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Measure No.5: Road space re-allocation



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Re-allocating general traffic lanes for use by other types of road user.

Cities can encourage more efficient or alternative uses of road space by dedicating space specifically for use by public transport, cycles and high occupancy vehicles. They may also narrow carriageways to improve public spaces.

5.1 Context and background

This measure encompasses Interventions that are concerned with re-allocating general traffic lanes, to alternate transport uses.

Road space re-allocation schemes in urban areas may have a number of objectives:

1. To increase the overall people (as opposed to vehicle) carrying capacity of urban networks by: a) increasing public transport or cycle network capacity and b) encouraging a modal shift away from single occupancy car use;
2. To reduce traffic levels, congestion and/or improve general quality of traffic flow;
3. To improve journey times and reliability for public transport to make journey times competitive with the private car;
4. To improve the overall journey experience for cyclists;
5. To reduce the number of road collisions and casualties;
6. To improve local air quality; and
7. To improve the public realm by

Key messages:

- Schemes in which general traffic lanes are re-allocated to alternative uses can be expected to reduce traffic volumes, improve journey times for the modes given additional priority (e.g. bicycles or buses), increase the use of non-car modes and reduce casualty numbers.
- However, little credible evidence was identified on the monetized costs and benefits of road space re-allocation schemes. This may be a result of such schemes often forming part of a wider package of measures which are then appraised as a whole.
- Journey times for general traffic (cars, vans etc.) may increase, although in some cases road space reallocation has not led to the anticipated increases in congestion. Therefore, it is possible to remove road space and improve conditions for users of other modes and the public realm without worsening conditions for general traffic.
- Accordingly, modelling exercises of road space reallocation under different scenarios indicate that benefit-cost ratios for road space re-allocation schemes are likely to be positive in cases where the benefits of increased person throughput or modal shift outweigh the dis-benefits of delays to general traffic.

Potential interventions

- Reallocation of road spaces to public transport lanes (including provision for taxis, motorcycles and bicycles);
- Reallocation to cycle lanes;
- Reallocation to high occupancy vehicle lanes (including tolled) lanes;
- Carriageway narrowing to improve public spaces.

“taking back” road space to become public space.

Note: This review does not consider access restrictions, or road closures which are dealt with in detail under measure review No4. It also does not include the provision of new capacity (e.g. bus/cycle lanes that are in addition to existing general traffic lanes) as these do not constitute road space re-allocation.

5.2 Statement of the Extent and Sources of Evidence

This measure review has drawn on 13 sources. A meta-study by Cairns et al^{1,2} - examining the impact of road space reductions from over 100 case studies around the world - has been used to provide a general context for more detailed case studies of specific road space re-allocation schemes. These interventions were categorised according to whether space has been re-allocated to mixed priority, public transport, cycle only, or high occupancy vehicle lanes. Whilst there is a great deal of evidence on the impact of these different forms of priority lanes, fewer studies were found to have examined the specific effects of re-allocating existing road space to these modes. This was particularly true for high occupancy vehicle lanes, where only one detailed case study was identified.

The review draws heavily on case studies from the UK, though these have been supplemented by examples from Sweden, New Zealand and the USA. It is common for monitoring studies to have been reported by local highway authorities or consultancies acting on their behalf, rather than being based on detailed academic research. A consequence of this is that few studies have applied statistical analyses, limiting the robustness of the findings to some extent. Given that it is usual for local highway authorities to monitor schemes in which road space has been adjusted it has been possible to identify up to date monitoring studies from the last five years. Academic studies are scarcer however. The meta-study dates from 1998¹ (updated in 2002²), while an informative study of bus priority measures, dates from 1996³.

With respect to intervention scale, the case studies usually apply to the re-allocation of road space along a single corridor in an urban area. Public transport priority measures may be rolled out on an area wide basis, and the examples reported for Bristol, and Cardiff, UK examine the effects of a series of bus lanes introduced across these cities.

5.3 Summary of What the High-quality Evidence Claims

5.3.1 Impacts on general traffic levels of reducing road space

The meta-study by Cairns et al^{1,2} is of relevance to this measure as it included numerous interventions that restricted general traffic lanes to use by a limited number of modes, in addition to road closures (dealt with in detail under measure review four). Monitoring periods varied between one day (single day of closure) and 10 years. A median reduction in overall traffic levels of 10.6% was observed indicating that “in half the cases, over 11% of the vehicles which were previously using the road or the area...could not be found in the surrounding area afterwards”. The study did not control for wider trends in traffic levels or other changes that may have been implemented at the same time as the intervention. Nevertheless, given the large number of case studies analysed, it can be stated with some confidence, that traffic levels can be expected to reduce (by quite a significant amount) if road space is taken away from general traffic.

