WORKING PAPER

ITLS-WP-11-03

No car lanes or bus lanes: which gives public transport the better priority? An evaluation of priority lanes in Tyne and Wear

By

Corinne Mulley

February 2011

ISSN 1832-570X

INSTITUTE of TRANSPORT and LOGISTICS STUDIES

The Australian Key Centre in Transport and Logistics Management

The University of Sydney

Established under the Australian Research Council's Key Centre Program.

NUMBER: Working Paper ITLS-WP-11-03

TITLE: **No car lanes or bus lanes: which gives public transport the better priority? An evaluation of priority lanes in Tyne and Wear**

ABSTRACT: Bus priority covers a wide range of measures intended to speed up the progress of buses and avoid congestion, especially in urban areas. The implementation of No Car Lanes as a method of allocating space on the highway differs from conventional bus priority measures since No Car Lanes give priority not just to buses but to other vehicles, facilitating the movement of goods as well as people in congested urban areas. This paper compares the impact of the different eligibility requirements of 'warrants' on the different classes of traffic using the road network in the single location of Tyne and Wear in the north-east of England, UK and reports quantification of benefits and disadvantages to give an improved understanding of the contribution of No Car Lanes within the more general context of bus priority measures. The motivation for the study was to give an evidence based approach to the development of conurbation-wide policy.

The paper concludes that the balance of evidence suggests No Car Lanes are preferable for all motorised modes (car, HGV, taxi and bus). From a practical point of view having many short lengths of priority lane (of whatever form) lowers the benefit arising from priority as well as having an adverse effect on user and non-user attitudes towards priority lanes. The modelling suggests that the impact on the environment is less negative from No Car Lanes. Against this is the less positive evidence for No Car Lanes in terms of road safety and enforcement.

KEY WORDS: ***Bus priority; no car lanes; policy evaluation.***

AUTHORS: Corinne Mulley

Acknowledgement: This paper is based on work undertaken for the Tyne & Wear Core LTP Team to evaluate the operation of the various types of bus priority measure on the Tyne and Wear road network. The author acknowledges the contribution of JMP Consulting, Newcastle to the work undertaken on this project. The accountability for error remains the responsibility of the author.

CONTACT: INSTITUTE of TRANSPORT and LOGISTICS STUDIES (C37)
The Australian Key Centre in Transport and Logistics Management

The University of Sydney NSW 2006 Australia

Telephone: +61 9351 0071
Facsimile: +61 9351 0088
E-mail: business.itlsinfo@sydney.edu.au
Internet: http://sydney.edu.au/business/itls

DATE: February 2011

1. Introduction

Prioritising public transport is not new. For rail systems running on-street, priority has been in existence for 70 years (TCRP 2010). The more recent concern has been with prioritising public transport vehicles in streets with mixed vehicle use and this relates more directly to prioritising buses. Bus priority covers a wide range of measures intended to speed up the progress of buses (and other selected groups of users, particularly the emergency services and sometimes taxis) and avoid congestion, especially in urban areas. The measures have been introduced as a way of prioritising the allocation of road space as a second best measure, with the first best measure being the introduction of a tax to reduce congestion. The relative importance attached to bus priority measures by stakeholders has fluctuated over time although the promotion of public transport is identified as a clear priority in current transport policy for many jurisdictions. Indeed, the recent interest in bus rapid transit (BRT) systems, as shown by the upsurge in their implementation, has brought renewed interest to prioritising on-street public transport.

Bus priority schemes generally involve physical measures such as bus lanes (with flow and contra-flow), bus only streets, bus gates, rising bollards and guided bus ways. Most measures are normally integrated with traffic control systems designed to give buses priority over other road traffic. Current best practice emphasises that bus priority measures work best in co-ordination with other traffic measures such as bus friendly traffic calming, anti-rat-run measures, careful placing of street parking and loading bays. The basic principles of bus priority can be applied in a number of different ways using a network approach applied to a complete bus network or on a whole route approach (considering particular routes, for example from city-centre to airport); using a corridor strategy with priority being implemented on, for example, the main ways in to town, used by many routes; or a “hot spots” approach which is especially common in the selective use of guided busway as in Leeds and Bradford in the UK.

The understanding of priority lanes is informed by a broad literature covering the role of specific types of priority within a given network or corridors or the impact on particular class of vehicle or passenger. This paper first reviews the relevant literature to this empirical study before turning to the nature of the problem in the case study area of Tyne and Wear in the north-east of England in the UK. This is followed by an explanation of the study methodology and results on the different impacts considered of journey times, environmental effects, road safety, traffic flow, the level of contravention in priority lanes, and the opinions of travellers to bus priority measures. The final section concludes with an assessment of the transferability of this study to other applications of bus priority.

2. Bus priority measures

The review of literature relevant to this paper is restricted to examining the impact of the reservation of road space for use by public transport vehicles. It does not consider the extensive literature on traffic and intersection optimisation per se which focuses on traffic systems nor the impact of bus priority on the quality of service literature where the emphasis is on increasing bus patronage. The literature on bus priority nevertheless has a number of dimensions. On the planning side, there are a number of standard sources of information to assist practitioners with the implementation of bus priority measures and many of these are country specific. For example, IHT (1997) and a DfT (2004) resource pack provide guidance and case studies in the UK. In the US, a comprehensive review of different priority treatments was presented by the National Research Council in 1973 (Levinson et al. 1973) which included international evidence and this was followed by planning and design guidelines two years later (Levinson et al. 1975). On the operational side, the literature related to bus priority has overwhelmingly been concerned with the different travel time savings associated with the different possible priority treatments covering curb side lanes and curb extensions, exclusive lanes such as used in BRT, signal priority (whether by signal priority or signal phasing) and queue jump or bypass lanes. A synthesis document (TCRP 2010) provides an overview of this evidence.

