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Impacts of motorcycles in Westminster bus lanes

I York, D Webster and K Sakamoto

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TRL Limited

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EXECUTIVE SUMMARY

Bus lanes are implemented to assist buses by allowing them to by-pass traffic queues. They reduce travel times and can improve reliability. Pedal cycles are also generally permitted to use these lanes to protect them from the main traffic flow. However, motorcyclists are also vulnerable road users and often classified as sustainable transport. This has resulted in them being considered for admission into the bus lanes.

There are concerns about allowing motorcycles into bus lanes. These are partly owing to them often being fast, capable of high acceleration and being manoeuvrable. It is therefore possible their rider's behaviour could result in them coming into conflict with other road users and pedestrians crossing the road who were not expecting motorcycles in lanes dominated by slower vehicles. One possible conflict is with vehicles turning right into a junction when there is a queue of stationary vehicles in the opposite direction within the non-priority lane(s): i.e. between the turning vehicle and the bus lane. A motorcyclist travelling in the bus lane, often at a higher speed, could be obscured by the stationary traffic and therefore come into conflict with the turning vehicle.

This study builds upon results from previous research conducted in Bristol and Swindon. It examined riders of motorcycles permitted to use eight bus lanes in the City of Westminster, London. A number of survey techniques were combined to assess impacts on bus operations, motorcycle journey times and the safety of motorcyclists and other road users.

This report is based upon the findings from a number of data sources. However, the STATS19 analysis was necessarily restricted to data available within the project's timescales. The examination of data from one year before and after the introduction of the schemes provides an indication of possible effects, but cannot be considered to be statistically robust. Further accident analysis exploring three years before and after the schemes' introduction is planned and this should provide a clearer insight into any safety effects (either benefits or disbenefits) achieved by permitting motorcycles into bus lanes. Emphasis is consequently given within the report to the more robust conflict analysis data. The results of this study are:

1. Overall traffic flows remained consistent on four of the eight sites. On Cockspur Street the original traffic flow was small, and consisted of buses and cycles. Afterwards motorcycles combined with the increased bus flow resulted in a large increase in overall Passenger Car Units (PCU) flow. Both bus and overall traffic flows increased on Knightsbridge, and motorcycle and overall traffic flows increased on Haymarket.

2. Measured traffic flows were found to be misleading on Piccadilly. Measured flows were relatively low indicating it was below capacity, but observation showed that the road was highly congested. It was believed that Piccadilly was actually operating near to capacity, but this resulted in the analysis being unable to correctly capture and explore the conditions on this site.

3. Three of the other sites Gloucester Place, Cockspur Street and Baker Street were operating at less than half of the theoretical link capacity. The remaining

four (on Knightsbridge, Haymarket and Bayswater Road) were operating at between 50 and 75% of link capacity.

4. Motorcyclists were found to use bus lanes (and not just encroach into them whilst filtering) when they were not permitted in them. The percentage of observed motorcyclists using the bus lane in the before surveys varied from 1 to 54%. One of the main reasons for motorcyclists encroaching on the bus lane was the degree of saturation on the link, with more motorcyclists deciding to use the lane as the road became congested.

5. The percentage of motorcycles using each of the bus lanes, and remaining in them, approximately doubled when they were permitted to use it. That is, the extent of use depended on the perceived journey time advantage, and not on safety considerations. It was therefore only on the highly congested roads of Haymarket and Bayswater that large percentages of motorcycles used the bus lanes.

6. Allowing motorcycles to use the bus lane had a variable effect on lane discipline. Less than 15% of motorcyclists weaved between the bus and non-priority lane at all sites except Haymarket. On Haymarket, many motorcyclists were recorded by the cameras using both lanes when they were not permitted in it. This behaviour on Haymarket altered to travelling down the centre of the wide bus lane when allowed to do so, although this may have also been affected by the increased traffic flow. This was in contrast to Baker Street, which was the only site where motorcyclists consistently increased the amount of weaving between the lanes in the “after” study. The other main change in behaviour was on Knightsbridge, where motorcyclists switched to using the outside of the non-priority lane. This was presumably to enable them to travel down the outside of any queues, utilising the opposite carriageway where necessary

7. Bus journey times were found to have increased slightly in the after survey. Those measured on Bayswater Road were not affected by traffic flow changes or site characteristics, as it was an uninterrupted section of bus lane. These indicated that buses took an extra 4 seconds, equivalent to a 2.5 mph reduction in speed, to travel between the timing points after motorcycles were permitted into the lane. It is therefore believed this was due to the increase in the percentage of motorcycle using the bus lane, from 17 to 40%, on this section of the road.

8. Overall, the effect on motorcycle speeds was varied. However, on sites where flows remained fairly consistent (Baker Street, Gloucester Place and Bayswater Road), there was evidence that motorcyclists reduced their journey times under the higher flow conditions. On Bayswater Road the average speed of motorcyclists increased by 2 mph, with the 85th percentile of speed being 43.1 mph in the after survey. Such behaviour is of concern, particularly in relation to the effect on cyclist and pedestrian safety, as there is a correlation between increased speed and severity of collisions for pedestrians and cyclists.

9. Motorcycles using bus lanes had little, if any, effect on the delay to buses at bus stops. It was found that the maximum delay was one second.

10. Motorcycle use of the bus lane decreased the number of conflicts with other vehicles and pedestrians at most of the sites studied, implying that there

could be safety benefits. However, there were increased numbers of conflicts at two sites: Baker Street and Haymarket. These implied that it would be advisable to deny motorcyclists access to bus lanes where a large number of buses and taxis manoeuvre to and from the kerb, and those with a highly trafficked side road.

11. The number of accidents (one year after compared to one year before) increased on Baker Street, the site with a highly trafficked side road and an increase in conflicts. Accidents on the whole of Haymarket decreased which is contrary to the conflict analysis. This perhaps implies that motorcyclists may have safety benefits overall on Haymarket, particularly as traffic flow had increased, even though there are issues with vehicles manoeuvring to and from the kerb in one section of the site. The number of accidents on other sites where traffic flows remained reasonably constant had either stayed the same or slightly decreased.

12. The number of serious and fatal injuries (KSIs) increased by one on both Baker Street and Haymarket. That is, the two sites where the conflict analysis indicated that safety benefits had been reduced by permitting motorcycles into the bus lanes. The number of injuries, and KSIs, decreased on all other sites except Knightsbridge eastbound where traffic flows had increased whilst motorcycle use of the bus lane had slightly decreased.

13. Overall, the accident and conflict analyses were not conclusive. It would appear that safety benefits for motorcycles were not compromised compared to when they were not permitted to use the bus lane. However, safety benefits may be reduced if there is a highly trafficked side road along the bus lane, or taxis and buses are manoeuvring to and from the kerb along a section of the lane. There were also some indicators of concern for cycle and pedestrian safety, In particular, on Bayswater Road a greater percentage of motorcycles were speeding. This is not only a known cause of accidents, but also results in more serious injuries.

14. The opinion of the professional rider of the DataBike coincided with the findings of this study. The rider considered there were limited advantages in motorcyclists using some of the bus lanes under the observed conditions, which coincides with the video survey analysis which showed motorcyclists did not greatly increase their use of many of the bus lanes. He also expressed concerns at three sites because of side roads and turning vehicles, one of which was Baker Street, which was also found to be of concern from the conflict and accident analysis. The rider also noted some concerns over parked vehicles and others manoeuvring at some sites; this increased the potential for conflicts on Haymarket.

1. Introduction

Bus lanes provide reduced travel times and improved reliability for buses by segregating them from the other vehicles and permitting them to bypass queues at junctions. Pedal cycles are usually permitted into bus lanes and often licensed taxis can also use them. Cycles are vulnerable road users, and permitting them access protects them from the main traffic flow. Otherwise they would need to cycle on the outside of the lane between buses and the main flow.

Motorcycles cover a wide range of vehicles from 50 cc mopeds to large, powerful motorcycles with rapid acceleration. Even with such variation, they are sometimes classified as sustainable transport. In addition their riders are vulnerable: they accounted for 19% of all fatalities in 2006 (DfT, 2007) whilst only accounting for 3% of passenger kilometres (DfT, 2007a) within the UK. The Government's motorcycling strategy (DfT, 2005) states, in line with these statistics, that "we have to recognise that motorcyclists are our most vulnerable road users." Furthermore, motorcycles have become a more popular mode of transport in London in recent years owing to them being exempt from the congestion charge. All these factors have combined and been influential in considering allowing motorcycles to use bus lanes.

There may be counter-productive effects of permitting motorcycles into bus lanes. Considering these two types of vulnerable users, firstly cyclists are relatively slow compared to other modes of transport. They are also generally aware of their own vulnerability. Thus they tend to remain towards the left hand side of the carriageway whilst travelling straight on, and only interact with buses. This behaviour cannot be extended to motorcycles. Motorcycles are often fast, capable of high acceleration and are highly manoeuvrable. Thus they would be expected to use the lane that best benefits a minimum journey time. Further, this behaviour could result in motorcyclists remaining on the outside of lanes and weaving between traffic (referred to as filtering). Hence, it is debatable whether greater choice would result in motorcyclists being safer.

In addition, the effect of motorcycles on other road users and pedestrians' safety also needs to be considered. The Government's motorcycling strategy (DfT, 2005) states "motorcyclists must recognise their responsibilities – to ride sensibly and safely within the law, be considerate to other road users." Even if complying with the law, it does not change the fact that motorcycles are often faster than current bus lane users and are not greatly visible to other road users. For example, pedestrians may not give sufficient consideration when crossing to observe a motorcycle, which could result in a accident. Alternatively, other slower bus lane users, may come into conflict with motorcycles. Cyclists when turning right, changing lane or pulling out to avoid an obstacle are at risk from motorcyclists coming up behind at greater speed than the rest of the traffic.

Finally, there is concern over conflicts between motorcycles and other vehicles manoeuvring across the bus lane. Consider a vehicle turning right into a junction when there is a queue of stationary vehicles in the opposite direction within the non-priority lane(s). If a motorcycle is using the bus lane, and able to travel at higher speeds, then it may be obscured by the stationary traffic and therefore come into conflict with the turning vehicle.

Previous work has examined the issues of how motorcyclists have behaved when permitted into bus lanes in Bristol and Swindon. These studies gave an indication of the issues that can occur and the circumstances under which they may be expected. However, no firm conclusions on whether the benefits of permitting motorcycles into bus lanes outweighed the disbenefits could be reached. This study builds upon these initial results to target a study examining the behaviour of motorcycles being permitted to use eight bus lanes in the City of Westminster, London. Sites were specifically chosen to conform with previously identified criteria which could affect conflicts.

The research examined how motorcyclists reacted to being permitted to use the eight bus lanes. Further, it considered how any behavioural changes affected their safety, and journey times. It also considered how other road users were affected and assessed the impact on bus services.

This is an interim report as the STATS19 analysis was necessarily restricted to data available within the project's timescales. One year of accident data before and after the introduction of the schemes can only provide an indication of the possible effects, and will not be statistically robust. An accident analysis which will explore data from three years before and after the schemes' introduction is planned. Emphasis in this report is consequently given within the report to the more robust conflict analysis data.

2. Background

Motorcycles were first permitted to use a bus lane in 1995 in Bristol. Since then several local authorities have allowed motorcycles to use bus lanes. A list of known schemes at the start of this study is shown in Table 1.

Table 1: Bus Lanes Permitting Motorcycle Use

Authority	Number of Bus Lanes	Details	Bus Lane Introduced	Motorcycles Permitted Access
Bath	3	Wells Road	1997	1997
		London Road	1995	1995
		Charles Street	1999	1999
Bristol	16 out of 18km			
Aylesbury	1	Aylesbury HUB development		Jan 2007
Colchester	8	5 earlier lanes		Apr 1999
			Aug 1999	Aug 1999
			Dec 1999	Dec 1999
			Nov 2000	Nov 2000
Derby	3	Nottingham Rd Uttoxeter Rd New Rd		May 2006
Hull	1	Holderness Rd	Jan 1996	July 1998
London	3	A13 East India Dock Road A23 Streatham High Street A41 Finchley Road		Sep 2002
Northern Ireland		Most lanes in Belfast and lanes in Ballymena, Carryduff, Castlereagh, Dunmurry and Newtonabbey		Jun 2004
Reading	4	King's Road Wokingham Rd Bath Rd Basingstoke Rd		1994
Sheffield	1	Abbeydale Rd		May 2003
Swindon	2			2002

Two facts are clear from this table. Firstly, there has been a steady but slow increase in the number of bus lanes permitting motorcycles to use them, with one or two councils introducing schemes each year, see Figure 1.

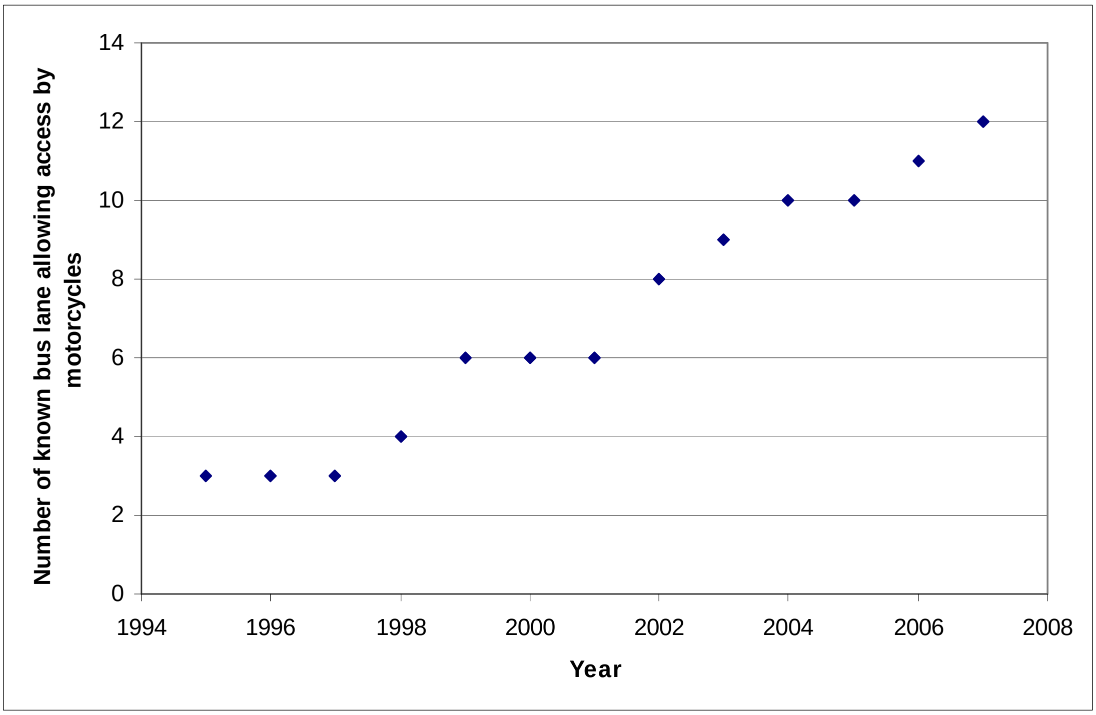


Figure 1: Councils introducing bus lanes

Secondly, apart from Bristol and possibly Colchester, councils only permit motorcycles to use a small number of bus lanes within their area. There is an issue that motorcycles are currently only being permitted to use what appear to be the obviously suitable bus lanes. However, as the number of bus lanes allowing motorcycles access increases it could be considered acceptable to allow them to use all lanes. In some of the above cases it was found the councils introduced schemes with the argument that it had been successful in another area.

In addition, the DfT has required monitoring of any introduced schemes owing to the unknown benefits of such schemes; but such monitoring has been at best fragmentary. For example, an accident analysis of 14 months of after data suggested an increase in accidents in Reading. However, this was mainly attributed to 'settling in' of the schemes and not investigated further.

Indeed there are always difficulties with accident data, unless the changes in safety levels are very large. In Sheffield, there were early indications that the rate and severity of accidents involving motorcycles had reduced, however more time was required before they could make a 'meaningful decision'. One of the largest accident studies was performed in London by TfL. This showed that the number of motorcycle casualties at the studied sites were down but not by as much as on the TfL road network. Part of the problem with this data was it was confounded by the introduction of congestion charging which reduced traffic flows and therefore accidents.

Overall little useful monitoring had been carried out by local authorities and accident data was inconclusive. TRL has also monitored two schemes to assess the effect of motorcyclists being permitted into bus lanes on their behaviour, their safety, the safety of other road users and bus services. These were the first scheme in Bristol and the later scheme in Swindon.

2.1. Bristol

Motorcyclists were allowed to use most bus lanes in Bristol from June 1995. TRL monitored the scheme in October 1996 (Balcombe 1996). This was a small scale evaluation consisting of analysing 72 hours of video at 5 sites. The limited nature of the study resulted in no qualitative results. In particular, there were few incidents involving motorcyclists, where they, or other road users, found themselves in hazardous situations and had to take avoiding action.

The analysis gave some credence to the view that other road users may not expect to see motorcycles in bus lanes and therefore may not always notice them. However, although this may create additional risk, it might not offset the reduced risk resulting from the separation of motorcycles and other traffic.

The survey showed that the majority of motorcyclists used bus lanes in preference to general traffic lanes except where they were approaching the end of a bus lane or where they needed to be in one of the outer lanes to be correctly positioned at the next junction. There were no accidents involving motorcycles with pedal cycles in the before 3 years or after 6 month periods.

2.2. Swindon

Swindon Borough Council committed to allowing motorcycles to use bus lanes on two corridors: Cricklade Road and Queens Drive. These were monitored by TRL by selecting three sites and videoing flows and behaviour over 12 hours on each of three consecutive days. The surveyed corridor was operating on average at approximately half of link capacity throughout the day for the non-priority lanes, though there was a narrow pronounced morning peak that reached 67% of link capacity. The bus lanes had flows representing less than 6% of available capacity.

Under these conditions motorcycles generally maintained good lane discipline before they were allowed into the bus lane, and they tended to travel within the main traffic stream. However, when permitted to use the bus lane, the number of motorcycles swapping between the bus lane and non-priority lane increased at two (of the three) sites. This behavioural change appeared site dependent. The sites where lane swapping increased contained bus stops, which might have been perceived as potential sources of delay. The other site included a pedestrian crossing and a signal controlled junction.

