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Greater London Authority

Economic Impact of TRAFFIC LIGHTS

Study Report

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Executive Summary

Context

In recent years there has been a sustained debate on the role of traffic signals in London. The number of traffic signal installations has steadily increased with around a 1,000 new sets being introduced since the year 2000 so that the total is now over 5,000. At the beginning of 2009 there were 2,532 signalised road junctions in Greater London. These are roughly split 50:50 between inner and outer-London with two thirds on non-Transport for London roads. Stand alone signalised pedestrian crossings make up the remaining installations (these are not addressed in this study).

This increase in traffic signals has led to a perception that there are now too many and at the margins their benefits may be outweighed by increased congestion, or at least unnecessary delays outside peak hours.

The Mayor for London is committed to tackling congestion by ensuring smoother traffic flow and Transport for London (TfL) continues to review all London traffic signals to ensure that they operate in the most efficient way in line with their own and Department for Transport standards - so traffic is stationary for shorter periods of time, whilst maintaining pedestrian safeguards. TfL has examined various options for reducing the impact of traffic signals including allowing left-turns on red and the introduction of flashing amber (this would indicate the need for caution and to possibly give-way to conflicting traffic but not necessarily having to stop). Such changes, however, require government approval which to date has not been forthcoming.

To inform the debate on the cost and benefits of traffic signals GLA Economics commissioned Colin Buchanan (CB), in 2007, to undertake an initial exploratory study which used a model of a theoretical junction to investigate whether or not it is beneficial, in economic terms, to remove traffic signal control and revert in that instance to a major / minor road priority rule.

The initial study concluded that the economic benefits and disbenefits of traffic signals are heavily dependent not only on the volumes of traffic but also traffic composition, vehicle occupancy, pedestrian volumes and time of day. The study also highlighted that any assessment of traffic signals should take into account a wider spectrum of influencing factors including safety and network management issues. Whilst a theoretical study using a simplified approach, the initial work demonstrated that there was indeed merit in considering the issue in greater detail.

For this study, further analysis was undertaken using actual traffic flows at signalised junctions in London during different times of the day. Junctions were evaluated using an assessment framework to assess the requirement for traffic signals and to define the considerations required to determine suitable alternative methods of control in place of existing traffic signals.

In appraisal of transport schemes, an assessment is made of the impacts of the scheme on the welfare of transport users. Travel is a ‘cost’ in the sense that an individual has to spend time and money making a journey, so a reduction in those travel costs is considered to be an economic benefit. Economists use the concept of generalised cost which combines the monetary cost of a journey (fare, petrol costs, etc.) with the time taken for the journey and various attributes associated with that journey such as crowding.

Traffic signals impact on travel costs by either increasing or decreasing journey delay depending on the journey conditions. As journey purpose, volume of trips and modal split varies by time of day and location it is necessary to explore the impacts of traffic signals taking account of these variations.

The management of London’s road network is mainly the responsibility of TfL and the individual boroughs, however, the management of traffic signals is the sole responsibility of TfL. TfL’s Directorate of Traffic Operations (DTO) issues guidance to the boroughs with regard to the

circumstances where it is appropriate to install signals. In essence signals will be installed at a junction only if:

a) it has an accident rate equal to or greater than the average signalised junction in inner or outer-London as appropriate, and;

b) traffic flows are above a certain level, or;

c) turning traffic or pedestrian flows are above a certain level.

So traffic signals fulfil both a safety and a traffic management function. In the past the case for traffic signals was principally made on traffic conditions during weekday peak traffic periods. More recently account has also been taken of off-peak periods and weekends. The choice for junction control has, however, generally been between full time traffic signal control or conventional priority control without traffic signals, rather than also considering whether there is a case for having traffic signals operational only for particular times of day.