The studies reported in the literature concentrate on the identification of time savings through the creation of priority. The majority use simulation, particularly micro-simulation methodologies, to investigate travel time savings to the public transport vehicles (Tanaboriboon and Toonim 1983, Shalaby 1999 for example). More recently, Arasan and Vedagiri (2010) reported the results of modelling the impact of the heterogeneous nature of traffic on mixed use streets, using calibration data for Chennai, India. This study is unusual for considering the impact of an exclusive bus lane on all traffic in terms of different speeds (and implied travel time implications) but the mix of traffic including significant quantities of motorised two and three wheelers is somewhat different from the mix experienced in many developed conurbations.

Apart from the studies concentrating on travel time savings, there are relatively few examples of literature considering the wider impact of bus priority schemes. The most comprehensive and recent paper, Currie et al. (2007), identifies limited evaluation criteria (or where more comprehensive, no indication as to how the criteria should be measured), simplified traffic flow modelling and limited travel behaviour modelling as a constraint to understanding the wider impacts of bus priority schemes. Currie et al. (2007), using a modelling approach, carries out an economic evaluation which considers not only the resource impacts of the infrastructure, the travel and reliability impacts on both public transport and private vehicle users and changes to the fare box revenue thus capturing patronage effects, but also some externality impacts.

In terms of our understanding of the impacts of bus priority, previous studies have a number of problems. Those focussing on planning guidelines have used evidence of different treatments in different locations but the location of the priority system in terms of traffic flows and of complementary measures such as parking policies or the level of enforcement can have a significant impact (May and Gardiner 1990; Cooper et al. 2001; LEK 2002; CPT 2002). In terms of simulation methodologies, the studies fall short by their more specific applicability to a location, even when calibrated to a locality, and by their concentration on travel time savings. Perhaps more importantly, the studies focus on a specific type of bus priority, for example, curbside lane or exclusive lane without recognising that in different jurisdictions the ‘warrants’ or conditions of a specific type of measure may differ in which vehicles of the traffic mix may use priority lanes.

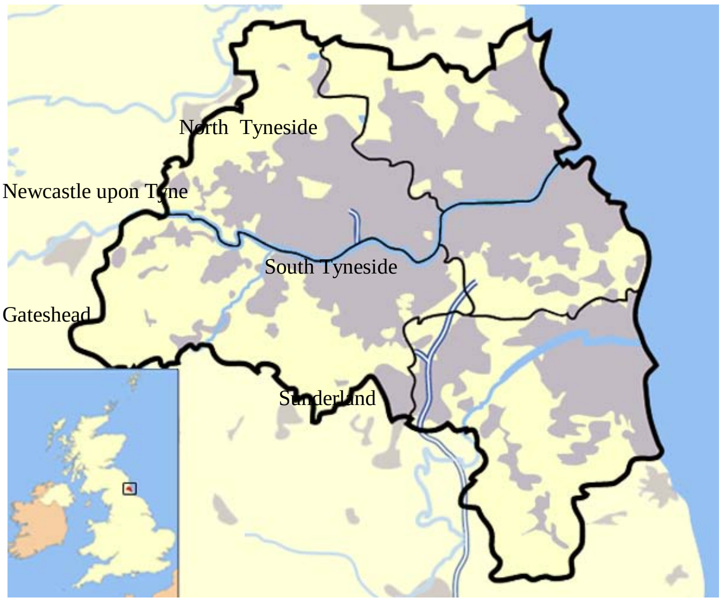
The study reported in this paper addresses some of these issues. The purpose of the study was to assess and quantify the benefits of priority lanes in the conurbation of Tyne and Wear in the north-east of England. An improved understanding of priority lanes was identified as key to informing policy development across the conurbation and required an understanding of the range of impacts. The case study area contains a number of different warrants for bus priority operation and thus provides an opportunity to examine how the different vehicles within the traffic mix are affected by the different priority conditions. The assessment included an investigation of the road safety, traffic flow and level of contravention of the priority lanes. The empirical evidence from the case study is enhanced by the use of a simple microsimulation model which allows different travel times and environmental impacts of different warrants to be investigated. Finally, opinions of a sample of travellers of all modes were sought to gauge the public’s view as to the effectiveness of the existing priority policy and its impact on the quality of public transport provision.

The paper next considers the nature of the priority lanes in Tyne and Wear before identifying the general methodology used in the study. This is followed by more detailed information on the data sources used which are linked to the results on the different impacts.

3. Priority lanes in Tyne and Wear

Tyne and Wear is a conurbation in the north-east of Britain and consists of five District authorities as shown in Figure 1.

Figure 1: Location of Tyne and Wear and its constituent district authorities



Source: Based on Wikipedia map, with additional labelling of district authorities.

The approval of priority lanes on highways is under the jurisdiction of the District authorities through the establishment of a Traffic Regulation Order (TRO) and this has given rise to two main types of priority lanes in Tyne and Wear: Bus Lanes and No Car Lanes. In general terms, Bus Lanes may be used only by local buses. They assist the movement of buses around congested city centres by reducing journey time and improving reliability. No Car Lanes are based on use of the lane by buses, goods vehicles and some other modes of transport, but cars are prevented from using the designated lane. In addition to helping the movement of buses and goods vehicles, No Car Lanes can potentially increase road capacity in some cases by segregating wider vehicles from standard vehicle lanes. Newcastle City Council has led the way in the implementation of No Car Lanes which required special authorisation for the TRO from the Secretary of State for Transport. The approach has subsequently been extended to Sunderland following the re-designation of the A690 Durham Road Bus Lane to a No Car Lane (again with special authorisation of the TRO).