Increased lane swapping was associated with an increase in the number of conflicts between motorcycles and other road users. The other safety concern arose from two accidents that occurred between motorcycles in the bus lane and vehicles turning across the lane, to or from the non-priority lane. However, allowing motorcyclists into the bus lane appeared to assist them in avoiding conflict when they made a left turn.

Results from this study must be considered indicative, as they were based on short term observations at a small number of sites. However, this study identified some interesting indications that permitting motorcycles into bus lanes could generate increased use of those lanes, but it encouraged poor lane discipline, and caused motorcycle riders to be in more frequent conflict with other road users.

3. City of Westminster Sites

A scoping study was conducted for Westminster City Council to assess the relative suitability of existing bus lanes within the City of Westminster area for motorcycle use. This excluded bus lanes that crossed borough boundaries or exhibited obvious negative safety issues.

The remaining sites were scored according to a set of characteristics, for example, bus lane width, number of bus stops and number of pedestrian crossings. These characteristics were chosen because the (limited) previous research indicated they could influence safety. Each individual site characteristic was scored on a scale of 0 to 10, to permit a relative comparison but not an absolute safety score. The sites judged safest obtained the highest scores. This initial site filtering resulted in eight bus lanes being considered as suitable for the admission of motorcycles. The location of these lanes is shown in Table 2, and their hours of operation are shown in Table 3.

Table 2: Bus lanes in Westminster permitting motorcycles

Site Number	Road	Direction
1	Knightsbridge / Kensington Road / Kensington Gore	Westbound
2	Knightsbridge / Kensington Road / Kensington Gore	Eastbound
3	Baker Street	Southbound
4	Gloucester Place	Northbound
5	Cockspur Street	Eastbound
6	Haymarket	Southbound
7	Bayswater Road	Eastbound
8	Piccadilly	Eastbound

Table 3: Operational hours of the bus lanes surveyed

<table>
<tr><th>Site No.</th><th>Street Name Reference</th><th>Hours of operation</th><th>Days of operation</th></tr>
<tr><td>1</td><td>Knightsbridge Westbound</td><td>4 pm – 7 pm</td><td>Mon – Fri</td></tr>
<tr><td rowspan="2">2</td><td>Knightsbridge Eastbound</td><td>7 am – 7 pm</td><td rowspan="2">Mon – Sat</td></tr>
<tr><td>Kensington Road/Gore</td><td>7 am – 10 am</td></tr>
<tr><td>3</td><td>Baker Street</td><td>8 am – 7 pm</td><td>Mon – Sat</td></tr>
<tr><td>4</td><td>Gloucester Place</td><td>4 pm – 7 pm</td><td>Mon – Fri</td></tr>
<tr><td>5</td><td>Cockspur Street</td><td>24 hours a day</td><td>7 days a week</td></tr>
<tr><td>6</td><td>Haymarket</td><td>24 hours a day</td><td>7 days a week</td></tr>
<tr><td>7</td><td>Bayswater Road</td><td>7 am – 7 pm</td><td>Mon - Sat</td></tr>
<tr><td rowspan="2">8</td><td>Piccadilly</td><td>10 am – 7 pm</td><td rowspan="2">Mon - Sat</td></tr>
<tr><td>Piccadilly (Hyde Park Corner)</td><td>4 pm – 7 pm</td></tr>
</table>

The operational times varied greatly across the sites, ranging from three hours on a weekday to permanent. However, the operational hours were not considered when deciding whether a scheme should be included. Instead the decision was made according to the physical characteristics of each site, which are summarised in Table 4.

Table 4: Physical characteristics of sites

Site No.	Average bus lane width (m)	Bus lane length (m)	Total number of lanes	Number of bus stops	Number of side roads	Number of pedestrian crossings
1	2.85	550	2	4	9	1
2	2.83	500	2	5	2	2
3	3.70.	450	3	1	4	0
4	4.00	226	3	1	2	0
5	3.07	132	2	1	1	1
6	3.75	197	3	2	1	2
7	3.40	248	2	1	1	1
8	3.70	600	3	4	5	2

Road space in central London is often limited; it is therefore unsurprising that only one of the bus lanes (Site 4) complies with the advice given in Traffic Advisory Leaflet 2/07 (DfT, 2007b) that its width should be at least 4 metres. All others were below this optimum threshold and varied considerably.

3.1. Studied Features

The study could not be performed along the whole of the bus lanes, as the scale would have been too great. The approach was to concentrate on features within each of the bus lanes where any conflicts would be expected to occur. In general, previous research has indicated that conflicts would not be expected where vehicles maintain good lane discipline. However, they could occur under the following circumstances:

- Near a bus stop – where motorcycles move to the outside of the lane to pass buses.
- At a side road – where other vehicles turn across the bus lane and therefore could come into direct conflict with bus lanes users
- At pedestrian crossings – where traffic queues form and motorcycles may filter to gain a journey time advantage
- At the end of a bus lane – where vehicles often change lanes before a junction

In total, twenty-one features were chosen for study. These included at least one feature with each of the above circumstances, and a number of them with combinations of circumstances. This was necessary as often more than one circumstance occurs close to each other. For example, often pedestrian crossings are often close to bus stops to facilitate the movement of passengers to and from the stop. Similarly, a pedestrian crossing can be close to the end of the bus lane because of the proximity of a junction. The full set of features studied is shown in Table 5.

Table 5: Features monitored at each site.

Site No.	Street Name	Feature of Interest	Feature No.
1	Knightsbridge Westbound	End of bus lane & Pedestrian crossing	1
	Knightsbridge Westbound	End of bus lane	2
2	Knightsbridge Eastbound	Bus stop	3
	Knightsbridge Eastbound	Bus stop & Pedestrian crossing	4
	Knightsbridge Eastbound	End of bus lane	5
3	Baker Street	End of bus lane & Pedestrian crossing	6
	Baker Street	End of bus lane & Pedestrian crossing	7
	Baker Street	Side road	8
4	Gloucester Place	Section of bus lane	9
	Gloucester Place	Section of bus lane	10
	Gloucester Place	Section of bus lane	11
5	Cockspur Street	Side road	12
	Cockspur Street	Bus stop	13
	Cockspur Street	Bus stop, Pedestrian crossing & Cycle ASL	14
6	Haymarket	Bus stand (Tour buses)	15
	Haymarket	Bus stop & Side road	16
7	Bayswater Road	Pedestrian crossing	17
	Bayswater Road	Bus stop	18
8	Piccadilly	Start of bus lane, Bus stop & Pedestrian crossing	19
	Piccadilly	Side Road	20
	Piccadilly	Start of bus lane & Pedestrian crossing	21

The site and feature selections provided a good cross section of situations that can occur in or near to bus lanes and affect safety through the conflicting space requirements of road users.

4. Data collection methods

A combination of techniques was employed to investigate the varied implications of permitting motorcycles to use bus lanes. These included both on site measurements and data extracted from an existing database. Furthermore, two forms of on-site surveys were utilised, both quantitative and qualitative.

The quantitative on-site surveys consisted of three elements. One of these was installing automatic traffic counters (ATCs) to collect information on the traffic flows classified according to vehicle type over five days. This information was collected to ascertain whether the flows had altered between the two surveys which could affect the behaviour of traffic and therefore speeds and safety. One ATC was installed at each of the survey sites.

Whilst the ATCs were present, both a video and a manual survey were performed on weekdays. A three-day video survey used a high mast camera being installed to cover a distance of 50 to 70 metres around each feature of interest: i.e. the approach to the feature and a distance after it up to where its influence would be expected to extend. Information was collected from these videos on motorcycle behaviour and conflicts. Also, where a bus stop was present, the duration for which buses were stationary together with the number of passengers boarding and alighting was recorded. Comparisons of delays before and after motorcycles were permitted access to the bus lane were used to investigate whether motorcyclists delayed the buses. Finally, for one feature at each site, a classified count according to lane was performed from the video recording for comparison with the ATC data.

The two-day manual survey consisted of a cordon survey recording bus and motorcycle number plates. The two survey days were scheduled on days when a video survey was taking place, and the data was analysed to assess the impact of motorcycles using the bus lanes on their, and buses, journey times. One cordon survey was performed at each of the eight sites. The timing of each of these on-site surveys is shown in Table 6.

Table 6: Survey timings

Survey	Site Number	Street Name	ATC	Video	Manual
Before (Aug/Sep 05)	1&2	Knightsbridge	18-19, 22-24 Aug	18,19,22 Aug	19,22 Aug
	3	Baker Street	22-26 Aug	23-25 Aug	24,25 Aug
	4	Gloucester Place	22-26 Aug	23-25 Aug	24,25 Aug
	5	Cockspur Street	26,29 Aug-1 Sep	26,29-30 Aug	29,30 Aug
	6	Haymarket	26,29 Aug-1 Sep	26,29-30 Aug	29,30 Aug
	7	Bayswater Road	29 Aug-2 Sep	31 Aug-2 Sep	1,2 Sep
	8	Piccadilly	29 Aug-2 Sep	31 Aug-2 Sep	1,2 Sep
After (Nov 06/Jan 07)	1&2	Knightsbridge	22-26 Jan	23-25 Jan	23,24 Jan
	3	Baker Street	15-19 Jan	16-18 Jan	16,17 Jan
	4	Gloucester Place	8-12 Jan	9-11 Jan	9,10 Jan
	5	Cockspur Street	11-15 Dec	12-14 Dec	12,13 Dec
	6	Haymarket	4-8 Dec	5-7 Dec	5,6 Dec
	7	Bayswater Road	20-24 Nov	21-23 Nov	21,22 Nov
	8	Piccadilly	27 Nov-1 Dec	28-30 Nov	28,29 Nov

The introduction of the changes to the bus lane resulted in the “before” surveys having to be conducted in the summer and the “after” surveys in the winter. This was not optimal, as travel patterns can alter during the seasons, which can affect the number and type of vehicles on the road, which can in turn affect behaviour and accident rates. For example, outside of central London, data collected in August could be expected to differ from other times of the year owing to school holidays. However the effect of the holiday season in central London is generally less that elsewhere. This was checked by installing the tube counters to identify changes in flows and the modes being used.

The qualitative surveys involved a professional motorcyclist riding through each site on TRL’s Databike in the non-priority lane both before motorcycles were allowed into the bus lane and in the bus lane after they were permitted to use it. This provided an expert site observation of difficulties and concerns.

The final source of information was the STATS19 database. This was used to assess any strong trends in accidents after the introduction of the schemes.

In summary, the following assessment techniques were employed:

- ATC classified counts
- Video surveys
- Manual cordon counts
- TRL’s Databike
- STATS 19 data

Each of these is described in more detail below.

4.1. Automatic Traffic Counters (ATC)

Automatic traffic counters are tubes that are secured across a road with brackets into the road surface perpendicular to the direction of traffic movement. Two parallel tubes, a known distance apart, each detect the passage of vehicle tyres across the tubes by a generated sound wave. The time of each sound wave is recorded by a receiver, in addition to the time of the reflected wave from the other end of the tube. The time taken between a receiver detecting the first and reflected wave indicates the lane in which the vehicle was travelling. The time between the waves from the two tubes determines the vehicle’s speed, and therefore the time between the waves from different vehicle axles implies the distance between axles.

This information can be interpreted by associated software to produce a classified vehicle count and information on vehicle speeds. The classifications can be through a number of standard classification systems to isolate motorcycles, cars, light goods, heavy goods and buses.

Classified counts provide information on the percentage of a links capacity in use, by conversion of flows to Passenger Car Units (PCUs). This was calculated for both the before and after surveys to assess whether the PCU flow had altered. This was of particular concern given that the before surveys were conducted at the end of the school summer holidays and after surveys conducted either side of Christmas.

4.2. Video Surveys

Static (high mast) cameras were used to record information on traffic movements within a distance of 50 to 70 meters around each of the features of interest. This provided information on the classified vehicle flows, the lanes used by motorcyclists, the conflicts between motorcycles and other road users and where appropriate the stop times of buses. This information was collected in the following time periods:

- 07:30 – 09:30
- 10:00 – 13:00
- 16:00 – 18:00

The classified counts were for each quarter of an hour period and each lane at the site, with the classification being:

- Cycles
- Motorcycles
- Buses
- Other PSV
- Car
- Light Goods (This was further divided by Taxi and other LGV at sites with high taxi flows)
- Heavy Goods

The lane use and conflict analysis collected the following information for each motorcycle passing by each feature of interest:

- Whether the motorcycle used the bus lane, the non-priority lane(s) or both
- The motorcycle's position in each lane (left/middle/right/varying)
- Whether a conflict occurred, and if it did, then the
    - level of braking used by the motorcycle
    - extent to which the motorcycle swerved
    - type of vehicle that was also involved in the conflict
    - level of braking used by the other vehicle
    - extent to which the other vehicle swerved

If the feature contained a bus stop, then the following information was collected for each bus using the stop:

- Time the bus became stationary at the stop
- Time the bus started to move away from the stop
- Number of passengers alighting from the bus
- Number of passengers boarding the bus
- Whether anything affected the stop time of the bus, for example, being hemmed in by other traffic.

4.3. Manual Cordon Counts

One possible advantage for motorcycles when permitted to use bus lanes is that they could reduce their journey time. However, it is possible that extra vehicles in the bus lane could increase the journey times of buses, particularly if they need to take account of motorcycles overtaking them at bus stops. The cordon survey consisted of recording both motorcycle and bus number plates at two points on the bus lane corridor. The points were chosen to reduce the sources of variability, for example bus stops and pedestrian crossings, whilst recording the journey times over a sufficient distance.

This survey was conducted for two days before, and after, motorcycles were admitted to bus lanes. The data was collected from:

- 07:00-10:00
- 11:00-14:00
- 16:00-18:00

The resulting datasets were matched to produce the journey times of a sample of buses and motorcycles over a known distance on the corridor, see Table 7.

Table 7: Distance between timing points

Site Number	Site	Distance between timing points (metres)
1	Knightsbridge Westbound	250
2	Knightsbridge Eastbound	165
3	Baker Street	437
4	Gloucester Place	200
5	Cockspur Street	114
6	Haymarket	165
7	Bayswater Road	212
8	Piccadilly	300

Thus it was possible to estimate the speeds of these vehicles and examine whether these had been influenced by permitting motorcycles to use the bus lane.

4.4. TRL's Databike

TRL's DataBike is a modified motorcycle that contains a video recorder linked to a helmet microphone and a GPS system. This provides real time information on the situations encountered by the professional rider and his evaluation of them.

The same rider rode through each of the bus lane corridors both before and after motorcycles were permitted to use the bus lane. In the before situation the rider complied with the law and rode in the non-priority lane(s). Afterwards the rider utilised the bus lane when able to do so.

This provided two comparative narratives on the relative safety of the route, and video evidence for the analysis. In addition, the professional rider produced a report detailing the overall preferences, identified advantages, concerns and issues with using the bus lanes. In particular, the rider was tasked with identifying any safety issues with using the corridor both in and outside of the bus lane.

4.5. STATS 19 Database

The Department for Transport (DfT) compiles data from police reports completed where road accidents involve a personal injury, and which become known to the police within 30 days. The dataset is hierarchical with the first level being the accident that occurred. Information on the accident includes its severity, the number of vehicles and casualties involved, time, location, road class, speed limit, and weather.

The second layer contains information on the vehicles involved in each accident. Details included are the type of vehicle, manoeuvre being performed at time of accident and details of the driver. The third and final layer is for the casualties. Information includes gender, age and injury severity.

Stats19 is a rich source to assess accident trends, though it has its limitations. Part of the issue is that it only includes those accidents reported within 30 days. Further, included details are reliant on the accuracy of the recorder; particularly in relation to the accurate location of the accident. In addition, the generally sparse nature of accidents results in significant differences only occurring if there is a very large change in accident frequency or trends are observed over a long period of time. It does however provide the best indication of whether a measure has improved or eroded safety.

Stats19 data was extracted for three years: twenty months before the motorcycles were admitted into bus lanes and for 16 months after. These raw data were analysed to give an aggregate view of scheme safety.

The subset of data extracted from the Stats19 database was restricted to consider interactions between motorcycles and other road users. In particular, it included the position and movements of the vehicles and pedestrians at the time of the collision. The number of accidents were related to the observed traffic flows (from the ATCs and video surveys) to consider whether the accident rate had altered. Other information on the accidents was included to explore the underlying explanations for any located changes in accident rates, i.e. whether there had been any consistent changes in behaviour that had resulted in the accident trends.

5. Vehicle flows

Vehicle flow and composition affect both driver behaviour and accident rates. It was therefore important to examine the vehicle flows in both the "before" and "after" survey to ascertain whether there were any significant differences, so these could be taken into consideration within the analysis. Flow information was collected from two sources.

- Manual counts from the video survey
- Automatic traffic counters (ATCs)

Manual counts involved the analysis of video recordings from high mast cameras installed at each site. Traffic was manually counted and classified from six hours of video (2 hours in each of the AM peak, off-peak and PM peak) from 3 days. However, only two days data was available for some sites owing to occasional camera failure.

Data from an automatic traffic counter (ATC) was obtained at each site. Five days of data was collected on the majority of sites, although slightly less data was utilised on some sites when tests indicated the data was inaccurate. The collected data was interpreted using Metrocount software to translate the raw axle counts into information on flow levels, vehicle types and speeds.

5.1. Manual video survey results

The manual counts detailed information on the traffic flow and its composition on the days when behaviour was being observed. Flows were classified into the categories of cycle, motorcycle, car, light goods vehicle (lgv), buses, other PSV and heavy goods vehicle (HGV). In addition, taxis were separately counted on sites where they represented a high percentage of the flow. Counts were performed for each lane of the carriageway and for each quarter of an hour period. These have been converted into passenger car unit flows by applying the weights contained in Table 8.