Methodology

In assessing the impact of traffic signals a representative sample of these 2,500 road junctions is needed. In choosing which junctions were modelled account was taken of:

- The availability of an existing and DTO approved traffic model
- The availability of all-day traffic flow data
- The location and type of junction
- Whether the junction was a stand alone junction or part of a network of junctions
- Safety (in principle there was no overriding safety reason why consideration should not be given to switching off the traffic signal)
- Junction geometry (principally linked to safety issues)

Following discussions with TfL, five junctions were chosen, namely

- A section of the Edgware Road covering seven separate junctions (all 4-arm junctions, inner-London)
- A312/B455 Target Roundabout (4-arm roundabout, outer-London)
- A13/River Road junction (3-arm junction, outer-London)
- East Barnet Road/Margaret Road (4 arm junction, outer-London)
- A215 Norwood Road/Palace Road (3-arm junction, inner-London)

These five junctions are broadly representative of two thirds of signalised junctions in London in terms of type and location, however it needs to be stressed that each junction is unique in terms of traffic volumes, composition and turning movements.

In modelling the junctions two scenarios were compared: ‘Do Minimum’, that is, the traffic signals operate as now yet with minor timing adjustments to achieve optimum performance if necessary, and ‘Do Something’ which is to remove the traffic signal control. In modelling traffic movements some assumptions are needed as to how traffic will react without signals. When the traffic signals are removed traffic is assumed to give-way to the right as normal on roundabouts, to give-way to traffic on the right on 4-arm junctions and to revert to major-minor road status for 3-arm junctions.

For each junction the model output included data on average delay per vehicle for the morning peak, inter-peak (ie the time between the morning and evening peaks), the evening peak and at night for the with and without traffic signal scenarios.

These delay figures were then converted to financial values using standard transport economic appraisal guidance from the Department for Transport. To do this account is taken of traffic composition, vehicle occupancy rates and journey purpose. This data comes from traffic counts and the London Area Transport Survey. The analysis valued the changes in time savings, vehicle operating costs and emissions between having traffic signals and no traffic signals by junction.

Modelling Assumptions

Transport modelling tools were used to develop computer simulations of real-life junctions where individual vehicle movements were simulated using established driver behaviour and car-following theories.

These micro-simulation models are regularly used throughout the UK for assessment of traffic operations and major new traffic generators such as property developments. The DTO has developed a number of such micro-simulation models for traffic junctions in London and provides guidelines for development and use of these models.

For the purpose of the present study, micro-simulation models approved by DTO were used to analyse a number of key performance indicators at selected signalised junctions. Each of the modelled junctions was used to analyse two sets of results: the existing situation and a scenario where the traffic signals are replaced with an alternate measure of control. These model results were then input into an economic model to determine the difference in economic terms between the with and without traffic signal scenarios.

These modelling tools represent only standard traffic behaviour. They are unable to accurately predict accidents and unobserved driver behaviour. In addition, there is currently no quantitative evidence in the UK that provides data on the likely form of behavioural response from road users including pedestrians before and after a change in junction control regime to the degree envisaged by this study.

In the absence of any substantial evidence, it was therefore assumed that if traffic signals were to be switched-off for all or part of the day, drivers would behave as they would normally do under whichever alternative traffic regime scenario was put in its place. For example, at a roundabout when the signals are removed they would 'give-way to the right' as usual while at a T-junction traffic on the minor arm would give-way to traffic on the major arm. This behaviour may be different to that commonly seen when traffic signals "fail" as there is usually little guidance to drivers, cyclists or pedestrians as to who has priority. It is not known whether these assumptions represent an optimistic or pessimistic evaluation of likely traffic capacity. Based, however, on anecdotal evidence from occasions when traffic signals fail, as well as engineering judgement, it is considered a reasonable approximation to the likely overall, average performance of the junction.

The present study highlights the limitations to firmly evaluating potential benefits of traffic signals; and the need for further understanding these potential behavioural responses through appropriate case studies.

Results

The results of the individual junction analysis showed considerable variation. All the junctions showed time savings at night by the removal of signals and hence an economic benefit. Four junctions showed benefits of removing signals during the inter-peak period, but at one, the Target Roundabout, there was a significant disbenefit due to the proportion of conflicting movements taking place. In three instances there are clear benefits from traffic signals in the morning and evening peaks.

The total benefits of signals by junction vary from a disbenefit of around £10,000 a year to a benefit of over £800,000 a year. These figures do not, however, fully take into account all the relevant costs and benefits. In some cases removing traffic signals reduces the capacity of the junction meaning it could not handle all the traffic which wished to pass through it. This leads to built up of a queue and the disbenefit to this traffic that is not able to pass through the junction is not captured by the model. In addition for reasons discussed below the results do not take account of the impact on pedestrians or safety.