Table 1 shows the type and length of priority measure by local authority district in Tyne and Wear. Of the 29.11km of priority measure in the conurbation, 17.36km (60%) are Bus Lane and 11.75km (40%) are classified as No Car Lane. Considering just the Bus Lanes, Gateshead has 47% of the length, Sunderland 21% and Newcastle 17%. North Tyneside and South Tyneside both have less than 10%. Considering just No Car Lanes, Newcastle has the majority (75%) with Sunderland (24%) and South Tyneside (1%) the remainder. Gateshead and North Tyneside do not have any No Car Lanes.

		Length of Priority Measure (m)					
Main Category	**Type**	**Gateshead**	**Newcastle**	**North Tyneside**	**South Tyneside**	**Sunderland**	**Total**
Bus Lane	Bus & cycle only	1,179			1,350	1,748	4,276
	Bus & taxi only	93			236	329	658
	Bus Lane	621	72			1,543	2,236
	Bus, taxi & cycle lane	3,662	2,533	1,019			7,214
	"Centrelink"	2,640					2,640
	No entry except buses		110				110
	Pedestrian zone		223				223
Bus Lane Total		8,194	2,938	1,019	1,586	3,620	**17,357**
No Car Lane	Buses, HGVs & Vans only				154		154
	No Car Lane		8,632			2,771	11,402
	No Cars		197				197
No Car Lane Total			8,828		154	2,771	**11,753**
Total		**8,194**	**11,766**	**1,019**	**1,740**	**6,391**	**29,110**

Source: JMP / Newcastle University (2006)

Table 1: Priority measures in Tyne & Wear by type and district

The majority of Bus Lanes are operational for 24 hours (84%) with 10% operating 7am-7pm. The remaining 6% are designed for specific locations or purposes. Conversely the majority of No Car Lanes are 7am-7pm (73%) with the remaining 27% operating 24 hours. The majority of measures are located on routes that experience flows of between 100 and 500 vehicles in a morning peak hour (8am till 9am). However there are some exceptions where measures are present and peak flows are low as well as routes where there are high bus flows but no measures.

Overall, in Tyne and Wear the pattern of priority measures appears to have no common rationale for implementation either on a flow basis, the type of measure and times of implementation and this was confirmed by Local Transport Planning Officers.

4. Methodology

One of the challenges faced by the study was that there are little available data on the traffic conditions before the No Car Lanes were introduced although the research team were advised that feedback from user groups has been positive following their implementation. The lack of available data meant that the traditional approach of comparing conditions before and after implementation was not available and there was little merit in doing extensive new primary research on the 'after' situation as this would have no matching data. The study resources were instead focused on assembling the various pieces of analysis that had previously been undertaken and combining this with some new modelling analysis and an understanding of the perceptions of road users. The intention was to draw conclusions as to the merits of implementing further No Car Lanes, whether recent examples of conversion of Bus Lanes to No Car Lane should be continued or extended, or whether other types of measures may be more effective.

The approach taken was to select a subset of corridors chosen in Tyne and Wear that had been subject to monitoring for the purposes of congestion and bus punctuality improvement. Twelve of these were chosen covering a mixture of No Car Lanes, various bus priority lanes and corridors without any measures in order to undertake appropriate comparisons. This approach meant that a variety of data was available to explore aspects of priority implementation. The data sources used are outlined in more detail in the discussion of the results under each of the headings of journey times, the environment, road safety, traffic flow and lane contravention or misuse. An assessment of public attitudes towards the different priority measures was undertaken as part of the study.

5. Results

5.1 Impact on journey times

Three potential data sources were identified which provided information on one or more of the corridors selected that allowed a comparison between before and after implementation of the priority measure.

The first was a study undertaken for one corridor before and after the introduction of one of the No Car Lanes. Traffic surveys were undertaken although journey times for Heavy Goods Vehicles (HGVs) were not collected in the after survey. A comparison of journey times for buses and cars showed that some journey times reduced and others increased. However, the traffic flows also changed between 2004 and 2005 so it is not possible to say that it was the change of measure from Bus Lane to No Car Lane that caused the change in journey time.

The second data source was to utilise the bus punctuality data provided by Nexus (the Tyne and Wear Passenger Transport Executive), for a number of corridors within the conurbation where data had been recorded for 3 different days. To use the data to assess the impact of priority measures on bus journey times it was necessary to extract the data on the study corridors that had a priority measure in one direction. The hypothesis was that the bus journey time in the direction that had a priority measure would be lower than that in the other direction.

The measured journey times could be affected by the traffic flows in each direction at particular time periods. For example, journey times on a section of road that has a priority measure, but which is inbound into a city centre, may have journey times higher than the outbound section in the morning peak. To account for this, classified traffic counts were also utilised in the assessment. The results are shown in Table 2. This shows that in one case the mean journey time with a priority measure is greater than that without a priority measure (A690 Durham Road); in another case the mean journey time with priority measure is less than that without priority measure (A186 Westgate / West Road); and in the third case the means are not significantly different (B1318 Great North Road). The conclusions are therefore ‘mixed’.