Table 8: PCU Figures

Vehicle Type	PCUs
Cycles	0.3
Motorcycles	0.75
Cars & LGVs	1
HGVs	2
Buses and coaches	3

Overall traffic flows in the before and after surveys are shown in Figure 2 and the equivalent passenger car units (PCUs) per non-priority lane in Figure 3. Also, the average PCU flows are summarised in Table 9.

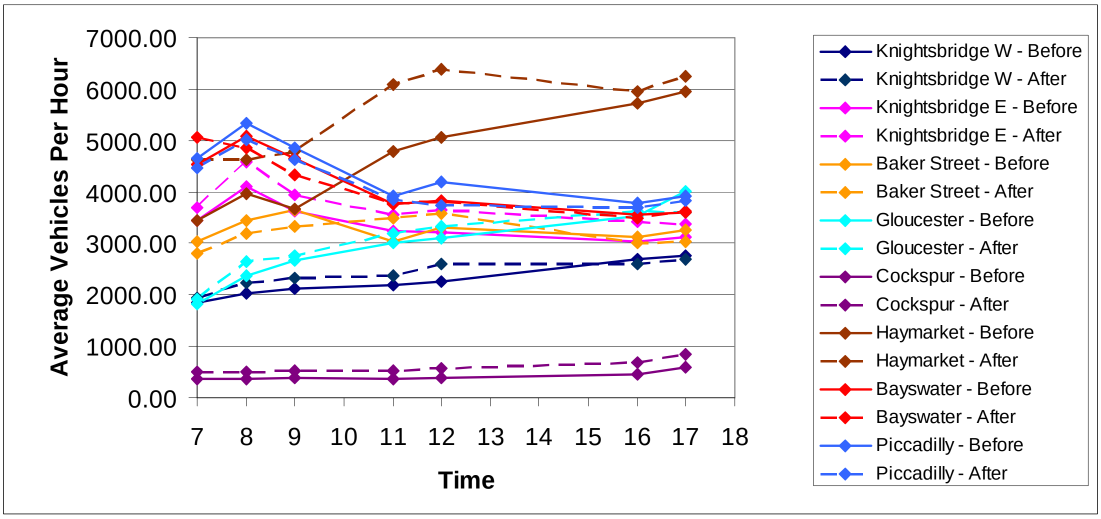


Figure 2: Total vehicle flows

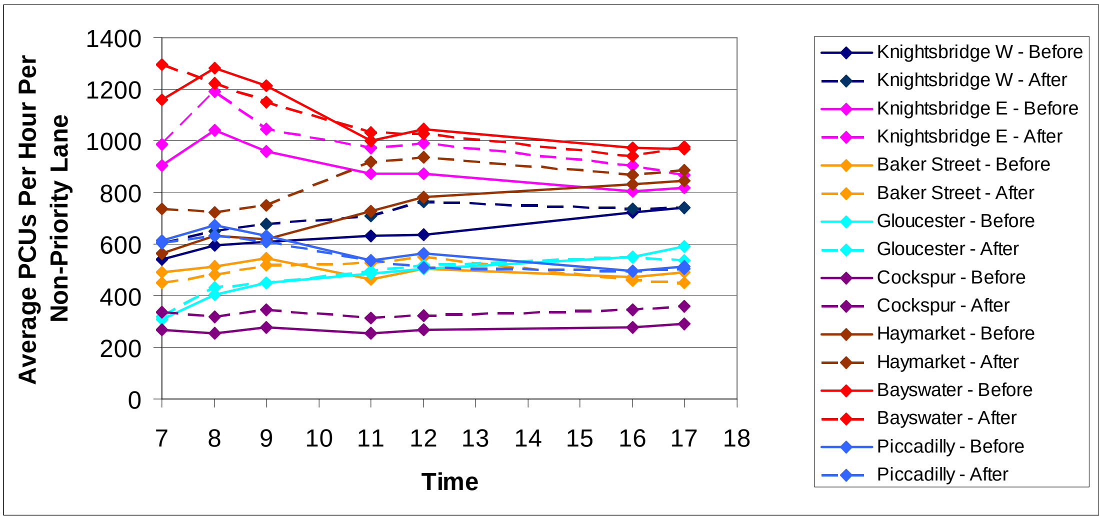


Figure 3: Total PCU flows per non-priority lane

Table 9: Average Hourly PCU flows

Site	Before	After	Percent Increase
Knightsbridge W	159.9	174.6	9.2%
Knightsbridge E	223.9	248.4	11.0%
Baker Street	124.3	122.6	-1.4%
Gloucester Place	117.7	118.0	0.2%
Cockspur Street	67.7	83.8	23.7%
Haymarket	178.7	207.6	16.1%
Bayswater Road	273.0	273.1	0.0%
Piccadilly	143.8	139.0	-3.3%

There were no major changes in the traffic flows on four of the sites studied, with the average flow at a site changing by less than five percent in any one hour. The main exception was Cockspur Street on which PCU flows increased by an average of 24%. One reason for this change is that the original flow was small, and motorcycles could not use the road in the "before" survey. Also, flows increased in the morning peak and off-peak on Haymarket and Knightsbridge Westbound, whilst the change in traffic flow was consistent throughout the day on Knightsbridge Eastbound.

Motorcycle and bus flows were separately considered because of their relevance in this study. Motorcycle flows increased in Cockspur Street in the "after" survey as they were not permitted to use the road in the "before" survey. Also, there was an increase of almost 20% in motorcycles travelling on Haymarket. The motorcycle flows and their patterns remained consistent on the other sites, see for example Figure 4, indicating the other schemes had not attracted new users and therefore re-routing had only occurred at the Cockspur Street and Haymarket sites.

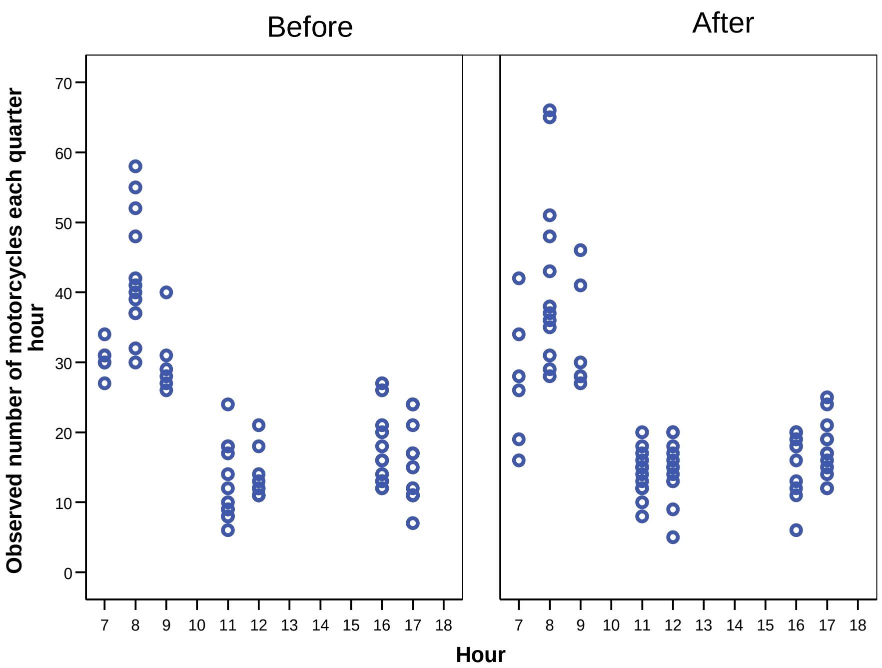


Figure 4: Quarter hour motorcycle flows on Knightsbridge eastbound

Table 10: Average hourly motorcycle flows

Site	Before	After
Knightsbridge W	50.4	48.1
Knightsbridge E	87.4	90.0
Baker Street	64.1	54.9
Gloucester Place	49.0	47.3
Cockspur Street	0.1	22.8
Haymarket	123.9	146.3
Bayswater Road	97.7	81.7
Piccadilly	171.9	173.2

Bus flows remained consistent on most of the sites between the two surveys. However, there was evidence of bus flows increasing on Knightsbridge particularly westbound. Also, bus flows appear to have increased on Cockspur Street between the two surveys.

Table 11: Average hourly bus flows

Site	Before	After
Knightsbridge W	32.0	41.9
Knightsbridge E	34.3	37.4
Baker Street	68.3	67.2
Gloucester Place	73.8	71.2
Cockspur Street	87.3	101.7
Haymarket	130.8	126.8
Bayswater Road	40.4	35.9
Piccadilly	54.2	56.0

5.2. Traffic composition

The video data also contains information on the proportion of different vehicle types at a particular site and time of day, and in each lane of traffic. This information was required to calculate the PCU flows, but also provides an insight into the relative numbers of different vehicles within each flow. For example, it indicates the percentage of motorcycles and this in turn could affect behaviour. Figures 5 to 7 below show the average percentages of each vehicle type within the flows during the morning peak (07:00 to 09:30), the off-peak (09:30 to 15:30) and the evening peak (15:30 to 19:00) respectively.

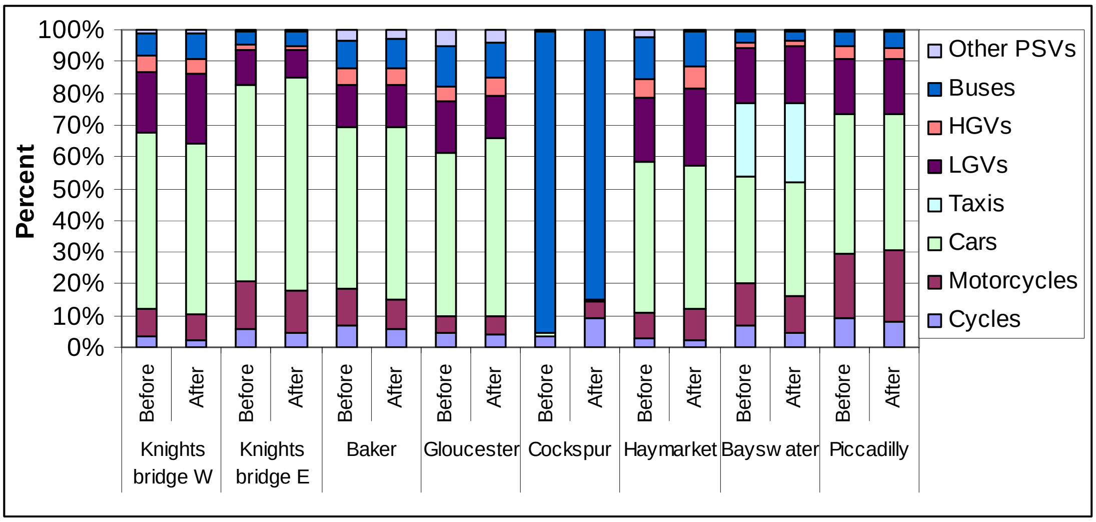


Figure 5: Traffic composition in AM Peak

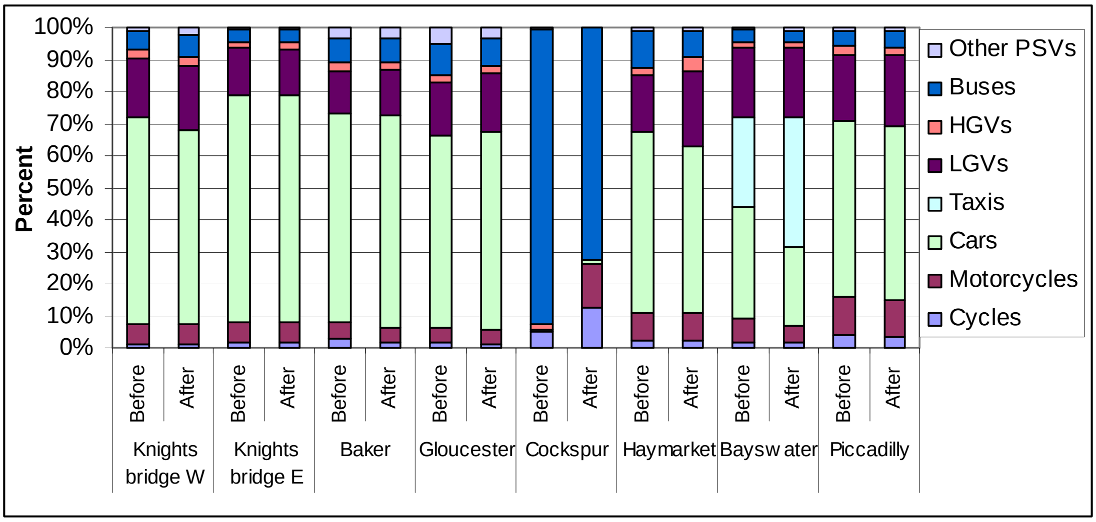


Figure 6: Traffic composition in Inter-Peak

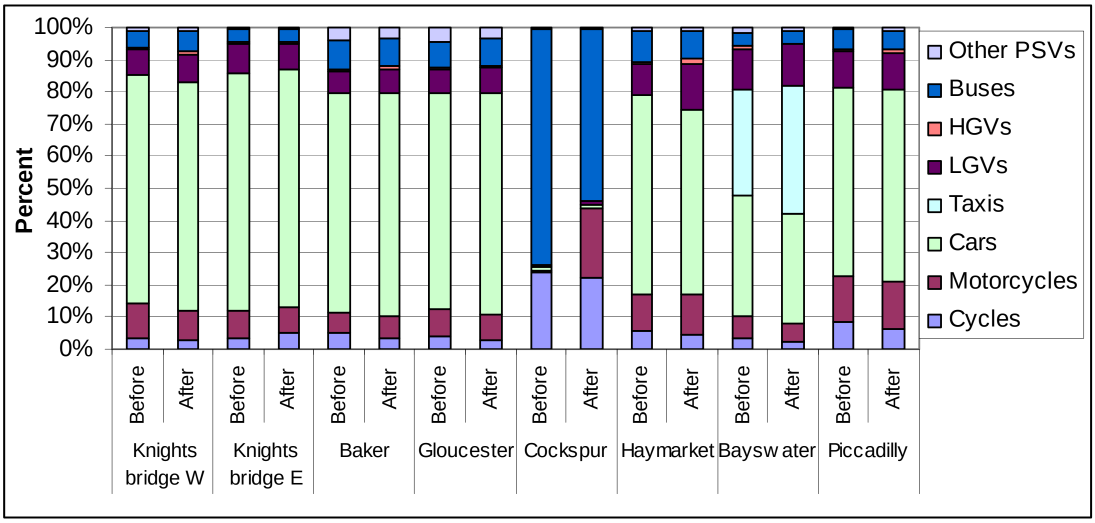


Figure 7: Traffic composition in PM-Peak

Although there were a number of small variations on some sites, generally the percentage compositions were relatively consistent between the two surveys. Apart from Bayswater Road and Cockspur Street, cars accounted for approximately seventy percent of the total traffic flow. Buses constituted between five and ten percent of the flow, motorcycles five to fifteen percent of the flow and cycles less than ten percent of the flow. Bayswater Road was different in there were very high taxi flows, representing over 30% of the total flow, and although the taxi to car ratio increased slightly in the “after” survey, the percentage of other vehicle types in the observed flows was relatively stable. Cockspur Street was restricted to buses and cycles in the “before” survey. In the “after” survey the increased use by motorcycles is visible.

5.3. ATC results and identified problems

Automatic traffic counters are generally relatively accurate, but the equipment has its limitations. One source of error is when two vehicles pass over the tube at the same time, as the equipment is unable to separate the two vehicles. Also, to obtain accurate counts, the tubes should be perpendicular to the direction of traffic flow otherwise one vehicle can be recorded twice. The tubes should be in free flowing traffic, otherwise speed changes can affect the vehicle classifications and low speeds can result in poorly interpreted data. In addition, it is important that vehicles do not remain on, and particularly not park on, the tubes. Problems with the tubes are often indicated by inconsistencies in the hits (or number of axles) recorded by them, for example see Figure 8.

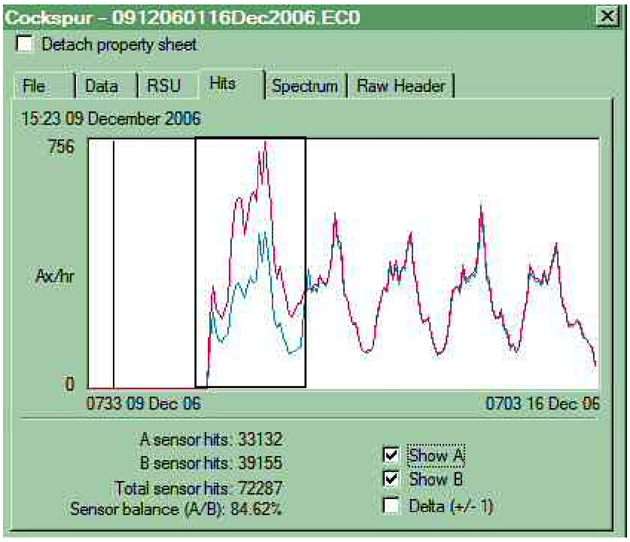


Figure 8: Number of hits by time of day in the "after" survey on Cockspur Street

This shows there was a problem with the information recorded on the first survey day, indicated by the grey area. However, the data on other days appears clean.

Initial tests indicated large discrepancies between the tube data and the manual classified counts on some of the sites. This remained even when restricting the analysis to days on which the manual counts were performed and the ATC data was also available and clean. The first step taken in investigating, and compensating for such issues, was to restrict attention to the axle counts, or hits, directly recorded by the equipment. These were converted to "ATC two-axle vehicle estimates" by dividing the axle counts by two. A comparison of these estimates with the totals obtained from the video surveys is shown in Figure 9.

