle;
 - it provides an obvious mechanism to meet other 'more popular' commitments, ie. local health plan or environmental plans;
 - (ideally cross-party) political support exists at city and county level;
 - there has been previous investigation of road user charging issues and a clearly preferred option has emerged;
 - charges are not unevenly distributed on a limited section of the population;

- framework/contract protects local government from risk/costs during set-up;
- concerns over competition for business with nearby cities have been satisfactorily addressed;
- concerns over longer term economic effects on commercial and residential property and investment markets, retailing, visitors etc. have been satisfied.

This leaves us with the following ranking of schemes for political viability:

1st. DSRC or paper based permits in Central London or Bristol City Centre.

2nd. DSRC or paper based permits in Leeds City Centre.

The position of Bristol is in agreement with earlier work where the Bristol City Centre scheme is identified as being readily accepted and therefore politically viable. It may be that options for a cordon slightly further out from the city centre could deliver a road user charging scheme which delivers greater environmental benefit, whilst continuing to have the same high level of political viability.

The scheme will need to be packaged in such a way as to offer a valuable advantage to all categories of people affected by urban road user charging. From the analysis completed within Trafficflow, there is a convincing case for clear winners being the:

- Local authority.
- Road user switching to public transport.
- Continuing public transport user.
- Continuing pedestrian/local resident:
 - inside charging zone;
 - within city outside charging zone.

The case has not yet been decisively proven for:

- Businesses:
 - inside charging zone;
 - within city outside charging zone.
- Visitors.
- Continuing road user.

These will be targets for further work in phase 2, to determine how a road charging solution can be made attractive to these parties.

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	Scenarios								
	DSRC in London	DSRC in Bristol	DSRC in Leeds	VLP in London	VLP in Bristol	VLP in Leeds	Permits in London	Permits in Bristol	Permits in Leeds
Political Viability Options	1	2	3	4	5	6	7	8	9
Privacy Options	All Scenarios								
Minimum Visual Intrusion	✓	✓	✓				✓✓	✓✓	✓✓
Well defined objective for revenues matched to local aspirations	✓		✓	✓		✓	✓		✓
Size of revenue sufficient to fund transport improvements on necessary scale		✓✓	✓		✓✓	✓		✓✓	✓
Possibility for strong consumer proposition — especially any added value potential	✓	✓	✓						
Scheme can deliver on timescales of local election cycle i.e. within 2 years	All scenarios								
Scheme provides obvious mechanism to meet other commitments	✓		✓	✓		✓	✓		✓
(Ideally cross-party) political support at city & county level	✓	✓		✓	✓		✓	✓	
Previous Investigation of road user charging	✓✓	✓		✓✓	✓		✓✓	✓	
Burden not unevenly distributed on a limited section of the voting population	See below								
Framework/contract protects local government from risk/costs during set up and first year	Depends on contract								
Number of nearby cities in competition for business	✓	✓✓		✓	✓✓		✓	✓✓	
Possible long term local economic effects.	Not yet known								

Table 5–3: Summary of political factors effect on scenario
(more ticks the more positive for the scenario)

6 Next steps

6.1 Introduction

This document summarises the feasibility work carried out within Trafficflow. The completion of the feasibility study effectively marks the end of phase 1 of the initiative. Two further phases are planned, with work already in progress and scheduled to run through much of 1999. Details of the remaining phases are set out below.

6.2 Phase 2 – Detailed design

Phase 2 is now building on the leading scenarios identified from the feasibility. The aim is to detail the political, financial and operational aspects of feasible schemes meeting the needs of selected localities. By Spring 1999, the project will have a number of fully developed models for practical road user charging schemes.

Among the key issues being addressed in phase 2 are:

- public acceptance,
- scheme finance and objectives,
- contractual frameworks, and
- consumer proposition.

On scheme finance, dialogue is now needed between local authorities and financiers. This needs to focus on assessing what range of public transport or other schemes within local transport plans they might consider targets for road user charging scheme revenues, and therefore how the financing of such projects might work.

Further work is also needed on contractual frameworks to identify the type of consortium which might be able to operate a road user charging scheme and the arrangements under which such a public-private partnership could operate.

The consumer proposition needs to be developed further. Overall, schemes must address satisfactorily the case for those groups the most at risk from losing out in road user charging, including businesses, visitors and continuing road user.

6.3 Phase 3 – Implementation

The third phase of Trafficflow is concerned with turning the practical schemes into action plans for each of the key stakeholders (politicians, suppliers, operators, etc). Phase 3 will produce plans which are sufficiently detailed and practicable that they demonstrate to local stakeholders and national politicians that road user charging schemes could go ahead. Clearly, the project will not produce the 'last word' on implementation, but the aim is to produce a route map to the implementation of road user charging in the reference sites.