Site	Type of Measure	Mean JT* With Measure (s)	Mean JT* Without Measure (s)	Is JT* With Measure < JT* Without Measure?	Significantly Different at 5% level?
A690 Durham Road	No Car Lane	157.03	132.42	No	Yes
B1318 Great North Road	Bus Lane	642.06	634.17	No	No
A186 Westgate / West Road	No Car Lane	298.82	354.18	Yes	Yes

JT = Journey time

Source: JMP / Newcastle University (2006)

Table 2: Summary of mean bus journey time – Nexus punctuality data

The third data source was data providing a 15-minute link level average journey times using GPS position data from individual vehicles. This data was investigated because it was the only readily available source that included HGV journey times as these data are available for cars, heavy goods vehicles (HGVs), light goods vehicles (LGVs), and long distance coaches (but not local buses). To allow comparisons to be made across two modes (car and HGV) the journey time data was converted into speeds using the supplied link lengths. Linear regression analysis was undertaken to investigate the relationship between car speed and HGV speed. The purpose of the analysis was to see if HGVs gain any speed advantage on sections of routes that have a No Car Lane as compared to the more conventional priority lanes where HGVs and LGVs are excluded.

Type of Priority	N	R Square	Slope
No Car Lane	372	0.521	0.673
Bus, taxi & cycle lane	324	0.287	0.502
Bus & cycle lane	60	0.399	0.525
No Measure	3,588	0.418	0.674

Source: JMP / Newcastle University (2006)

Table 3: Linear regression HGV v car speed

The results are shown in Table 3. The data are somewhat limited but the regressions suggest that there is a linear relationship between car speed and HGV speeds, although it should be noted that there is a much greater frequency of 'no measure' observations in the dataset. The slope of the linear regression is always less than 1 which indicates that in general HGV speeds are less than car speeds. For a given HGV speed, there is little difference for cars between no priority at all and No Car Lanes. For the same HGV speed, the car speed is higher when other forms of priority measure are implemented. No Car Lanes, everything else being equal, would appear to be better for HGVs but it would be difficult to say that this analysis offers conclusive evidence.

In the case where no specific evaluation process was set up in advance of the implementing the 'No Car Lane' priority, the preceding analysis has shown the problems of analysing 'real' data when attempting to understand the impacts of various types of priority measure on journey times and reliability. The microsimulation package, VISSIM, was therefore used to examine a variety of factors which could affect vehicle journey times under different forms of priority. A 2 lane length of road was modelled that allowed a number of options to be tested, including a signal controlled junction. The type of vehicles allowed to use the nearside lane was changed depending on the type of priority measure being modelled.

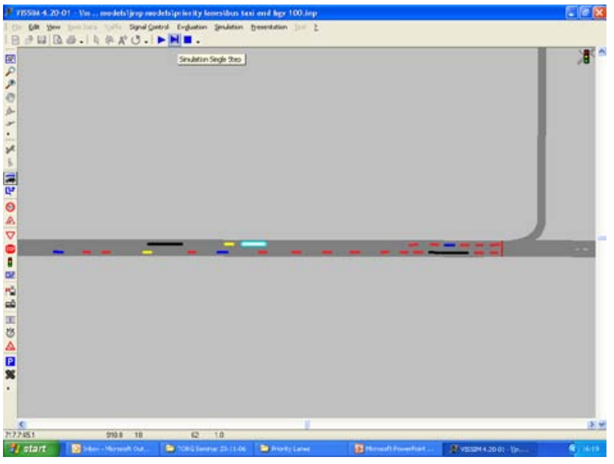
For each different priority measure, the length of the priority measure, total flow of traffic, percentage of HGVs in the traffic mix, percentage of taxis in the traffic mix, and bus headway were varied around values that were observed typically in Tyne and Wear. For each test, three runs were performed, each with a different random seed to start the process. The simulation period was 3600 seconds (1 hour). A second series of tests were run with a banned left turn. The factors tested in the model are shown in Table 4 and a screen shot of the model is shown as Figure 2.

OTHER FACTORS	# Levels	Value1	Value2	Value3
1. Bus Headway (s)	2	300	120	
2. Length of Priority Lane (m)	3	100	300	500
3. Traffic Flow (vehs/hr)	2	800	1000	1200
4. Percenatge HGV	2	5	10	
5. Percentage taxi	2	5	10	

Source: JMP / Newcastle University (2006)

Table 4: Factors tested in the microsimulation model

Figure 2: Screen-shot of VISSIM model



Source: JMP / Newcastle University (2006)

The results show that the mean journey time does vary by vehicle type by type of priority. In general, increasing the level of priority leads to an increase in journey time, for all vehicle types. Table 5 shows that the percentage increases over the 'no priority' reference case for each type of vehicle vary with buses showing the smallest increase in journey time with the 3 options tested and HGVs the highest.