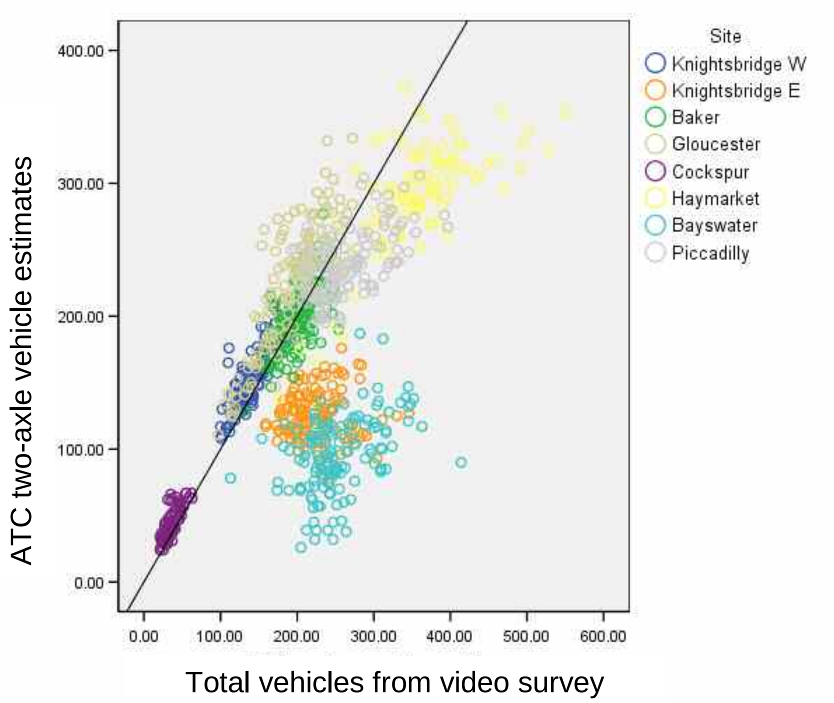


Figure 9: Total vehicles from video survey compared to ATC estimates (each quarter hour)

ATC and video survey data were significantly different from each other on two sites, Bayswater Road and Knightsbridge Eastbound. The reason for this on Bayswater Road was the tube counter only recorded data from the bus lane and therefore was expected to undercount the flow. On Knightsbridge Eastbound, it was necessary to position the tube counter a long distance from the camera used to record the vehicle counts. Thus a number of side roads were between the two positions, which resulted in the counts being incomparable.

Two other factors affected the accuracy of the ATC two-axle vehicle count estimates. Firstly, as vehicles numbers increased, and speed decreased, tube counters tend to miss (or undercount) numbers of vehicles. This appears to have occurred on Piccadilly and Haymarket once the flows had increased above approximately 800 vehicles an hour. Secondly, estimating the number of vehicles by dividing the number of recorded axles by two results in the number of vehicles being over-estimated, as two three-axled vehicles would be estimated to be three two-axled vehicles. This may account for the over-count occurring on Gloucester Place.

The ATC two-axle vehicle count estimates were re-scaled to form better estimates of vehicle flows. These “Adjusted ATC two-axle vehicle count estimates” were calculated according to the following rules, excluding Bayswater Road and Knightsbridge, see Table 12.

Table 12: Calculation of Adjusted ATC two-axle vehicle count estimates: (ATC two-axle vehicle count estimates – A)/B

Site	Flow	A	B
Gloucester Place	All	29.000	1.011
All Others	Greater than 723 per hour	98.200	0.527
	Less than 723 per hour	7.400	1.032

The effect of adjusting the ATC counts can be seen in Figure 10. Generally, the fit is good. However, the standard deviation of the error becomes greater with flow. This is in line with expectation, given that the accuracy of both manual and ATC counts decreases as flows increase.

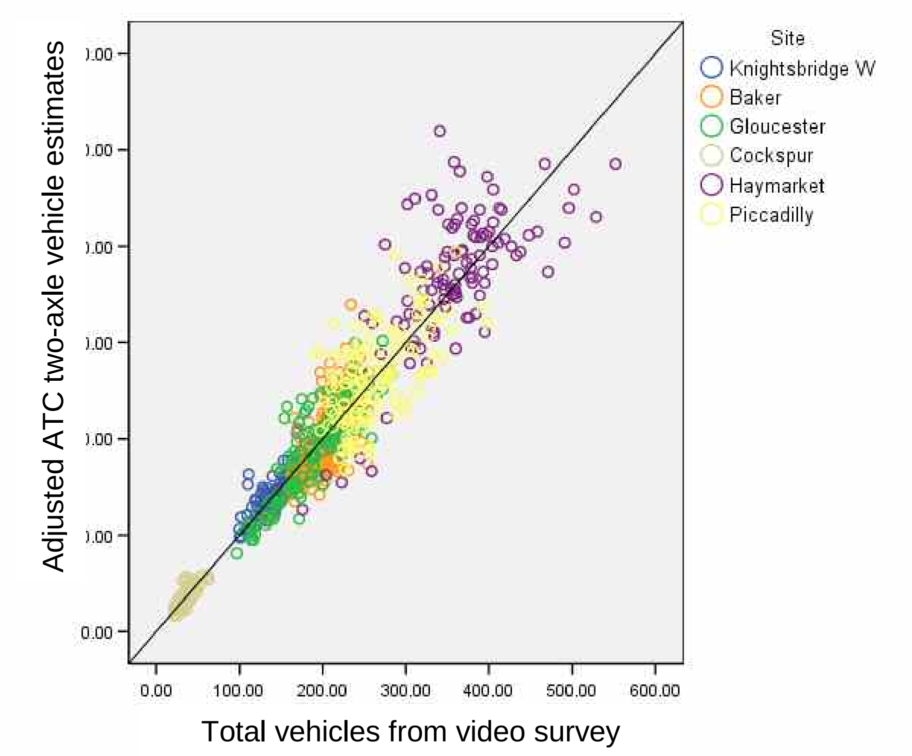


Figure 10: Total vehicles from video survey compared to Adjusted ATC estimates (each quarter hour)

The adjusted ATC counts provide a best estimate of the total vehicle flows throughout the times where the manual surveys were not being conducted. However, this does not provide details of the composition of the traffic at these times. The next section investigates the accuracy of the ATC data with respect to composition.

5.4. Traffic composition from ATC data

The installed tubes collected information on the time axles passed over them. This should have been sufficient to directly provide information on the class of vehicle and its speed. However, as previously discussed, the associated software was unable to correctly extract this information. A number of tests were performed on this data to investigate the underlying cause, partly it was owing to the density of the traffic, which was identified and corrected in the previous section. However, this was not the only issue.

Another problem was the identification of articulated buses within the data. These were incorrectly classified as heavy goods vehicles. The associated classification software identified the axle spacing for the first two axles of the bus, but ignored the third axle. TRL worked with Metrocount to try and resolve these issues by creating a new classification system and altering the default settings within the software.

Unfortunately, it was not possible to recover accurate classified counts from this source.

Instead, the adjusted ATC axle counts were converted to classified counts by applying the average proportions observed in the manual surveys during each half hour. In addition, a linear trend between manual observation periods was assumed, so for example, if the proportion at 10:00 was 0.5 and at 12:00 it was 0.3, then if no observation was available at 11:00 a proportion of 0.4 ([0.5+0.3]/2) was assumed. The resulting numbers of motorcycles and buses within the flows are shown in Figures 11 and 12, for the six sites where the ATC counts could be adjusted.

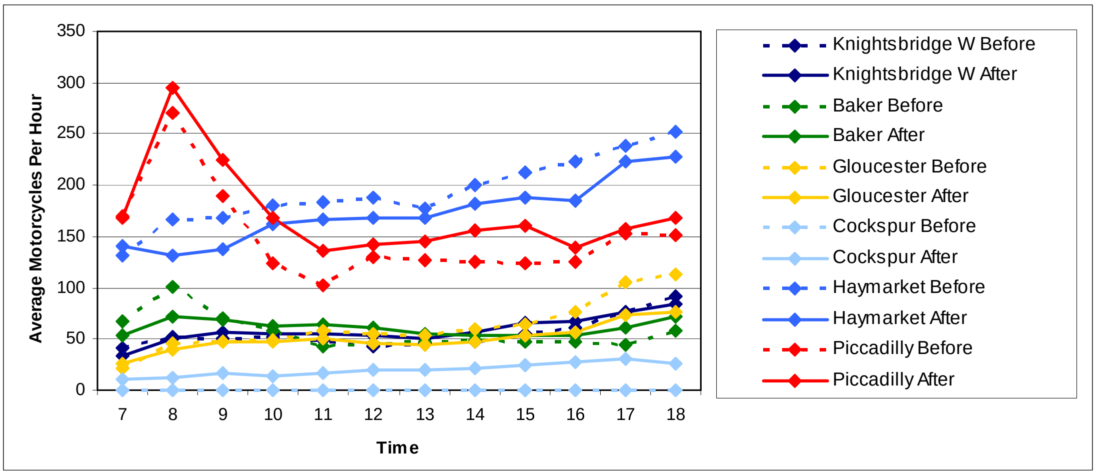


Figure 11: Estimated number of motorcycles per hour from ATC counts

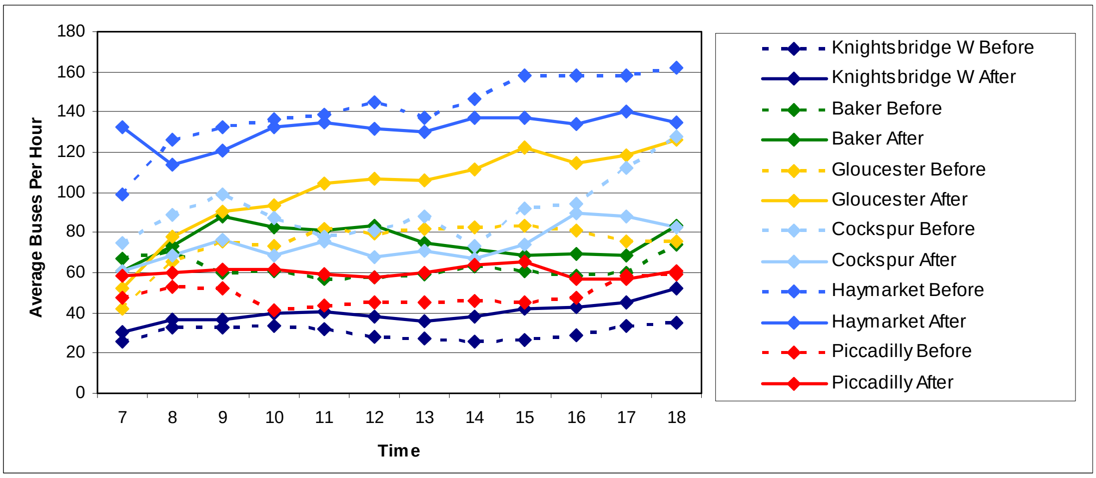


Figure 12: Estimated number of buses per hour from ATC counts

5.5. Calculation of overall PCU flows from ATC data

Previous sections have discussed the identified issues with the ATC data and methods employed to compensate for them. Applying the methods produced half-hourly classified counts for the five days when ATC surveys took place, provided the tubes were operating correctly and the axle counts could be adjusted (i.e. excluding Knightsbridge Eastbound and Bayswater Road).

These adjusted classified counts were converted into PCU flows using the same weightings as in Table 8. The resulting PCU flows are shown in Figure 13.

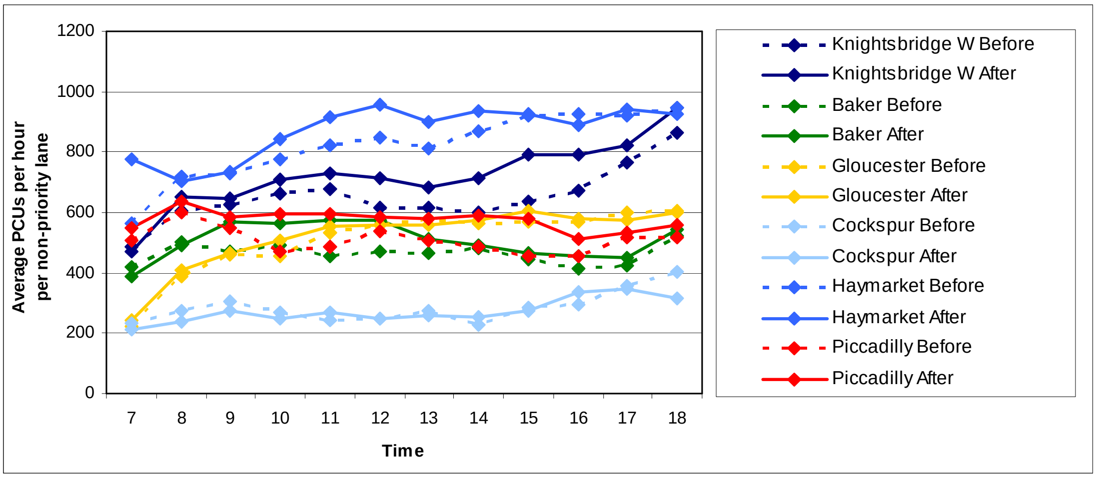


Figure 13: Estimated PCU flows from ATC counts

Piccadilly was found to be a special case by observation. It was highly congested through the majority of the day; however the measured flows indicated that it was only operating at approximately 35% of saturation. It is believed that in reality Piccadilly was actually operating near capacity and the measured flows are not representative of the actual conditions. Also, on Cockspur Street the flow consists of buses and motorcycles, so the general traffic congestion has little relevance.

The other four sites in the figures were estimated to be generally operating between 30 and 60% of available link capacity. They could therefore be considered as often congested, but unlikely to be very slow moving traffic, although this would have been influenced by the capacity of downstream junctions.

The remaining two sites (Knightsbridge Eastbound and Bayswater Road), where flows could not be estimated from ATC data, were also the sites with the highest flows recorded in the manual counts. The manual counts indicated these sites were operating between 50 and 75% of available link capacity. They would therefore be considered as congested.

6. Motorcycle lane use

Motorcyclists often aim to minimise their journey time. This results in them “filtering”, which is to ride between the queues of traffic to reach the front of a queue. In addition, the high manoeuvrability of motorcycles enables riders to easily change lanes and make maximum use out of available road space. Motorcycles were restricted to the non-priority lanes in the “before” study, and therefore none should have been observed in the bus lane. Practically, it is known that some motorcyclists will (illegally) stray into the bus lane if they consider it sufficiently advantageous.

The lanes used by motorcyclists and their position in them were recorded from the video surveys for each of the features on each of the sites. The following sections explore how motorcyclists adapted their behaviour when they were permitted into the bus lane.

6.1. Use of the bus lane

A bus lane will only be used by motorcyclists if they consider there is an advantage in them riding in it. If the bus lane is congested with slow moving vehicles, particularly if there are large numbers of buses and bus stops, they would be expected to remain in the non-priority lanes. The observed percentages of motorcycles utilising the bus lane, and not switching lanes, within each of the cameras’ views is summarised in Table 13.

Table 13: Percentage of motorcycles using bus lane

Site	Feature Number	Survey	
		Before	After
Knightsbridge W	1	3.8	8.1
	2	6.5	13.2
Knightsbridge E	3	14.2	14.0
	4	7.4	5.1
	5	20.8	14.4
Baker Street	6	1.3	11.3
	7	1.0	11.8
	8	1.3	12.2
Gloucester Place	9	5.5	9.0
	10	5.2	7.4
	11	2.1	3.6
Cockspur Street	12		81.8
	13		100.0
	14		100.0
Haymarket	15	54.2	95.7
	16	26.6	85.7
Bayswater Road	17	17.3	39.4
	18	17.2	34.2
Piccadilly	19	1.3	4.5
	20	9.3	13.7
	21	7.3	12.6

In line with expectation, motorcycles used the bus lane when they were not permitted to do so. The extent of use was highly variable, from 1 to 54%, and there was no clear common underlying layout or type of feature that resulted in this misuse. Instead, the primary reason for using the bus lane appeared to be related to the extent of congestion on the link, see Figure 14, where an approximation of maximum capacity of 1725 pcus per lane was assumed.

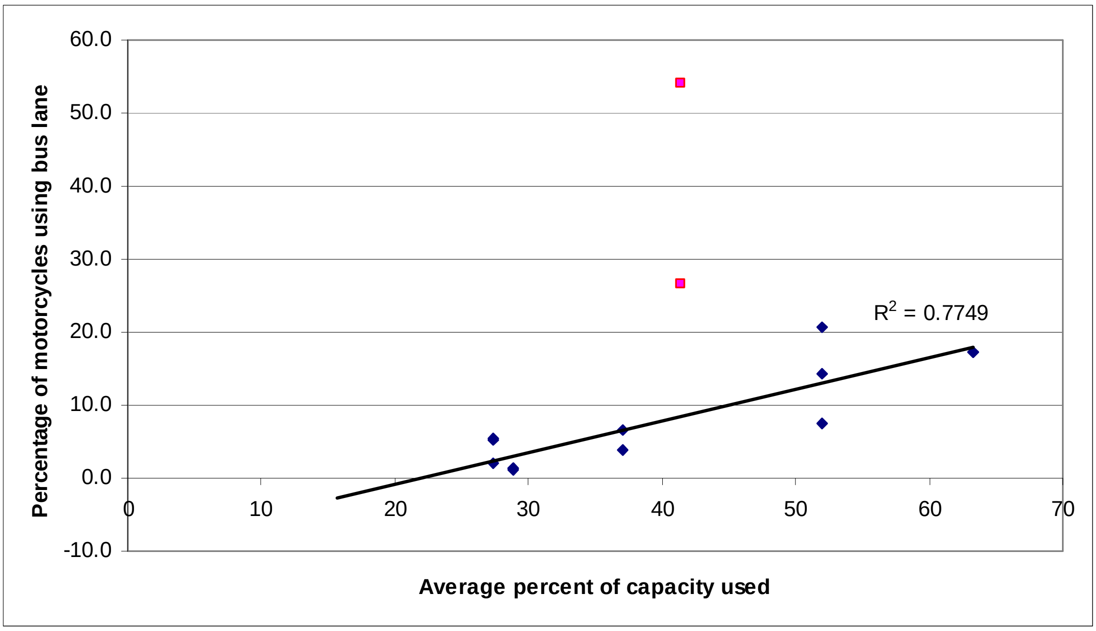


Figure 14: Relationship between bus lane use and capacity used

Two sites were excluded from this diagram, Cockspur Street and Piccadilly. Cockspur Street was excluded owing to its uniqueness, as it was a bus-only road in the "before" study. Piccadilly was not included because observations indicated the road was operating at over-capacity for most of the day, and therefore the recorded flows were not representative of the actual road conditions. In addition, there were two outliers, particularly Feature 15, but also Feature 16, on Haymarket, see Figure 15.