Single case studies of the following types of road space re-allocation scheme are now presented in sequence:

1. Re-allocation of general traffic lanes to mixed priority routes;
2. Re-allocation of general traffic lanes to public transport;
3. Re-allocation of general traffic lanes to cycle lanes; and
4. Re-allocation of general traffic lanes to high occupancy vehicle lanes.

5.3.2 Re-allocation of general traffic lanes to mixed priority routes

Mixed priority lanes are accessible to multiple modes - including cycling, public

transport or high occupancy vehicles – but not to general traffic. Three case studies of interventions in which general traffic lanes were re-allocated to mixed priority use were identified for review:

1. The Lewes Road Scheme, Brighton, UK;
2. The Wilmslow Road Mixed Route Scheme, Manchester, UK; and
3. The Broadway – Union Square improvement scheme, New York City, USA.

1. The Lewes Road Scheme, Brighton (UK, opened in September 2013)⁴.

The Lewes Road is a primary radial route connecting a major inter-urban highway to the north east of the city to the city centre. The intervention involved converting one lane of the two-lane general traffic dual carriageway into a bus lane (both northbound and southbound, over 4.5km) and incorporating a widened, continuous cycle lane in both directions. Scheme objectives included reducing traffic volumes and speeds, encouraging greater use of non-car modes, and reducing collision numbers and severity. Traffic surveys were undertaken on neutral days in October and No-

vember 2012 and again 12 months later in October and November 2013. The results of the monitoring study are summarised in Table 1.

General traffic flows on the Lewes Road were observed to reduce by 13% and not to increase on alternative routes. However, queue lengths had significantly worsened at one junction and this required a subsequent reconfiguration of signal timings. While car journey times increased in one direction, bus journey times generally improved (with the exception of the evening peak) and this had the desired effect of attracting additional passengers (patronage increased by 7%). An increase in evening peak bus journey times in the northbound direction was attributed to longer dwell times at bus stops (a result of the higher patronage) and the introduction of a lower speed limit. The number of cyclists was seen to increase by 14%. No information was provided on collision rates.

Overall then, it can be said that the re-allocation of road space successfully reduced traffic volumes along the route and encouraged greater use of both cycling and public transport.

Indicator	Impact of intervention
Car journey times northbound	Unchanged
Car journey times southbound	Increased by 1 min 5 secs in the AM peak and 1 min 28 secs in the PM peak.
Bus journey times northbound	Reduced by 23 secs in the AM peak but increased by 1 min 29 secs in the PM peak (as a consequence of a reduced speed limit and more people boarding the bus)
Bus journey times southbound	Reduced by 1 min 27 in the AM peak and by 19 secs in the PM peak
Bus passenger numbers on Lewes Road	Increased by 7% compared to 4% city wide
Cyclist numbers on Lewes Road	Increased by 14% (an additional 298 cyclists)
General traffic levels on Lewes Road	Reduced by 13% over 12 hour period (-2,300 vehicles)
Diverted traffic	No significant increases in traffic on possible alternative routes
Queue lengths	Queue lengths had significantly increased at one junction (in the AM peak), but other junctions were not significantly impacted.

Table 1: Lewes Road Scheme, Brighton – Performance Indicators

2. *The Wilmslow Road Mixed Route Scheme, Manchester (UK, opened May 2004)*⁵.

Wilmslow Road is a main radial route between south Manchester and the city centre. As a district high street, it accommodates high volumes of vehicles and pedestrians and had been identified as a collision hot spot, given the potential for conflicts between these two user groups. The scheme involved converting a four lane carriageway into a single lane for general traffic in each direction. The re-allocated space was used to introduce a 'curvilinear' road alignment to reduce vehicle speeds. Bus lanes were also provided on the approaches to bus gates at each end of the route, as well as continuous cycle lanes and widened footways in each direction. The main aim of the scheme was to reduce casualty rates, with secondary objectives to reduce vehicle speeds and to improve traffic flow.