Vehicle Type	Variable	No priority (Ref Case)	Type of Priority Measure: No Car Lane	Bus & Taxi	Bus Lane
Car	Mean Journey time (s)	124.03	127.90	130.54	133.47
	Increase with respect to the reference (no priority) case(%)	-	3.1%	5.2%	7.6%
LGV	Mean Journey time (s)	124.92	128.57	131.26	134.04
	Increase with respect to the reference (no priority) case(%)	-	2.9%	5.1%	7.3%
Taxi	Mean Journey time (s)	125.08	125.37	126.55	134.89
	Increase with respect to the reference (no priority) case(%)	-	0.2%	1.2%	7.8%
HGV	Mean Journey time (s)	126.62	127.03	134.27	137.68
	Increase with respect to the reference (no priority) case(%)	-	0.3%	6.0%	8.7%
Bus	Mean Journey time (s)	227.01	227.48	228.55	230.01
	Increase with respect to the reference (no priority) case(%)	-	0.2%	0.7%	1.3%

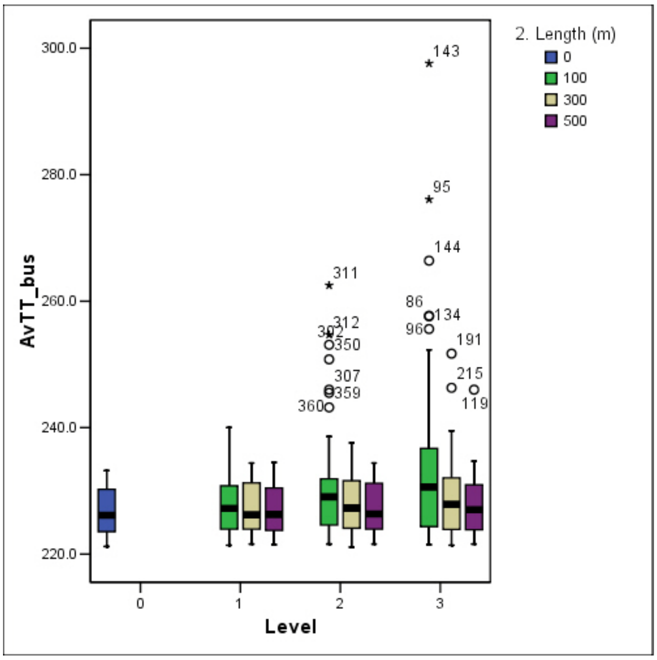
Source: JMP / Newcastle University (2006)

Table 5: Mean vehicle journey time by priority level - microsimulation data

Looking at different levels of headway for buses showed that average journey times were significantly different (with a p-value of 0) for a doubling of headway but little variation between the different priority types. In contrast, the effect of headway on HGV speeds showed insignificant differences although greater variability in average speeds for bus and taxi and bus only priority. Reliability of travel times is just as (if not more) important than mean journey time. A comparison of the mean and standard deviation of journey time by vehicle type by type of priority using the ratio of standard deviation to mean as the measure of variability showed that the Bus Lane had the highest variability for all vehicle types, while the No Car Lane shows values only slightly higher than the Reference Case of no priority for all vehicle types.

The length of priority lane was also varied within the microsimulation model. Post hoc comparison of means indicated that the mean for 100m length lane is significantly different from the other lengths (0m, 300m and 500m). A box plot of the mean data for buses is shown in Figure 3. The black strip across the coloured box represents the median with the outer edges of the box representing the interquartile range. Any times which are 1.5 times that of the upper or lower interquartile range create the 'whiskers' of the plot with outlying data being represented as a circle or for more extreme cases an asterisk. The headings on the x-axis of the graphs refer to the type of bus priority measure; No priority measure is level 0, No Car Lane is level 1, Bus and Taxi Lane is level 2 and Bus Lane is level 3. Means and standard deviations were also calculated for each average journey time. T-tests and ANOVA were used to test the significance of the difference of the means.

Figure 3: Average bus travel times by length and type of priority measure



Key: 0 is the reference (no priority) case, 1 is the 'No car lane' priority access, 2 is priority lane allowing bus and taxis, and 3 is a priority lane allowing buses only.

Source: JMP / Newcastle University (2006)

As the wider the spread of data for a particular scenario gives a wider range of journey times, this can be particularly a disadvantage for buses as it makes accurate timetabling difficult. From the graph it can be seen that the scenario with the widest spread of data, by quite some margin, is the 100m long Bus Lane. The difference between the quickest and slowest time is about 76 seconds (32% of mean), which is considerable. The overall trend seems to be the longer the bus priority measure the less the travel times vary. This is particularly obvious when looking at the box representing the 500m long bus and taxi lane. However the more classes of vehicles that are allowed to use a lane the greater the distribution of travel times and the more prone it is to having extreme times. Level 0, which demonstrates no priority measures, performs the best out of all the scenarios.

For HGVs, the modelling suggests that the effect the length of bus priority measure has on HGV travel is negligible. HGV travel time does not decrease when able to use the No Car Lane however the width of the distribution does become narrower making travel times more consistent. The distribution of car journey times and median travel time dramatically increase with the length of bus priority measure, and further increases when more classes of vehicle can use the priority measure. Although, due to the large distribution of results, car journey times could be unaffected there is a greater chance that a journey could take an unpredictable amount of time. The only exception is for Bus Lanes where, as the length increases, the distribution of car travel times also decreases. As expected, the inclusion of any bus priority measure has a significant detrimental effect on car journey times which is part of the strategy to encourage public transport use.

The modelling suggests that the effect traffic flows have on car journey times is large. As flows increase car journey times increase exponentially as does the variability in the time distribution. No Car Lanes show the most extreme results. For a flow of 800 vehicles per hour there is a median of 122 seconds but for 1200 vehicles per hour the median is 143 seconds. Higher percentages of taxis in the traffic flow had a negligible influence on the journey times of buses, HGVs and cars. Higher percentages of HGVs in the traffic flow had insignificant effects on car and taxi journey times and very little effect on HGV journey times, but did have a detrimental effect on bus journey times with these increasing as the percentage of HGV vehicles in the traffic flow increased.