Figure 15: Haymarket, Feature 15

Although the reason for the high use of this bus lane by motorcycles is not totally apparent, the very wide bus lane could have influenced motorcyclists to have used it. Across the remaining sites there is a clear relationship between the congestion on the road and the percentage of motorcyclists using the bus lane explaining 77% of the variation in the data. Under free flow conditions, below approximately 20% of capacity, no motorcyclists encroach into the bus lane. However, when approaching severe congestion, above 70% of capacity, approximately a fifth of motorcyclists decide to use a bus lane although they are not permitted in it.

Consequently, the extent of bus lane use in the “before” study indicates the level of journey time advantage motorcyclists can obtain. It is therefore not surprising that the percentage of motorcycles using the bus lane in the “after” study tended to increase more where they could obtain the greatest advantage and were consequently already using it. The fitted relationship is shown in Figure 16.

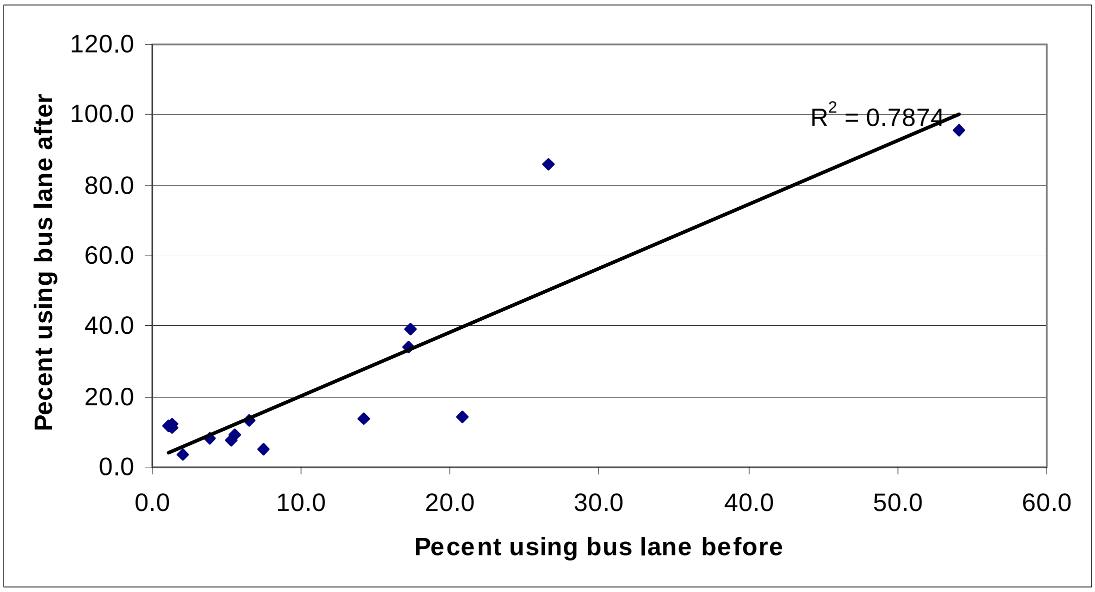


Figure 16: Relationship between bus lane use and capacity used

Permitting motorcycles to use the studied bus lanes in London approximately doubled the percentage already using them. This confirms the finding that motorcyclists use the lane when there is a journey time advantage. It would appear they do not enter the bus lane to improve the safety of their journey in London, and they will generally remain in the non-priority lanes unless they are congested. It is therefore believed that most motorcyclists did not perceive any journey time advantage on using six of the bus lanes.

6.2. Use of both lanes

Motorcyclists will use the bus lane when they perceive a journey time advantage. However, there are two ways that they can make use of the bus lane. Firstly, they can use the lane instead of the non-priority lane, keeping to the its centre and becoming part of the flow. Alternatively, motorcycles are able to use the bus lane to filter through the traffic. This requires them to travel between the bus and non-priority lane and therefore regularly switch lane.

Lanes used by all motorcycles within the camera's field of view were recorded. The percentage of the observed motorcyclists using both the bus and non-priority lane are shown in Figure 17.

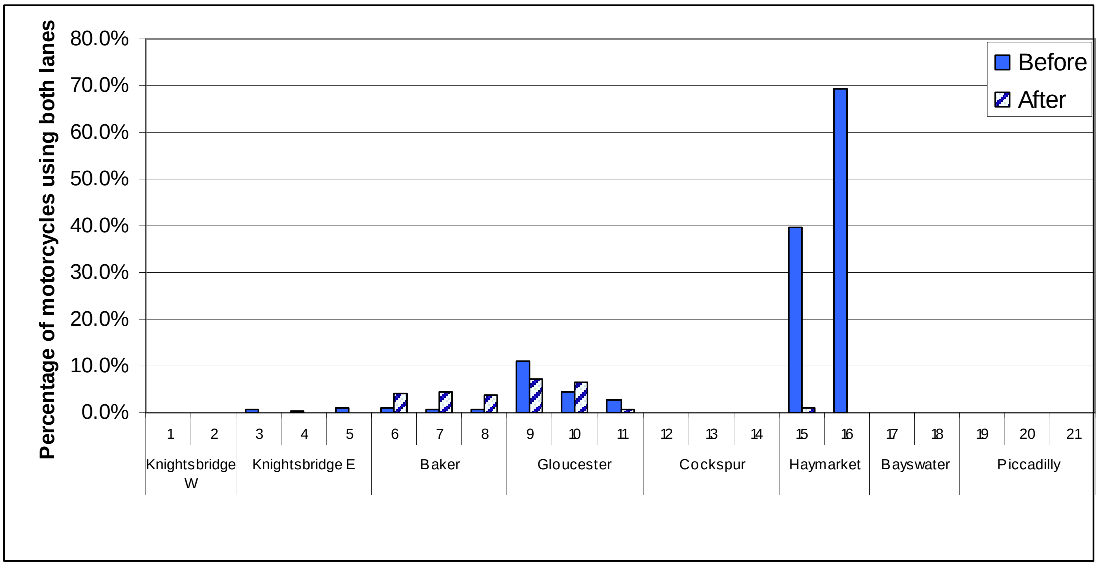


Figure 17: Percentage of motorcycles swerving between the lanes

Few motorcyclists used more than one lane when travelling through the observed sites. The main exception was Haymarket. It has previously been noted that high percentages of motorcyclists were using the bus lane illegally during the "before" study. This was mainly due to them weaving between the lanes, and therefore between traffic queues. However, they stopped this behaviour in the "after" survey.

In contrast, the percentage of motorcyclists using both lanes increased, by approximately 5% on Baker Street. Section 6.1 shows an increase in the region of 10% in motorcyclists using this bus lane. Therefore roughly half the lanes new users were travelling between the lanes.

6.3. Lane Position

The behaviour of motorcyclists is determined by both the lane(s) they chose and their position in those lanes. If they travel in the centre of the lane, they are part of the main traffic flow and queues. However, if they travel on the right side of a lane, this can indicate they are keeping their options open to filter through traffic between two lanes. Similarly, travelling on the left side of the non-priority lane can also indicate they are considering switching to travelling in the bus lane. The actual positions used according to the lane is summarised in Figures 18 to 20. The percentages are those for all motorcyclists travelling through the sites. However, on some sites the percentages during a given survey do not sum to 100% owing to missing information through obscuration. In addition, it is possible for the sum of the percentages to be greater than 100%, as the position in both lanes is recorded if a motorcycle switched lanes.

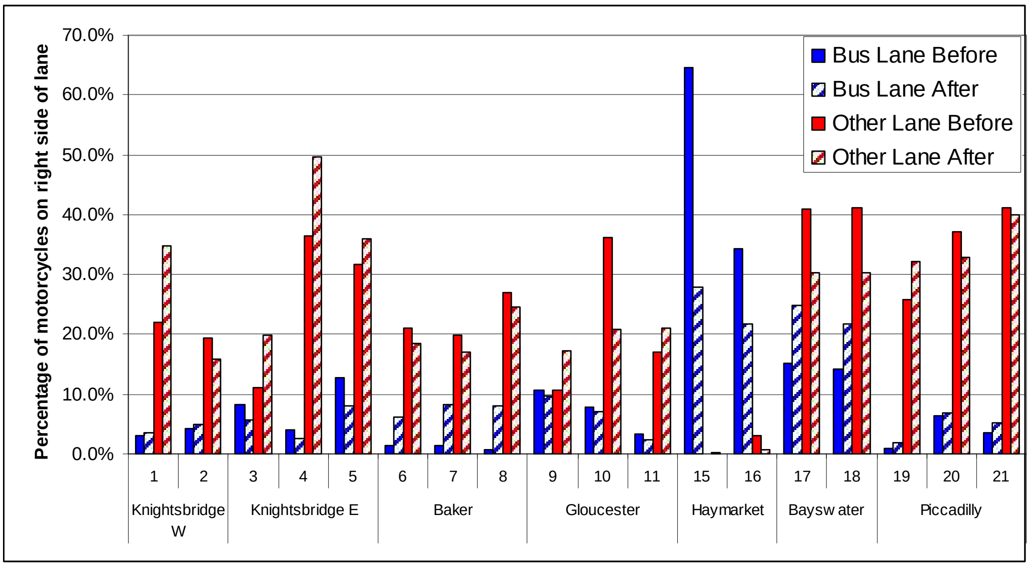


Figure 18: Percentage of motorcycles on right side of lane

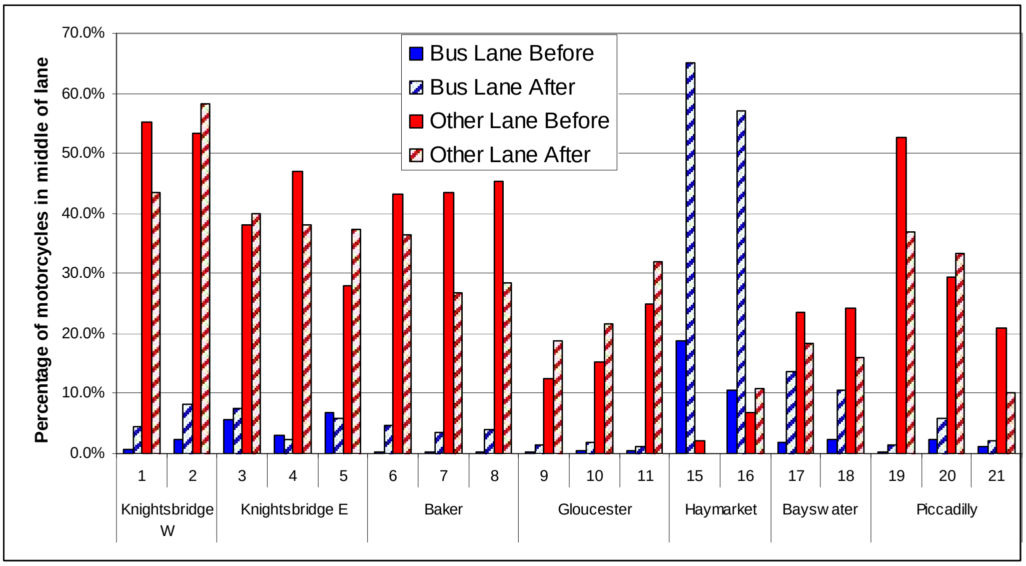


Figure 19: Percentage of motorcycles in middle of lane

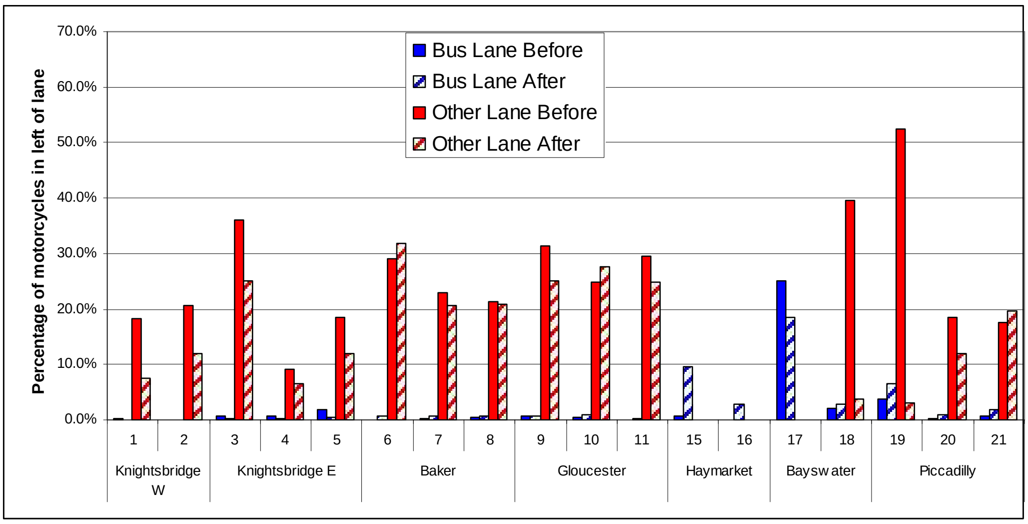


Figure 20: Percentage of motorcycles on left side of lane

Cockspur Street has been excluded from these figures owing to its uniqueness. On Knightsbridge, where traffic flows had increased and motorcycles had not greatly increased their use of the bus lane, they had instead tended to switch to the outside of the non-priority lane. This was presumably to enable them to travel down the outside of the queues, utilising the opposite carriageway where necessary.

On Baker Street, the increased bus lane use can be seen to comprise of motorcyclists travelling mainly down the centre of the bus lane, whilst others still travelled on the right hand side of the bus lane, possibly giving them the option to filter between the lanes (see Section 6.2).

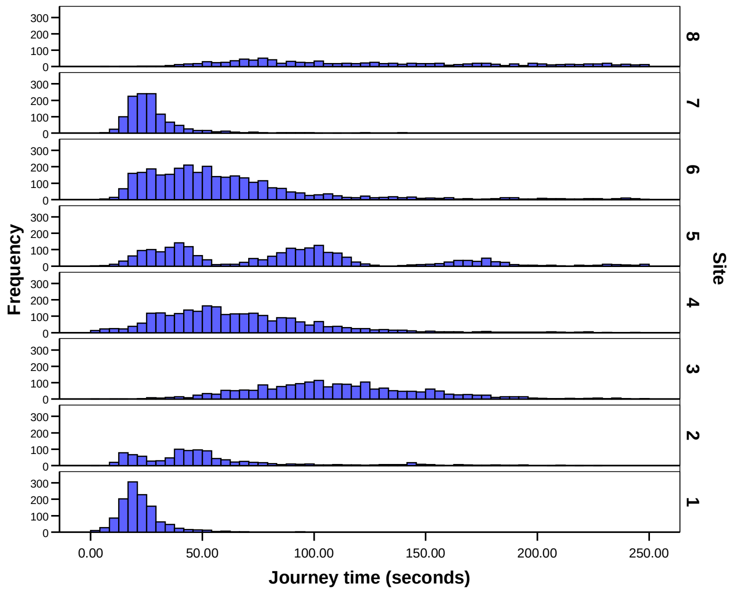
Traffic flow had significantly increased on Haymarket and motorcyclists had switched to using the bus lane. In addition, they started to travel down the middle of the lane, rather than the right hand side and filtering through the traffic.

Finally, motorcyclists changed their positions in the non-priority lane on Gloucester Place and Piccadilly. However, there appeared to be no consistent changes owing to motorcyclists being able to use the bus lane.

7. Journey times and speeds

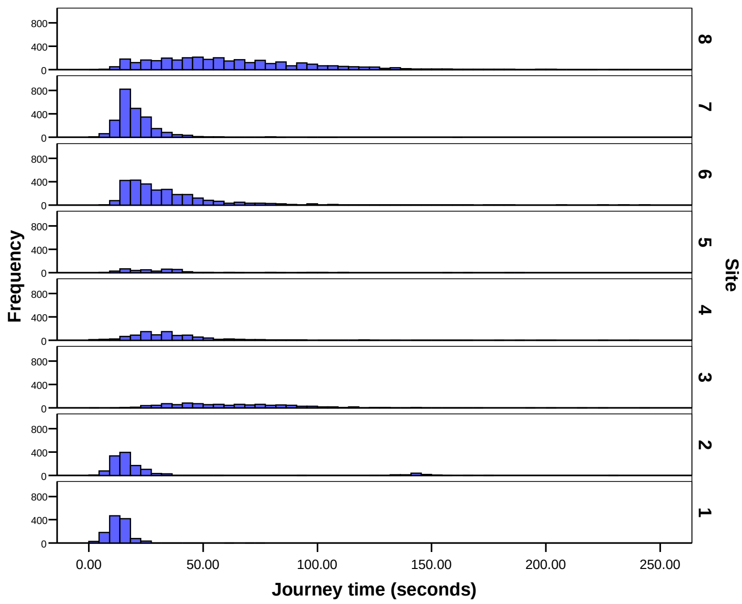
Surveyors recorded the number plates of buses and motorcycles at two points along each of the bus lanes. The timing points were selected so as to measure the free flow times and speed of the vehicles by avoiding other delay sources where possible. For example, the timing points were not positioned too close to, or either side of, a major junction. The journey times were examined to consider whether the introduction of motorcycles into the bus lane had hindered buses and therefore increased their journey time. It also aimed to quantify any travel time improvements obtained by motorcycles through being given the opportunity to travel in the bus lane.

The resulting number plates were matched into pairs to provide individual journey times and speeds. The resulting journey times for buses and motorcycles are shown in Figures 21 and 22.



Site Number	Site Name
1	Knightsbridge W
2	Knightsbridge E
3	Baker Street
4	Gloucester Place
5	Cockspur Street
6	Haymarket
7	Bayswater Road
8	Piccadilly

Figure 21: Observed bus journey times



Site Number	Site Name
1	Knightsbridge W
2	Knightsbridge E
3	Baker Street
4	Gloucester Place
5	Cockspur Street
6	Haymarket
7	Bayswater Road
8	Piccadilly

Figure 22: Observed motorcycle journey times

The standard deviation of journey times, and in particular bus journey times, is high. This is particularly the case on roads with high flows. However, the influence of other confounding factors can also be seen. For example, the short length of Cockspur Street resulted in a bus stop being present between the two timing points. This resulted in two, or three, distinct journey time distributions being included in the diagram for this site.