While there were some similarities between the results by junctions, given the small number of junctions modelled and the fact that each junction is unique in terms of traffic composition and volumes it was not felt appropriate to scale up the results to a London wide figure.

Pedestrians

The results do not take into account the benefits and disbenefits to pedestrians. This is due to a lack of data on pedestrian movements during off-peak hours and also due to a lack of validated methods of forecasting and modelling pedestrian behaviour when traffic signals are not in use.

It is apparent from the analysis that there are disbenefits from removing traffic signals during morning and evening peaks, and this generally coincides with periods when pedestrian numbers are also high. The inter-peak period is more complex; in parts of London both pedestrian and vehicle numbers are high during this time, but in other locations numbers are much reduced.

Where it has been shown that there are benefits from switching off (or introducing flashing amber) traffic signals during certain periods, it is possible that these benefits would significantly reduce if pedestrian actuation of an all-red pedestrian crossing stage was introduced, resulting in additional delay to vehicles. This is more likely to be an issue at inner-London sites and could therefore negate any benefits. At night however, traffic and pedestrian movements are lower and disbenefits to pedestrians in most parts of London are likely to be very low.

Road safety

The results also do not take into account safety issues. There are very limited studies of the impact of removing formal control at junctions on road safety, and what data there is seems to provide mixed messages. The only recent study, published by TRL and commissioned by TfL, concludes that there is not a safety case one way or other when considering 'simplified streetscapes' (with minimal traffic regulations, signs and lines), and so it is possible that removal of signal control would have a neutral effect on safety.

Although there is data available regarding personal injury accidents that occur when traffic signals fail, it is rarely clear whether the accident occurred as a direct result of the signal failure, or if this was a coincidence and other factors such as weather conditions or lighting were not greater contributory factors. It is possible that the lack of guidance to road users on appropriate behaviour in these situations is an important factor, which would not be the case if traffic signals are removed or switched-off with sufficient advance warning and public awareness. The use of flashing amber signals at junctions to advise users on junction behaviour is seen as a method to reduce risk where it has been adopted on the continent. The UK, however, has no experience of using flashing amber signals to warn of potential conflicting traffic movements at junctions and its use would require alterations to highways legislation.

The average cost of a personal injury accident on London's road network is around £90,000 and an assessment would need to be made at each location where traffic signals could potentially be removed or switched-off to ascertain what, if any, are the safety risks and whether there is likely to be a net gain in economic benefits when compared to possible savings in travel time.

Conclusions and Recommendations

The study has demonstrated that on the basis of the junctions modelled there are significant benefits to road users arising from having traffic signals in London. If benefits to pedestrians were added and account taken of the higher junction capacity that signals can provide this figure would be higher. The study also shows that there are benefits of removing traffic signals in certain locations and at certain times provided safety was not compromised.

It is recommended that consideration is given to a pilot of switching off traffic signals at junctions at times when the level of traffic does not justify such controls subject to a safety audit. There is present Department for Transport guidance as to the level of daily traffic that justifies particular types of traffic control. Based on this guidance it is possible to determine the hourly level of traffic below which formal control is not necessarily appropriate and therefore junctions which could be piloted. (The actual traffic numbers depend on the flows on each arm of the junction so is not a single number.)

In the UK legislation does not allow for the use of switching all signals at a junction to flashing amber at less busy times, a measure which is commonplace in a number of European countries. We recommend discussions should take place with the appropriate European traffic authorities to obtain evidence and ascertain their views on the impact that such traffic control methods have on safety, vehicle and pedestrian movement.

The study assumes that when traffic signal control is disabled, traffic behaviour would revert to some form of conventional priority control, which might even be stipulated through analysis of traffic demand and turning patterns and the use of advance signing. It is possible, however, that junctions could operate without any imposition of regulated traffic controls, with the expectation that road users would behave appropriately. This form of behaviour cannot, at present, be modelled – yet it is recommended that scope for this form of uncontrolled arrangement is also investigated. This can only be achieved through live trials at a variety of sites. The results would have the potential of determining precisely how traffic would behave at ‘shared space’ type environments and could provide unparalleled knowledge in this field. Such work would also need to monitor the behaviour of pedestrians.