These results suggest that, in general, longer lengths of priority measure should be preferred. In Tyne and Wear, there are many short lengths of priority lanes in order to allow car drivers to turn left. Intuitively, the reason for this result is that it is vehicle upon vehicle interactions that lead to a slowing down of all vehicles on the road which is a result supported by a study in Australia (Currie et al. 2007). This is reinforced by the general literature on bus priority which suggests that priority schemes work best operated alongside complementary traffic measures.

5.2 Environmental impacts

To evaluate environmental impacts defined as fuel use and pollutants, the same set of VISSIM models were re-run at 1-second time step to generate output suitable for input to the add-on EnvPro software. This calculates various pollutants and fuel consumption from the speed and acceleration of every vehicle at every time step. Table 6 shows the mean value for each pollutant variable generated during the simulation run, by type of priority. Post hoc comparison of the means indicates the group means are all significantly different from each other. All means increased as the Priority Level changed in the following order from No Priority to No Car Lane to Bus and Taxi Lane to Bus Lane suggesting that the minimum environmental impact is made with no priority measure and that of the available priority measures, No Car Lanes fared best.

Pollutant	Variable	No priority (Ref Case)	No Car Lane	Bus & Taxi	Bus Lane
		Type of Priority Measure			
Carbon Monoxide	Mean (g/km)	5.333	5.472	5.590	5.711
	Increase with respect to the reference (no priority) case(%)		2.6%	4.8%	7.1%
Nitrous Oxide	Mean (g/km)	0.711	0.718	0.724	0.730
	Increase with respect to the reference (no priority) case(%)		1.0%	1.8%	2.7%
Hydrocarbons	Mean (g/km)	0.538	0.551	0.561	0.572
	Increase with respect to the reference (no priority) case(%)		2.4%	4.3%	6.3%
Carbon Dioxide	Mean (g/km)	162.404	166.644	170.282	174.061
	Increase with respect to the reference (no priority) case(%)		2.6%	4.9%	7.2%
Particulate Matter	Mean (mg/km)	5.431	5.573	5.694	5.820
	Increase with respect to the reference (no priority) case(%)		2.6%	4.8%	7.2%
Fuel Consumption	Mean (l/100km)	13.139	13.207	13.267	13.339
	Increase with respect to the reference (no priority) case(%)		0.5%	1.0%	1.5%

Source: JMP / Newcastle University (2006)

Table 6: Mean emissions / fuel consumption by priority level - microsimulation data

5.3 Road safety

To evaluate road safety impacts, data from the Tyne and Wear Traffic and Accident Data Unit (TADU) was used. TADU is responsible for collecting traffic flow data from an extensive network of automatic traffic count sites that it manages in Tyne and Wear. It also holds a database of manual traffic counts. Using this TADU database allowed the examination of all personal injury accidents for Tyne and Wear between January 2003 and December 2005. For the purposes of this study accidents that occurred on the same stretch of road within 50m of a bus priority lane were examined.

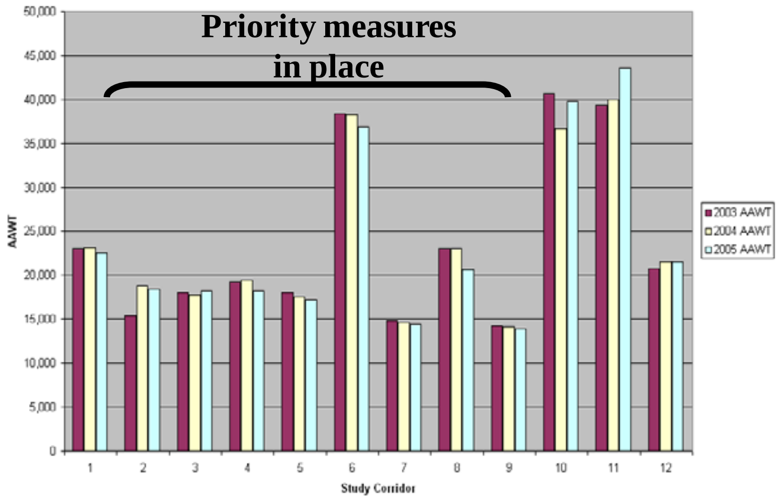
The highest number of serious accidents (defined as an accident when a person is detained in hospital as an 'in-patient') occurred in the Haymarket area in the city centre of Newcastle. Due to the city centre location there is a higher proportion of pedestrian accidents, and potential conflict with buses, which would account for this. Out of the 360 personal injury accidents that occurred during the 3 year study period, 19 (5.3%) of them were attributed to the existence of priority measures on the corridors. Of these 19, 18 were slight (defined as an accident when a person receives injuries only requiring roadside assistance or no medical treatment) and one was serious.

The highest proportion of personal injury accidents attributed to the a priority measure was found with a bus, cycle & taxi lane. Out of the 75 slight accidents that occurred, 7 of them were due to the bus priority measures (9.3%). But the figures for all types of priority were low. This evidence does not show that one type of priority should be preferred to another, on grounds of road safety.

5.4 Traffic flows

Traffic flows and volumes were of interest in this study as there is a general preconception that the implementation of priority measures has the effect of diverting traffic onto routes where there is not priority. The concern here is that diversion may take place on roads less suitable for high volume flows and would therefore be undesirable. Using a number of Automatic Traffic Counts (both cordon and screenline) collected by TADU, this was investigated for the corridors examined in this study. The results are shown in Figure 4.