In addition to factors that can confound on the site, changes to flows will also affect journey times. Increases in bus flows can increase bus journey times, as they interact with each other, whilst increases to other flows can affect the journey times of motorcyclists. Therefore any changes need to be placed into context. The effect of increased general traffic flows on bus journey times on Haymarket can be seen in Figure 23.

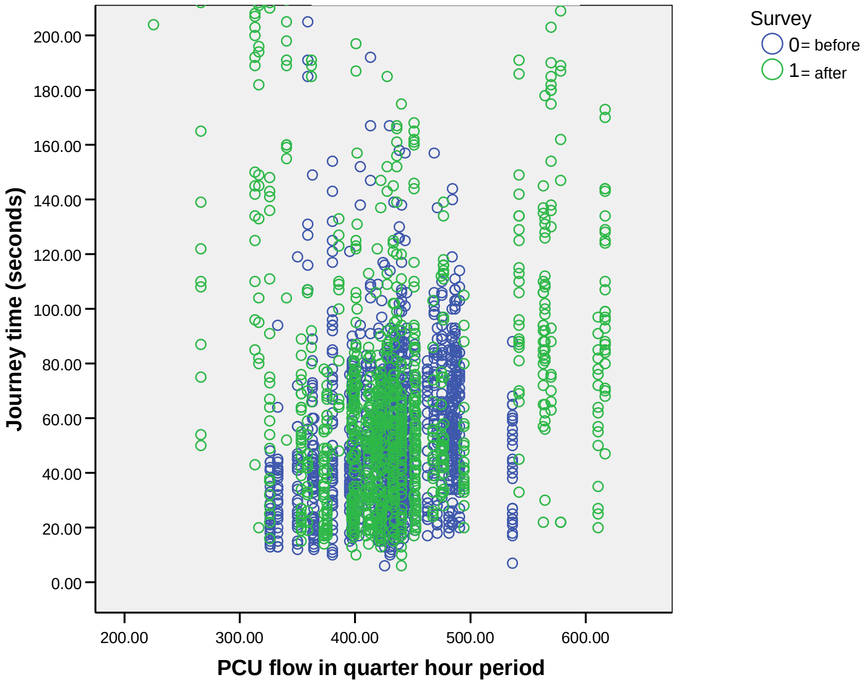


Figure 23: Bus journey times according to flow on Haymarket

7.1. Bus journey times

Bus journey times will generally be affected by the presence of, and interaction with, other buses in the bus lane. However, they can also be affected by the traffic flow if the timing points are close to the start, or end, of the bus lane. The average observed journey time at each site is shown in Table 14.

Table 14: Average bus journey times

Site	Time (seconds)		Distance Between Timing Points (m)	Speed (mph)	
	Before	After		Before	After
Knightsbridge W	19.9	23.7	250	28.0	23.6
Knightsbridge E	51.0	59.1	165	7.2	6.2
Baker Street	102.9	128.6	437	9.5	7.6
Gloucester Place	71.8	58.6	200	6.2	7.6
Cockspur Street	64.8	110.8	114	3.9	2.3
Haymarket	57.3	83.0	165	6.4	4.4
Bayswater Road	25.7	29.9	212	18.5	15.9
Piccadilly	109.2	234.7	300	6.1	2.9

The average bus journey time only decreased on Gloucester Place. However, this is misleading. A more detailed analysis of journey times allowing for different flow conditions shows that although the buses were faster in the "after" survey when the road was congested, the difference was not statistically significant. In fact, across all sites, the only significant changes in bus journey times were increases.

Increases in bus journey times can occur for a number of reasons. Some of them are caused by natural variation in the data, others by increases in bus or traffic flows, and changes to numbers of pedestrians using a crossing. Excluding Gloucester Place, the only remaining sites without flow changes were Baker Street and Bayswater Road. Although both were generally unaffected by other delay sources, the cleanest was Bayswater Road owing to the site layout. Data from this site implies the buses took an extra 4 seconds, equivalent to a 2.5 mph reduction in speed, to travel between the timing points. It is suspected this could be due to the increase in motorcycles using the lane which increased from 17 to 40% of motorcycles on this section of the road. The difference in the bus journey time distributions is shown in Figure 24.

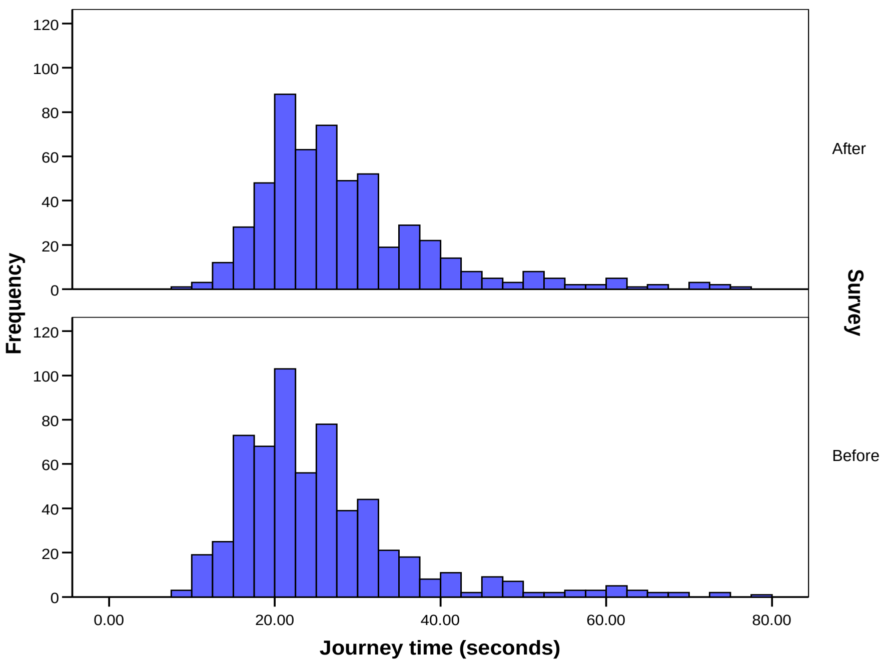


Figure 24: Bus journey times on Bayswater Road

The difference appears to be across the whole of the distribution. Therefore it would appear that the increased motorcycle flow from approximately 17 to 33 vehicles per hour could have affected bus speeds.

7.2. Motorcycle journey times

Motorcyclists would be expected to benefit from having access to the bus lane. It provides them with an alternative route through the traffic and therefore a way of minimising their journey time. However, in reality a number of other factors can affect the actual time taken. It will depend on whether the motorcyclist is willing to filter through the traffic, the perceived benefit at the time (for example whether a bus is present at a bus stop), and the lane required by the motorcyclist at the downstream junction. The average observed journey times for motorcyclists are summarised in Table 15, Cockspur Street and Piccadilly have been excluded owing to the motorcycles not being permitted on Cockspur Street in the "before" survey and the highly congested conditions occurring on Piccadilly.

Table 15: Average motorcycle journey times

Site	Average Journey Time (seconds)		Average Increase in Speed (mph)	85th Percentile of Speed (mph)	
	Before	After		Before	After
Knightsbridge W	17.0	15.4	3.3	46.6	46.6
Knightsbridge E	39.7	19.3	9.9	41.0	36.9
Baker Street	56.5	73.8	-4.0	39.1	27.5
Gloucester Place	42.6	34.6	2.4	29.8	26.3
Cockspur Street					
Haymarket	33.7	37.0	-1.0	26.4	24.6
Bayswater Road	21.6	20.5	1.2	39.5	43.1
Piccadilly					

On initial inspection there are no clear patterns of improvements: their average speeds increased on 4, but decreased on 2, sites. Journey times would be expected to be influenced by the traffic flow and the extent of use of the bus lane. Under the high flows existing on Knightsbridge, even though the flows increased in the "after" study, motorcycle journey times improved. There is evidence that motorcycles were using the bus lane to avoid delays.

Restricting attention to sites where flows remained fairly consistent: Baker Street, Gloucester Place and Bayswater Road. There is some evidence that motorcyclists tended to be able to reduce their journey times under the higher flow conditions. This was particularly evident on Bayswater Road which had the cleanest observations. On this site, even under the highest flow conditions observed, they only reduced their average travel time by 1.8 seconds, an increase of 2 mph. However, examining the 85^{th} percentiles of it is clear that the increase in speed is at least in part because a more motorcyclists were speeding in the "after" survey. Such behaviour is of concern, particularly in relation to the effect on cyclist and pedestrian safety.

8. Bus stop times

Buses travelling in the bus lane spend a fairly large proportion of their time at bus stops to allow passengers to board and alight. The time a bus remains at the stop is dependent on a number of factors. These include the number of bus doors, number of passengers boarding and alighting, the time taken for the doors to open and close, and the time taken by the driver to wait for a safe gap in which to pull away from the bus stop. It is this last component of the stop time that could be affected by permitting motorcycles into bus lanes.

Motorcycles are relatively fast and difficult to see. Consequently it is possible that bus drivers may take longer to check it is safe to pull out. Furthermore, they may be delayed by the motorcycles: i.e. they wish to move away from the bus stop, but are unable to do so because a motorcycle is passing the bus.

Data was collected from the video surveys on the time each bus spent at the bus stop, the number of passengers boarding and alighting from the bus and whether the bus was delayed by other vehicles. The number of occasions when a bus was observed to be delayed at the bus stop at each site are summarised in Table 16.

Table 16: Percentage of buses delayed at the bus stop

Site	Before	After
Knightsbridge W	3.2%	1.7%
Knightsbridge E	1.2%	1.0%
Gloucester Place	5.3%	6.8%
Cockspur Street	5.2%	19.9%
Haymarket	6.3%	2.1%
Bayswater Road	12.7%	1.2%
Piccadilly	5.8%	8.5%

The interaction of buses with other passing traffic would be expected to be highly variable, and this can be seen in the variations in Table 16. However, permitting motorcycles into the bus lanes did not have a negative impact on the percentage of buses delayed at the stop on the majority of the sites studied.

The only exception was the large increase in numbers of buses being delayed on Cockspur Street. The only vehicles permitted to use this road were buses and cycles in the “before” study and motorcycles were also allowed to use the road in the “after” study. However, the bus flows had also increased significantly in the “after” study. It is therefore possible that the increase in number of bus delays was due to the interaction between buses owing to more of them using the stops, and was not caused by the presence of motorcycles. Unfortunately, it is not possible to isolate the impact of motorcycles under these conditions.

The time spent by buses at stops can be analysed to measure passenger boarding and alighting times. A linear regression is generally used, which assumes the processes of boarding and alighting are sequential. This assumption can be seen to be generally valid for the buses on Haymarket in Figures 25 and 26.

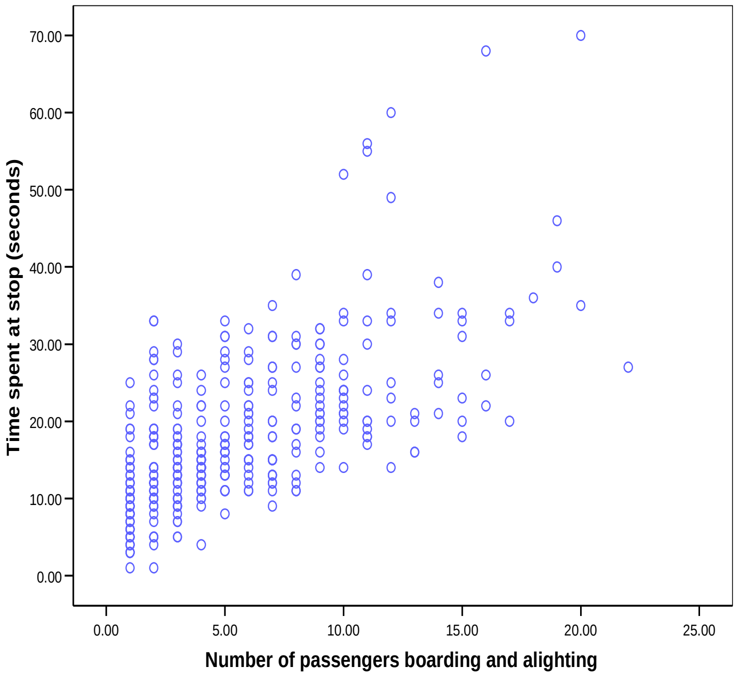


Figure 25: Bus stop times on Haymarket – Before Survey

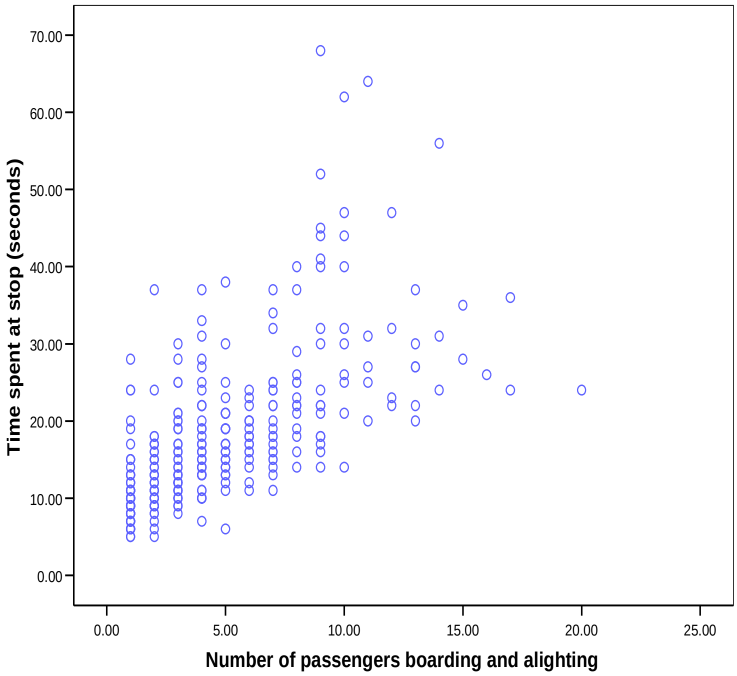


Figure 26: Bus stop times on Haymarket – After Survey

The resulting regression constant is often referred to as the dwell time constant, and consists of the time for the doors to open and close and for the driver to check the traffic before moving away from the bus stop. The observations on Haymarket indicate that there was little change in the stop times on this road, and this was found to hold on all sites.

Motorcycles being permitted into the bus lane were found to have little, if any effect, on the delay to buses at the bus stop. The difference in the dwell time constant between surveys at a given bus stop varied considerably, with it being reduced at some and increased at other stops. However, the maximum possible increase in the dwell time constant was found to be approximately one second.

9. Conflicts

Conflict analysis provides a first indicator of the safety of a section of carriageway. An accident involving two parties can be thought of as occurring when two road users (including pedestrians) try to use the same space at the same time. For an accident to occur both road users must fail to observe (or account for) the manoeuvre being made by the other. Generally, one of the road users does observe the other and take avoiding action and this is classified as a conflict.

All motorcycles were monitored whilst passing through each of the site features. Any conflicts between each motorcycle and other road users were recorded and classified as to which of the following occurred:

- The motorcycle/other road user braked
- The motorcycle/other road user braked hard (for example, one indicator of a car braking hard is its front dipping)
- The motorcycle/other road user swerved
- The motorcycle/other road user swerved hard

It would be expected that if the number of conflicts increase then so would the number of accidents. The percentage of motorcycles in conflict with another road user is shown in Figure 27, except for Cockspur Street that was excluded owing motorcyclists generally not using the road in the "before" study.

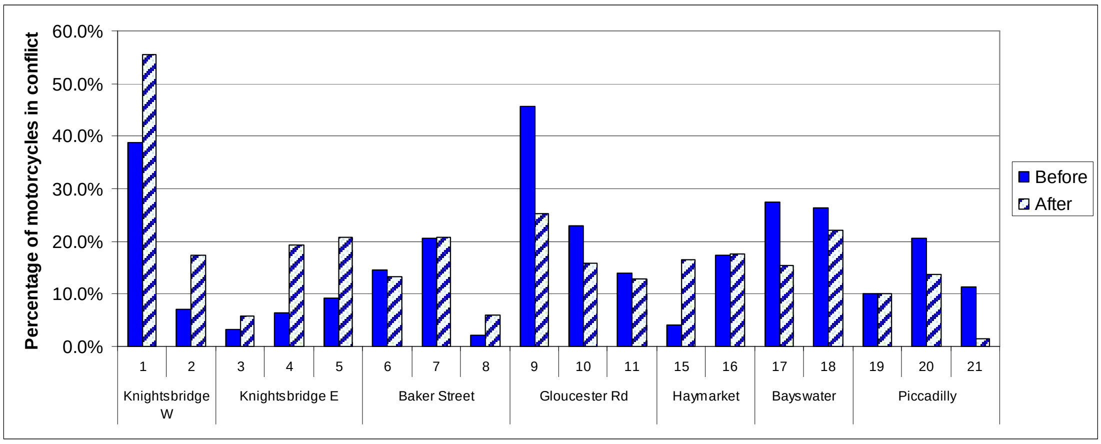


Figure 27: Percentage of motorcycles conflicting with other road users

The increase in conflicts on Knightsbridge is almost certainly due to the increase in traffic flow on this road: it increased by approximately 10% in each direction. There was also an increase in traffic flow on Haymarket; however, unlike Knightsbridge motorcycles also significantly increased their use of the bus lane: hence the effects appear confounded.

However, the majority of these motorcyclists on Haymarket travelled in the centre of the bus lane during the "after" survey, and were thus isolated from the increases in the main traffic flow. As a consequence it would appear that the large increase in conflicts at Feature 15 on Haymarket was a result of the motorcyclists using the bus lane. Site observations indicated a large number of buses manoeuvred around each other at the double bus stop at this feature (see Figure 15) and taxis also regularly pulled in an out from the kerb. It is therefore believed that the motorcycles using the centre of the bus lane caused them to be in conflict with these vehicles.

Traffic flows were fairly consistent during the two surveys on Gloucester Place, Bayswater Road and Piccadilly. In addition, the percentage of motorcycles using the bus lane on these sites increased slightly. The use of the bus lane therefore appears to have reduced the number of conflicts on these sites.

Finally, the traffic flows on Baker Street were also consistent, and the percentage of motorcyclists using the bus lane also increased by approximately 10%. Some of these motorcyclists travelled in the centre of the bus lane, whilst others rode on the its right hand side and alternated between the bus and non-priority lane. This change in behaviour appears to have had no effect on the number of conflicts at Features 6 and 7. However, the number had increased at Feature 8, see Figure 28.

Figure 28: Feature 8 on Haymarket

It would appear that using the bus lane, and possibly filtering through traffic using the outside of the lane, had a detrimental effect on conflicts involving motorcycles near to this junction.

The lane in which the motorcycle was travelling was recorded for each conflict. The percentage of conflicts occurring in the bus lane is shown in Figure 29.

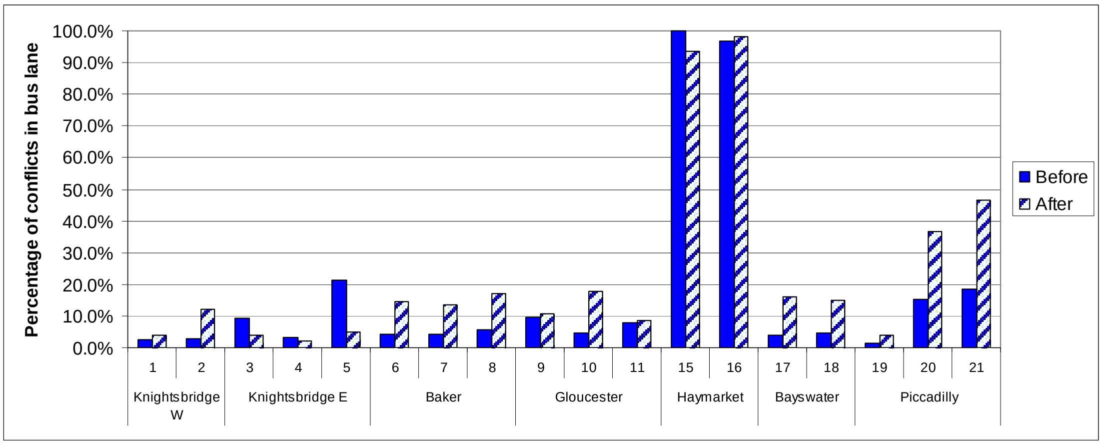


Figure 29: Percentage of motorcycles conflicts within the bus lane

On most sites the percentage of conflicts occurring in the bus lane increased with the percentage of motorcycles using the bus lane. The main exceptions to this rule were Haymarket and Bayswater Road. On Haymarket nearly all conflicts occurred in the bus lane, irrespective of the percentage of motorcycles using it. This implies that motorcycles were inherently safer travelling in the non-priority lane.

On Bayswater Road the percentage of conflicts in the bus lane increased in the "after" survey. However, the increase was less than the increase in motorcycles using the lane. It would therefore appear that motorcyclists were safer when using this bus lane.

Overall, the conflict analysis indicates allowing motorcyclists into bus lanes has a mixed effect on safety. Conflicts reduced on some sites, implying motorcyclists were safer. However, there appears to be some circumstances where permitting them into the bus lane was detrimental to safety. It is not possible to be certain of the reasons for this reduction in safety. However, it would appear that bus lanes where large numbers of buses and taxis manoeuvre to and from the kerb, and bus lanes with a highly trafficked side road, should be avoided.

10. Injurious Accidents – STATS 19

STATS 19 is a database of injurious accidents occurring in the UK. The police must be informed of any motor accident if a person is injured. They complete a form detailing the vehicles involved, resulting casualties, information on the position of the accident, road conditions at the time of the accident and the manoeuvres being performed directly before the accident. The database provides detailed and useful information on the accident trends in a given area and the circumstances underlying them. It is therefore possible to examine the effect of a scheme on safety by examining these statistics and understand the causes of any observed changes.

Injurious accidents are relatively rare occurrences. Thus small perturbations in yearly numbers are common and not statistically significant. To obtain robust trend information either requires a large change, or information over a number of years. There are also a number of known deficiencies with STATS 19 data. For example, accidents on private land or roads are not recorded. Also, there is often a degree of under-reporting particularly when motorcycles are involved in minor accidents with pedestrians or pedal cyclists.

The STATS 19 data was obtained for the years 2004 to 2006 inclusive for all accidents which involved a motorcycle in a pre-defined area including each of the studied sites. Accidents which occurred strictly on the opposite carriageway to the bus lane were excluded. The resulting motorcycle accidents according to month and year are summarised in Figure 30. The examination of data from one year before and after the introduction of the schemes provides an indication of possible effects, but cannot be considered to be statistically robust. Further accident analysis exploring three years before and after the schemes' introduction is planned (and this should provide a clearer insight into any safety effects (either benefits or disbenefits) achieved by permitting motorcycles into bus lanes.

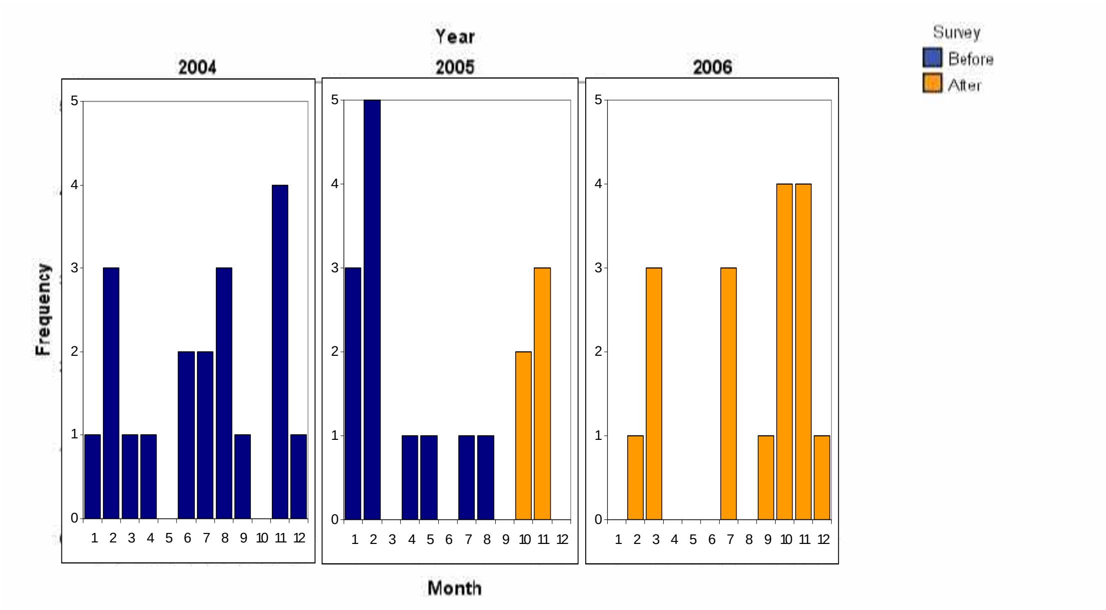


Figure 30: Total number of motorcycle accidents on all eight sites

There appears to have been little change in the number of motorcycle accidents between 2004 and 2006: from 19 in 2004 to 17 in 2006. However, the picture is somewhat different when the accidents occurring on each site are examined, see Figure 31.

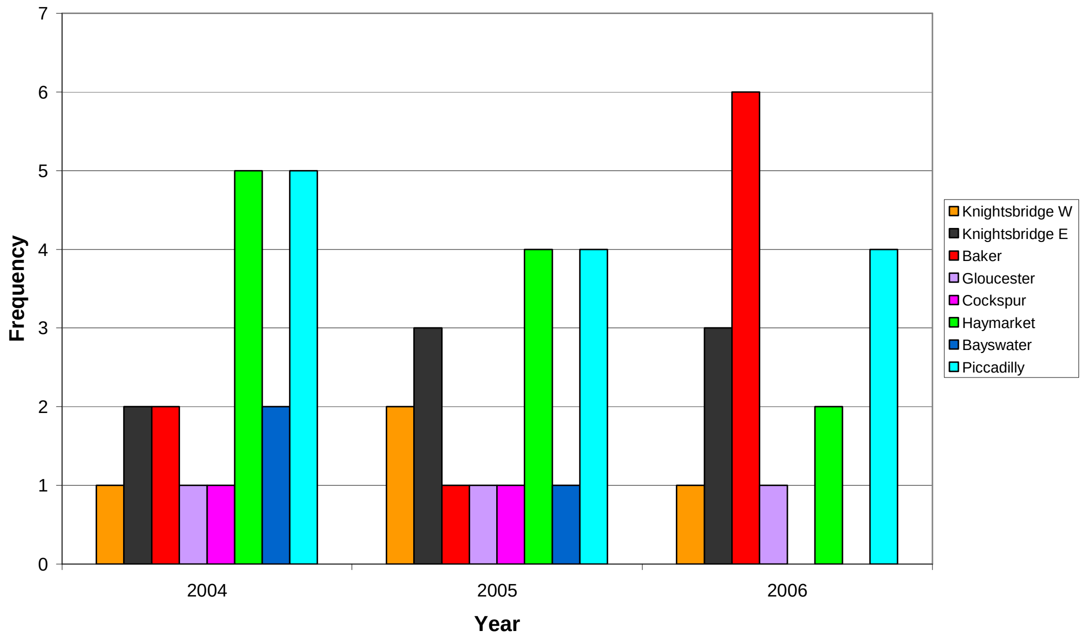


Figure 31: Accidents per year on the sites

There has been a large increase in the number of accidents involving motorcycles on Baker Street, increasing from two in 2004 to six in 2006. It was on this site that there was a notable increase in conflicts at one of the features, near to a side road. Further, motorcyclists at this site often utilised the bus lane by switching between it and the non-priority lane. Overall, permitting motorcycles into this bus lane appears to have adversely affected safety.

This is in direct contrast to the other sites where number of accidents varied by at most one or decreased. It is not possible to draw firm conclusions from such a limited amount of data. However, certain trends appear to hold, the percentage of motorcycles using the bus lane only decreased on Knightsbridge Eastbound, and apart from Baker Street, this was the only site where there was a slight increase in numbers of motorcycle accidents.

There were moderate percentage increases in motorcycles using the bus lanes on Knightsbridge Westbound, Gloucester Place and Piccadilly, and motorcycles accidents on these sites varied by at most one over the three years studied. The conflict analysis also implied the motorcyclists were possibly slightly safer after being permitted to use the lane. However, the low usage of the bus lane has resulted in this being inconclusive.

Cockspur Street is a special case as motorcycles could not use the road in the “before” study, but there was some evidence that motorcycle accidents in the area had slightly reduced.

On the two other sites (Haymarket and Bayswater Road) where the percentage of motorcycles using the bus lane had increased significantly, the number of accidents decreased. This is in agreement with the conflict analysis for Bayswater Road (an uninterrupted section of bus lane) and motorcyclists appeared to be safer on this site. Unfortunately, the picture is inconsistent for Haymarket. Although the number of accidents decreased, the number of conflicts increased near a double bus stop and nearly all conflicts occurred in the bus lane. This is possibly because the effect of one bus stop is masked by the area-wide data from STATS 19. Overall, the results indicate that there could be a safety issue on Haymarket due to motorcycles conflicting with buses and taxis manoeuvring in and out from the kerb, and around each other. Therefore, caution should be used in allowing motorcycles into the bus lane under such circumstances.

The general effect on accidents on the sites, excluding Baker Street, was a slight overall reduction, see Figure 32.

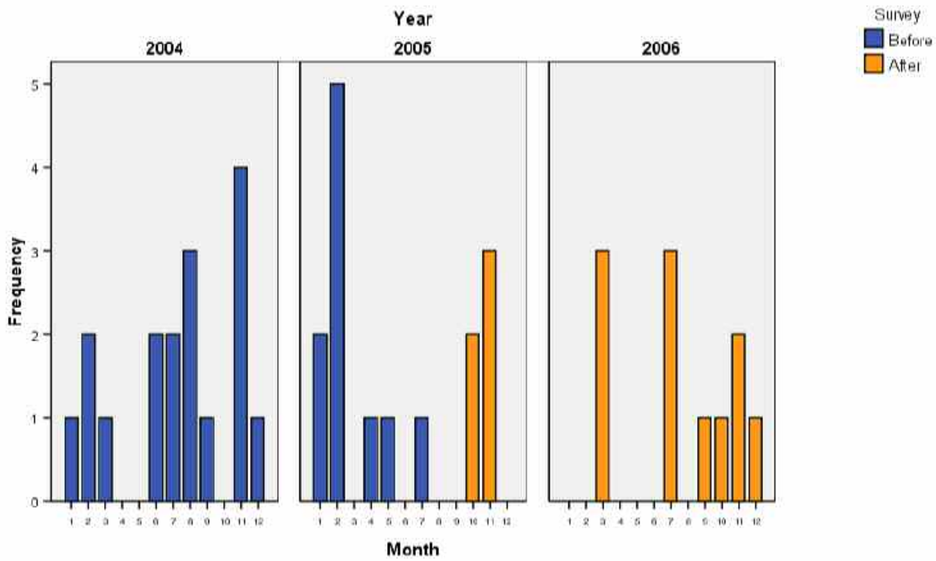
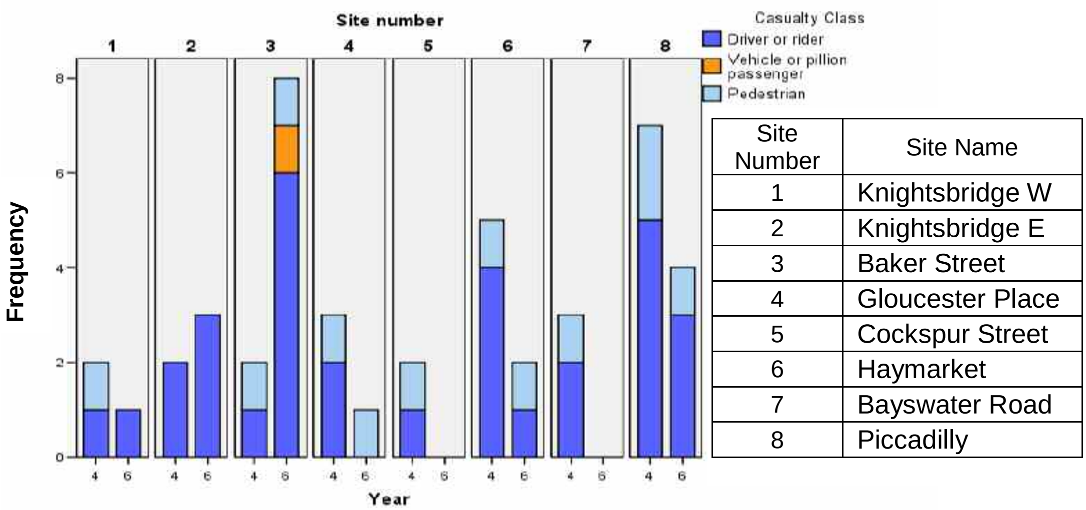


Figure 32: Total number of motorcycle accidents, excluding Baker Street

The schemes would have taken a while to settle in. That is, motorcyclists would have taken a while to become familiar with the changes and adapt their behaviour. To allow for a settling in period, and to also remove seasonal variations, the 2004 and 2006 data were compared: i.e. one year before and after introduction, with a three month settling in period.

10.1. Casualties

Casualty numbers can be considered of greater relevance than accident numbers, as they relate directly to the underlying costs. These compared with the severity of the accidents provides a complete picture of the effect of the accidents. Accidents are only recorded if a person is injured, therefore there are at least as many casualties as accidents. The accidents at each site split according to whether the person injured is a rider or a pedestrian are summarised in Figure 33.



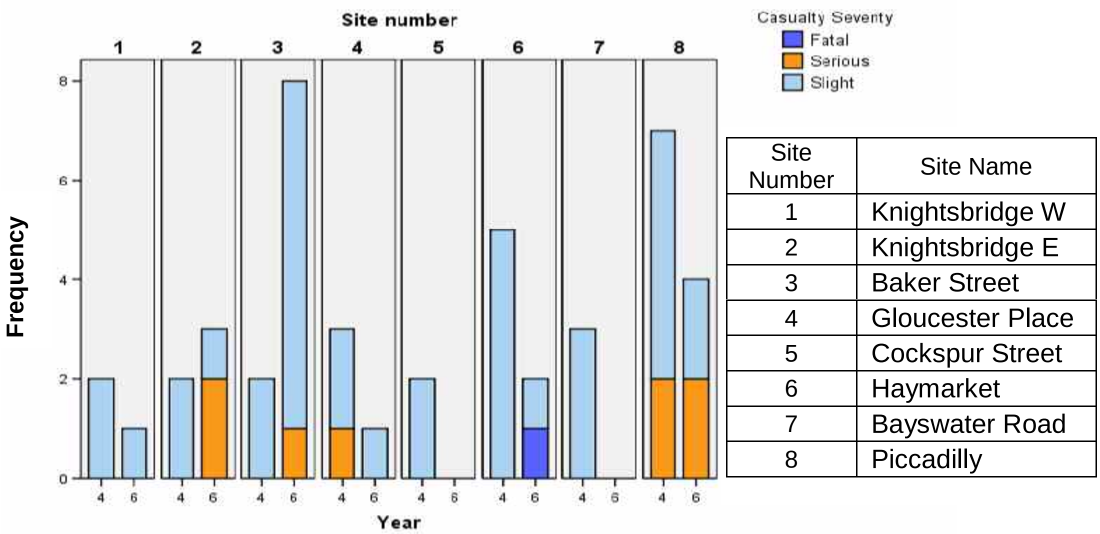
Site Number	Site Name
1	Knightsbridge W
2	Knightsbridge E
3	Baker Street
4	Gloucester Place
5	Cockspur Street
6	Haymarket
7	Bayswater Road
8	Piccadilly

Figure 33: All casualties by site for years 2004 and 2006

In line with the accidents, the number of casualties at each site reduced if motorcycle usage of the bus lane increased, except at Baker Street. The number of casualties on Baker Street increased four-fold from two in 2004 to eight in 2006. Mainly more riders (or drivers) were injured in the “after” survey, however, most (90%) of these accidents were slight: i.e. generally sprains, cuts and bruises.