Figure 4: Annual average daily total traffic flows for the corridors in the case-study area, comparing those with and without priority measures in place



Source: JMP / Newcastle University (2006)

Figure 4 shows that in general traffic volumes on those corridors with existing bus priority lanes (corridors 1-9) have reduced year on year with corridors 2 and 3 being exceptions to this. Bus priority measures were only introduced on site 2 in 2005 and site 3 is a dual carriageway which has spare capacity within the current road layout. Unconstrained corridors have generally shown an increase in traffic volumes. Specific areas of vehicle diversion, highlighted by the District Councils, were considered in more detail but there is little hard evidence to support significant increases in diverted traffic, despite public concern and concern raised by Councillors. The fact that the reduction of road space to private cars has been accompanied by a decrease in volumes is more likely to be an expression of 'disappearing traffic' identified by Cairns (2002) which comes about through a mixture of mode shift, trip diversion/re-timing/re-routing or trip suppression in the presence of enhanced congestion. This is also consistent with the Downs Thomson paradox discussed in Wood (2007).

5.5 Lane contravention or misuse

There is a general perception that priority lanes are badly enforced and that this limits their effectiveness. The issue of contravention or misuse was considered by using manual classified counts, collected in 2005 and 2006 for a 14 hour period. Table 7 summarises the information from a number of sites, categorised by the type of priority.

	Cars in all veh lane	Cars in priority lane	%age violati on
All No Car Lane Sites	**36,846**	**911**	**2.41%**
All Bus Lane Sites (excl Great North Road))	**27,605**	**198**	**0.71%**

Source: JMP / Newcastle University (2006)

Table 7: Percentage violation for priority lanes

The results show that overall contravention of Bus Lanes measures is lower in comparison to a No Car Lane with 2.41% of general traffic users likely to commit an offence (compared to 0.71%). A more detailed examination shows that cars are more likely to use No Car Lanes in the evening peak period particularly in the final hour that enforcement applies. Whilst this would appear to favour Bus Lanes over No Car Lanes, this data needs to be treated with caution since the data related to Bus Lanes which are 24 hour lanes whereas the No Car Lanes were only active between 7am and 7pm. Nevertheless, enforcement generally is more difficult the less homogeneous the permitted traffic in a particular road space. In this context, Bus Only Lanes are least problematic as a vehicle which is not a bus is unambiguously contravening the priority.

5.6 Community perceptions of bus priority in Tyne and Wear

Two web-based questionnaires were designed to elicit views about priority traffic lanes for motorised traffic in the Tyne and Wear area. One was targeted at the general public, both users and non-users of the road space, and a second targeted more specifically at road haulage operators who are critically affected in a comparison of No Car Lanes versus the more conventional priority lanes.

The general public questionnaire elicited over 1300 responses. Whilst the respondents were not typical of the population of Tyne and Wear as a whole, being under-representative of non-working adults, these respondents were more likely to be travelling in peak times and to be aware of any impact of priority lanes. The road haulage questionnaire only achieved a small number of respondents and the results of this must be treated more tentatively.

There were a significant number of respondents who showed lack of awareness of the presence of priority lanes on their most frequent journey and when travelling on corridors which had some element of priority. However, it would be possible to travel on a corridor which had some element of priority but not travel on the section with priority. To screen for this, a subset of the data was further examined: this contained respondents who identified their destination as one where it would be impossible not to encounter priority lanes on their most frequent journey. The subset provided a sample of 730 respondents and still showed a high percentage of respondents (nearly 30%) unaware of priority lanes. Whilst some of this is understandable when the most frequent mode of travel is public transport, just over 20% of respondents arriving at their destination by car were unaware of priority lanes.

To elicit attitudes to priority lanes, the questionnaire offered statements about traffic priority lanes for respondents to identify their degree of agreement. Table 8 summarises the responses on opinions as to whether priority lanes are good or bad and the issues of enforcement, to complement the quantitative data above. Table 8 is restricted to respondents who used a road based mode of transport for their most frequent journey and who claimed to be aware of traffic priority lanes on this journey (836 respondents).

Mode of travel on most frequent journey	Bus	Car (as driver)	Car (as passenger)	Bicycle	Motorcycle or Moped	Walk	Mixed	Taxi
Number of respondents	*156*	*517*	*49*	*72*	*11*	*18*	*9*	*4*
Attitudes in general to priority lanes								
No car lanes and bus priority lanes are a good idea because bus journeys are quicker	0.82%	0.25%	0.49%	0.71%	0.36%	0.61%	0.78%	0.75%
No car lanes and bus priority lanes are a bad idea because car journeys are slower	0.04%	0.38%	0.27%	0.08%	10.09%	0.11%	0.00%	0.00%
No car lanes are better than bus priority lanes for car drivers because commercial vehicles go with the buses	0.2%	0.31%	0.31%	0.13%	0.36%	0.22%	0.00%	0.75%
No car lanes are worse for bus users than bus only priority lanes	0.16%	0.05%	0.10%	0.15%	0.00%	0.22%	0.44%	0.00%
It upsets me to see buses going faster than my car	0.01%	0.06%	0.02%	0.01%	0.00%	0.00%	0.00%	0.00%
Enforcement issues								
No car lanes and bus priority lanes should be better enforced so that illegal use is stopped	0.53%	0.50%	0.47%	0.58%	0.36%	0.50%	0.78%	1.00%
Car drivers seem to respect the No Car Lane rules	0.38%	0.39%	0.39%	0.47%	0.27%	0.33%	0.11%	0.50%
No car lanes and bus priority lanes are a bad idea because car drivers take no notice of them	0.04%	0.12%	0.02%	0.03%	0.09%	0.06%	0.11%	0.00%

Source: JMP / Newcastle University (2006)

Table 8: Percentage (%) responses to attitude questions from road based travellers who are aware of traffic priority lanes on their most frequent journey

The first group of questions (questions 1-5) show that in general car users, whether as a driver or a passenger, dislike priority lanes whereas bus and cyclists are more positive. This is as anticipated. The second group of questions relating to enforcement appear to show little difference between road users. There is a consensus that priority lanes should be better enforced and that car drivers seem to respect the No Car Lane rules. Overall, car users, whether as a driver or a passenger, disliked priority lanes. By contrast, bus and cyclists were more positive and this was supported by the more in-depth, one to one consultation with key stakeholders.