On the other sites the number of riders (or drivers) injured halved from sixteen to eight and the number of pedestrians injured decreased by 63% from eight to three. Even with the small numbers of accidents and casualties, a pairwise t-test implies that the reduction was significant at the 95% confidence level. However, further data would be required to confirm this trend, particularly as this includes all sites irrespective of whether there had been increased use of the bus lane by motorcyclists.

Although the number of casualties has reduced, this is only a reduction in the number of slight accidents. Overall, there was an increase in the number of KSI (Killed or Serious Injured): from three to five. Thus the percentage of KSIs in the observed casualties increased dramatically from 13 to 45%, see Figure 34.



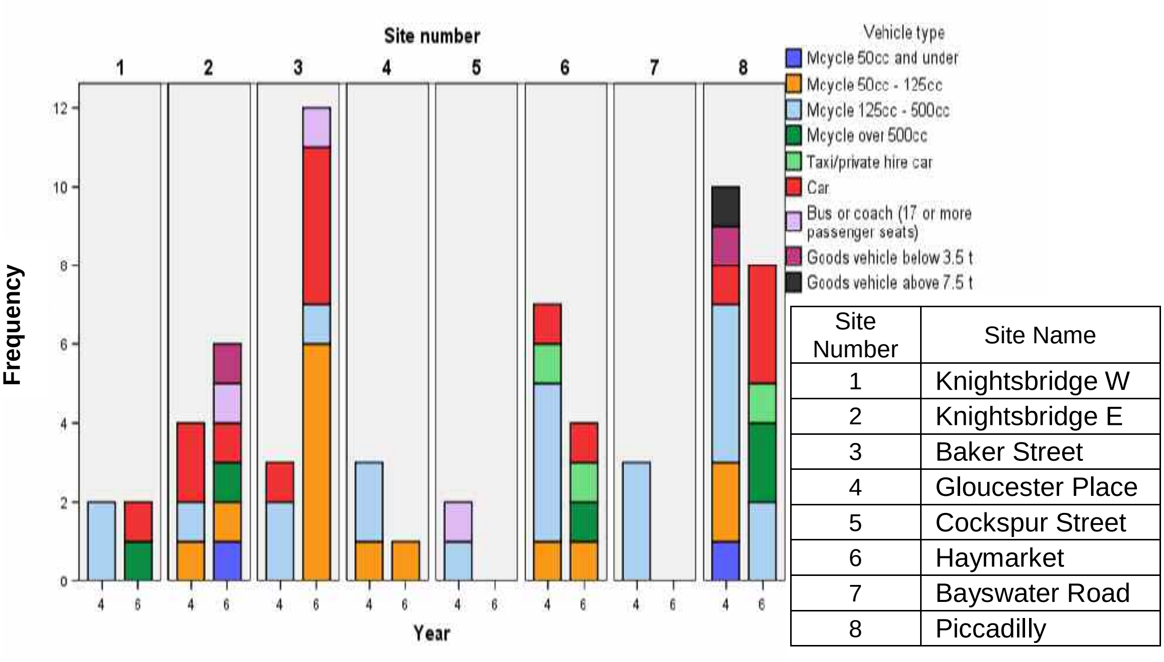
Site Number	Site Name
1	Knightsbridge W
2	Knightsbridge E
3	Baker Street
4	Gloucester Place
5	Cockspur Street
6	Haymarket
7	Bayswater Road
8	Piccadilly

Figure 34: Severity of casualties 2004 and 2006

The serious and fatal accidents increased (albeit by only one) on Baker Street and Haymarket. That is, the two sites where the conflict analysis indicated that safety had been reduced by permitting motorcycles into the bus lanes.

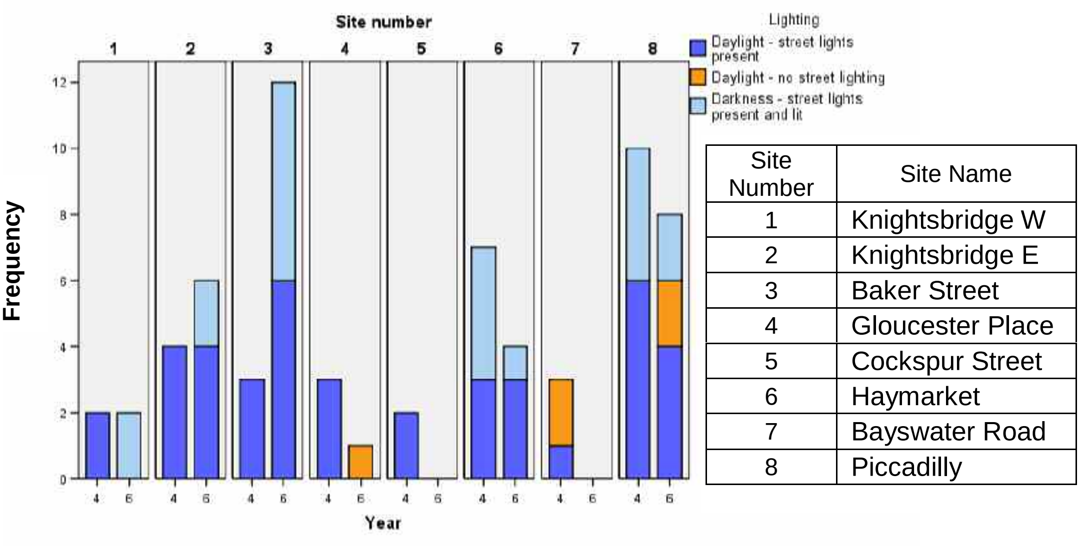
10.2. Vehicles and conditions involved

The number of accidents and casualties had reduced on all but one site (Baker Street). However, the number of severe casualties had if anything increased. This section considers the vehicles and circumstances involved in the accidents and therefore explore the reasons leading to the changes in the severity of the accidents. The people involved in each of the accidents according to the vehicle they used are shown in Figure 35, and the lighting conditions at the time of the accident in Figure 36.



Site Number	Site Name
1	Knightsbridge W
2	Knightsbridge E
3	Baker Street
4	Gloucester Place
5	Cockspur Street
6	Haymarket
7	Bayswater Road
8	Piccadilly

Figure 35: People according to vehicles involved for years 2004 and 2006



Site Number	Site Name
1	Knightsbridge W
2	Knightsbridge E
3	Baker Street
4	Gloucester Place
5	Cockspur Street
6	Haymarket
7	Bayswater Road
8	Piccadilly

Figure 36: People according to lighting involved for years 2004 and 2006

Lighting should not have been a contributing factor to the accidents as it was good in all cases. However, it also shows that half the accidents on Baker Street in the “after” study occurred in darkness, whilst all those in the “before” study were in daylight. It is unclear whether this indicates an issue due to the low visibility of motorcycles and their use of the bus lane.

In addition, all but one of the accidents on Baker Street occurred within 50 metres of a junction. Unfortunately, this could be a cause or an effect. Baker Street was the only site with short bus lane sections and an increase in bus lane use by motorcycles. However, the presence of so many junctions on Baker Street results in a high probability that an accident will occur close to one of them, see Figure 37.

Figure 37: Junctions on Baker Street

On all sites in the “before” survey 15 of the 19 accidents (79%) were within 50 metres of junctions which was similar to the percentage in the “after” survey: 14 out of 17 accidents (82%). Clearly junctions play an important role in the accidents, probably owing to the increased manoeuvres made by vehicles changing lanes especially after the end of the bus lane. Examining the manoeuvres made by motorcycles at the time of the accidents, they were generally (86% of cases) going ahead or overtaking. This possibly indicates they were filtering through the traffic at the time of the accidents.

On all sites except Baker Street, eight other people not using a motorcycle were involved in motorcycle accidents in the “before” survey, and ten in the “after” survey. This could at least partly explain the increase in the number of severe casualties. It would be expected that accidents between motorcycles and other vehicles (cars, light goods and buses) would result in a high probability of severe injury to the motorcyclist.

Overall the accident analysis is non-conclusive, but raises some issues of concern. On one site (Baker Street) there appears to have been a large increase in the number of motorcycle accidents, although these were generally of minor severity. Also, on both Baker Street and Haymarket there were small increased in KSIs, which might indicate an erosion of safety. Combined with the results of the conflict analysis, these suggest that allowing motorcycles into these two bus lanes has adversely affected safety.

On the other sites, numbers of motorcycle accidents appeared to have decreased provided motorcycles used the bus lane more. However, the reduction was obtained for accidents involving slight injuries, and numbers of KSIs had not improved.

11. DataBike

TRL's DataBike is instrumented to record the situations encountered by an experienced rider and their professional opinions on those situations. A rider travelled through each of the studied sites in the non-priority lane(s) in March 2005, before motorcycles were permitted to use the lanes. The same rider then returned to each site and travelled in the bus lanes in January 2007, when motorcycles were permitted to use the lanes. The riders opinions are summarised in Table 17.

Table 17: Scheme assessment

Site	Advantage	Perceived Dangers	Comments
Knightsbridge W	No	Side roads	Traffic level low
Knightsbridge E	No	None	Prevented ongoing filtering (part)
Baker Street	No	Side roads	Road wide
Gloucester Place	No	No	Road wide, traffic level low
Cockspur Street	No	No	M/cyclists prefer quicker original route
Haymarket	No	No	Some advantage if turning left at end
Bayswater Road	No	No	Low traffic volumes
Piccadilly	Little or No	Side roads	No. and freq of stationary buses

The rider considered there was no advantage in motorcyclists using the bus lanes at most of the sites. However there were some concerns at three sites due to side roads and turning vehicles, one of which was Baker Street. Also, the rider noted concerns over parked vehicles and others manoeuvring at some sites. Observations made on the site conditions are summarised in Table 18.

Table 18: Observations

Site	Pedestrians	Parking	Traffic speed	Notes
Knightsbridge W	None seen	Negligible	High	N/A
Knightsbridge E	None seen	N/A	N/A	Roadworks
Baker Street	Low Flow	Several vehicles	Fairly high	N/A
Gloucester Place	Low Flow	Along length	High	Short traffic queues
Cockspur Street	N/A	Empty	N/A	Short lane
Haymarket	High flow	Several vehicles	N/A	Surface bumpy
Bayswater Road	N/A	N/A	N/A	N/A
Piccadilly	High flow	Cabs etc	Very Slow	Busy road

The lack of advantage in using many of these lanes is in agreement with the fact that less than 15% of motorcyclists used five of the lanes. The concern over side roads and manoeuvring vehicles is also in agreement with the results of the conflict and STATS 19 analysis.

12. Discussion and conclusions

A detailed study has been performed on eight bus lanes in Westminster, where motorcycles were permitted to use them. A number of survey techniques were combined to assess any impacts on bus operations, motorcycle journey times and safety. In addition, traffic flow surveys were performed to identify any changes between the two surveys that could have also influenced delays and motorcyclist and other road user safety on the sites and hence have confounded the experiment.

The surveys consisted of tube counter/classifiers to record the flow of traffic over five days. Video surveys over three days, from which classified counts, bus stop times, motorcycle lane use, and conflicts with motorcycles were extracted. Manual cordon surveys over two days recording bus and motorcycle journey times. The findings of the analysis were:

1. Overall traffic flows remained consistent on four of the eight sites. On Cockspur Street the original traffic flow was small, and consisted of buses and cycles. Afterwards motorcycles combined with the increased bus flow resulted in a large increase in overall Passenger Car Units (PCU) flow. Both bus and overall traffic flows had increased on Knightsbridge, and motorcycle and overall traffic flows had increased on Haymarket.

2. Measured traffic flows were found to be misleading on Piccadilly. Measured flows were relatively low indicating it was below capacity, but observation showed that the road was highly congested. It was believed that Piccadilly was actually operating near to capacity, but this resulted in the analysis being unable to correctly capture and explore the conditions on this site.

3. Three of the other sites Gloucester Place, Cockspur Street and Baker Street were operating at less than half of the theoretical link capacity. The remaining four (on Knightsbridge, Haymarket and Bayswater Road) were operating at between 50 and 75% of link capacity.

4. Motorcyclists were found to use bus lanes (and not just encroach into them whilst filtering) when they were not permitted in them. The percentage of observed motorcyclists using the bus lane in the before surveys varied from 1 to 54%. One of the main reasons for motorcyclists encroaching on the bus lane was the degree of saturation on the link, with more motorcyclists deciding to use the lane as the road became congested.

5. The percentage of motorcycles using each of the bus lanes, and remaining in them, approximately doubled when they were permitted to use it. That is, the extent of use depended on the perceived journey time advantage, and not on safety considerations. It was therefore only on the highly congested roads of Haymarket and Bayswater that large percentages of motorcycles used the bus lanes.

6. Allowing motorcycles to use the bus lane had a variable effect on lane discipline. Less than 15% of motorcyclists weaved between the bus and non-priority lane at all sites except Haymarket. On Haymarket, many motorcyclists were recorded by the cameras using both lanes when they were not permitted in it. This behaviour on Haymarket altered to travelling down the centre of the

wide bus lane when allowed to do so, although this may have also been affected by the increased traffic flow. This was in contrast to Baker Street, which was the only site where motorcyclists consistently increased the amount of weaving between the lanes in the “after” study. The other main change in behaviour was on Knightsbridge, where motorcyclists switched to using the outside of the non-priority lane. This was presumably to enable them to travel down the outside of any queues, utilising the opposite carriageway where necessary

7. Bus journey times were found to have increased slightly in the after survey. Those measured on Bayswater Road were not affected by traffic flow changes or site characteristics, as it was an uninterrupted section of bus lane. These indicated that buses took an extra 4 seconds, equivalent to a 2.5 mph reduction in speed, to travel between the timing points after motorcycles were permitted into the lane. It is therefore believed this was due to the increase in the percentage of motorcycle using the bus lane, of 17 to 40%, on this section of the road.

8. Overall, the effect on motorcycle speeds was varied. However, on sites where flows remained fairly consistent (Baker Street, Gloucester Place and Bayswater Road), there was evidence that motorcyclists reduced their journey times under the higher flow conditions. On Bayswater Road the average speed of motorcyclists increased by 2 mph, with the 85th percentile of speed being 43.1 mph in the after survey. Such behaviour is of concern, particularly in relation to the effect on cyclist and pedestrian safety, as there is a correlation between increased speed and severity of collisions for pedestrians and cyclists.

9. Motorcycles using bus lanes had little, if any, effect on the delay to buses at bus stops. It was found that the maximum delay was one second.

10. Motorcycle use of the bus lane decreased the number of conflicts with other vehicles and pedestrians at most of the sites studied, implying that there could be safety benefits. However, there were increased numbers of conflicts at two sites: Baker Street and Haymarket. These implied that it would be advisable to deny motorcyclists access to bus lanes where a large number of buses and taxis manoeuvre to and from the kerb, and those with a highly trafficked side road.

11. The number of accidents (one year after compared to one year before) increased on Baker Street, the site with a highly trafficked side road and an increase in conflicts. Accidents on the whole of Haymarket decreased which is contrary to the conflict analysis. This perhaps implies that motorcyclists may have safety benefits overall on Haymarket, particularly as traffic flow had increased, even though there are issues with vehicles manoeuvring to and from the kerb in one section of the site. The number of accidents on other sites where traffic flows remained reasonably constant had either stayed the same or slightly decreased.

12. The number of serious and fatal injuries (KSIs) increased by one on both Baker Street and Haymarket. That is, the two sites where the conflict analysis indicated that safety benefits had been reduced by permitting motorcycles into the bus lanes. The number of injuries, and KSIs, decreased on all other sites except Knightsbridge eastbound where traffic flows had increased whilst motorcycle use of the bus lane had slightly decreased.

13. Overall, the accident and conflict analyses were not conclusive. It would appear that safety benefits for motorcycles were not compromised compared to when they were not permitted to use the bus lane. However, safety benefits may be reduced if there is a highly trafficked side road along the bus lane, or taxis and buses are manoeuvring to and from the kerb along a section of the lane. There were also some indicators of concern for cycle and pedestrian safety, In particular, on Bayswater Road a greater percentage of motorcycles were speeding. This is not only a known cause of accidents, but also results in more serious injuries.

14. The opinion of the professional rider of the DataBike coincided with the findings of this study. The rider considered there were limited advantages in motorcyclists using some of the bus lanes under the observed conditions, which coincides with the video survey analysis which showed motorcyclists did not greatly increase their use of many of the bus lanes. He also expressed concerns at three sites because of side roads and turning vehicles, one of which was Baker Street, which was also found to be of concern from the conflict and accident analysis. The rider also noted some concerns over parked vehicles and others manoeuvring at some sites; this increased the potential for conflicts on Haymarket.

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Abstract

Bus lanes are implemented to assist buses by-pass traffic queues. They reduce travel times and can improve reliability. Pedal cycles are also generally permitted to use these lanes and motorcyclists are being considered for admission however there are some concerns.

Motorcycles are capable of high acceleration and are manoeuvrable. It is therefore possible their rider's behaviour could result in them coming into conflict with other road users and pedestrians crossing the road who were not expecting motorcycles in bus lanes. One possible conflict is with vehicles turning right into a junction. The motorcyclist travelling in the bus lane could be obscured by stationary traffic in the non-priority lane and come into conflict with the turning vehicle.

This study builds upon results from previous research conducted in Bristol and Swindon. It examined motorcycle riders permitted to use eight bus lanes in the City of Westminster, London. A number of survey techniques were combined to assess impacts on bus operations, motorcycle journey times and the safety of motorcyclists and other road users.

This report is based upon the findings from a number of sources including conflict analysis and STATS19 accident analysis. The STATS19 analysis was necessarily restricted and further accident analysis is planned.

Impacts of motorcycles in Westminster bus lanes

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