Whilst additional comments were not specifically requested, a number of respondents found a way to communicate their views. Almost without exception these comments referred to No Car Lanes in Newcastle and commenting on the way in which short stretches of priority were considered more of a danger than being helpful.

The road haulage questionnaire, circulated by weblink to hauliers with e-mail addresses in the Tyne and Wear Freight Partnership, produced a much lower response. Similar questions were asked to elicit attitudes and it was clear that hauliers are more in favour of No Car Lanes although problems with their operation were identified.

A significant proportion of respondents from both questionnaires identified the rules for priority lanes as being unclear. This is no doubt a function of the variety of types and timings of priority lanes in the area. Also, both questionnaires identified the view that priority lanes were not adequately enforced but there was a subtle difference in perspective: the general public perceiving that drivers do respect the rules whereas the more tentative results of the road haulage questionnaire suggest that the hauliers perceive car drivers not complying particularly with No Car Lane rules.

6. Conclusions

The contribution of this study is to offer a comparison between the impacts of a variety of different conditions or 'warrants' for bus priority corridors at a single geographical location. Overall the type of measure that consistently demonstrate the shortest travel times and the narrowest distribution was the absence of any priority lanes with No Car Lanes, on balance, offering the best form of priority.

Tyne and Wear as a conurbation includes the three medium sized cities of Newcastle upon Tyne, Gateshead and Sunderland. The study area included an examination of the impacts in these cities on on corridors between them. The transferability of this study is limited to cities with similar characteristics in terms of traffic flow for the road network as a whole but more specifically for a mix of traffic whereby the priority lanes, if restricted only to public transport vehicles, would have spare capacity. This is typical of many cities in the world as well as being true of larger cities on parts of the road network away from the central areas where priority for public transport is in place..

Whilst existing data gave mixed results on journey times, a modelling approach suggests No Car Lanes are preferable to other forms of priority for all motorised modes (car, HGV, taxi and bus) and this is reinforced by the results for the reliability of journey times. However, it is clear that having many short lengths of priority lane (of whatever form) lowers the benefit arising from priority as well as having an adverse effect on user and non-user attitudes towards priority lanes. The modelling also suggests that the impact on the environment is less negative from No Car Lanes. Against this is the less positive evidence for No Car Lanes in terms of road safety and enforcement.

The examination of community perceptions suggests that priority measures are generally viewed positively as a way of increasing public transport speeds (even if they do not!) but that who and what is allowed in the reserved road space must be clearly signed and that for equity reasons, if no other, should be well enforced.

References

Arasan, VT and Vedagiri, P (2010) Study of the impact of exclusive bus lane under highly heterogeneous traffic condition, *Journal of Public Transportation* 2, 135-155.

Cooper, J, Ryley, T and Smyth, A (2001) Energy trade-offs and market responses in transport and residential and land-use patterns: promoting sustainable development policy, *Urban* Studies 38 (9), 1573-1588.

CPT (2002) *Better Buses*, Confederation of Passenger Transport, UK.

Currie, G, Sarvi, M and Young, W (2007) A new approach to evaluating on-road public transport priority projects: balancing the demand for limited road-space, *Transportation* 34, 413–428.

Department for Transport (2004) *Bus priority – the way ahead*, Resource Pack; Edition 2: December.

IHT (1997) *Transport in the Urban Environment*. Institution of Highways and Transportation, London.

JMP / Newcastle University (2006) *Assessment of Priority Lanes in Tyne & Wear*. Contract Report.

LEK (2002) *Obtaining best value for public subsidy for the bus industry*, Final Report, London, Commission for Integrated Transport. Available from http://cfit.independent.gov.uk/pubs/2002/psbi/lek/index.htm

Levinson, HS, Hoey, WF, Sanders, DB and Wynn, FH (1973) *NCHTP Report 143: Bus Use of Highways – State of the Art,* Transportation Research Board, National Research Council, Washington DC.

Levinson, HS, Adams, CL and Hoey, WF (1975) *NCHTP Report 155: Bus Use of Highways – Planning and Design Guidelines,* Transportation Research Board, National Research Council, Washington DC.

May, AD and Gardner, KE (1990) **Transport** policy for London: the case for an integrated approach, ***Transportation*** , 16, 257-277.

Shalaby, SA (1999) Simulating performance impacts of bus lanes and supporting measures, *Journal of Transport Engineering* 125, 390–397.

Tanaboriboon, YTS and Toonim, S (1983) Impact study of bus lanes in Bangkok, *Journal of Transport Engineering* 109, 247–255.

TCRP (2010) *Bus and Rail Transit Preferential Treatments in Mixed Traffic: A Synthesis of Transit Practice,* Transportation Research Board, Transit Cooperative Research Program, Washington DC.

Wood, K (2007) The Paradox of Congestion, *IPRNZ Transportation Group Conference, Tauranga, New Zealand.* Available from www.ipenz.org.nz/ipenztg/papers/2007_pdf/B8_Wood.pdf