- *Casualty rates:* The average annual casualty rate was observed to reduce from 53.3 per year in the three year period before the scheme to 37.8 per year in the three year period following implementation. Whilst this represents a 15% reduction, the analysis did not account for wider area trends and so the reduction cannot be directly attributed to the scheme. The benefits of casualty reduction were estimated at over £0.696m per year.
- *Pedestrian and cycle flows:* Pedestrian footfall increased by 22% (comparing flows measured immediately before and two years after scheme implementation). Bicycle flows also increased from 408 to 1002 on a weekday, but were shown to reduce from 265 to 232 on a Saturday (the time frame of the before and after comparison is not defined). This limited number of observations was not set against wider area trends and again it is not possible to attribute the variation to the scheme alone.
- *Traffic volumes:* The number of motorised vehicles entering the route at each end was observed to reduce by 25% (attributed to the presence of bus gates). No data is reported on whether vehicles diverted to alternative routes.

- *Journey times:* Despite fewer vehicles using the route, journey times, including those of buses increased by up to 60% as a consequence of the capacity reduction (the time frame of the before and after comparison is not defined).
- *Air quality:* Nitrogen dioxide levels were monitored between Dec 2002 and Sep 2003 and between June 2004 and 2005 and were shown to have increased by 41%. This is a significant decline in performance, when set against observed increases of 13% to 47% at other monitoring stations in Manchester. Given the reduction in traffic volumes, worsening air quality was attributed to increasing congestion and slower vehicle speeds, but could also be partially related to potential changes in the number of diesel versus petrol vehicles using the route (not reported).

To summarise the results of this case study, it can be stated that the re-allocation of road space contributed to:

- 1) improvements in road safety (meeting the main objectives of the scheme)
- 2) reductions in general traffic volumes and
- 3) Increases in the numbers of cyclists and pedestrians.

However, whilst the scheme had the desired effect of reducing traffic speed, the absence of continuous bus lanes in each direction had the unintended consequence of compromising journey times for bus users.

3. *The Broadway – Union Square scheme, New York City*⁶.

This scheme involved converting East 17th Street on the approach to the Broadway theatre district, from two-way operation to one way in the westbound direction. The removed carriageway was re-allocated to a floating parking lane which protected a new curb-side segregated bicycle lane. A number of related changes were also made to simplify traffic movements at nearby junctions around Union Square and Broadway. As well as general improvements to

the public realm, the scheme was intended to improve safety, reduce vehicle speeds and improve conditions for cycling and walking. The changes were implemented in the summer of 2010 and the New York Department of Transport reported findings from a monitoring study in 2011.

- *Collision rates:* The number of collisions involving injuries reduced from 66 in the year before implementation to 49 in the year after implementation – a reduction of 26%. This was found to be statistically significant and attributable to the scheme after accounting for the variability in traffic collisions over the previous 10 year period.
- *Impact on cycling:* Bicycle volumes were found to increase by 18% (from 1150 to 1362) on a weekday and by 49% (from 372 to 554) on the weekend comparing one month before to one month after data.
- *Traffic speeds:* Traffic speeds on Broadway were found to decrease by 7% from 27mph to 25mph (between 7-9am and 8-10pm) comparing data one month before the scheme to three months after the scheme.

No further data was reported on the longer term impacts on cycling volumes and traffic speed. Nevertheless, in the short term at least, this evidence suggests that the scheme had been successful in improving safety and encouraging cycling in the area.

5.3.3 Re-allocation of general traffic lanes to public transport

The meta-study by Cairns et al¹ included a number of case studies on the impacts of re-allocating road space to bus lanes. In Bristol, UK, bus lanes were introduced on five corridors between 1991 and 1994. Journey times, bus patronage and traffic flows were monitored before and (three to 12 months) after implementation. Bus journey times were shown to reduce by up to two-thirds, and journey time variability also reduced by up to 89%. General traffic levels had increased by 2.4% along one corridor, although this was set against a general increase in traffic across the city region. Limited data on patronage indicated that passenger numbers had increased

by 9% on one corridor and 4% along another. These increases were observed to be greater than the increase in general traffic along the corridors, indicating that increased travel was being absorbed by the improving bus services. The study also suggested that separating buses from general traffic can have the effect of reducing journey times for non-priority vehicles e.g. along one corridor, journey times reduced from 8mins to 4mins³.

In two other UK case studies¹, traffic levels were shown to reduce as a consequence of re-allocating road space to bus lanes. Traffic entering Cardiff central area reduced by 4.2% in association with the introduction of several bus lanes between 1994 and 1996 (indicated by a cordon count). In Belfast, traffic reduced by 29% along the Ormeau Road after the introduction of a bus lane (although experts expected some of this to have diverted to alternative routes). Bus journey times were shown to reduce by 20 to 30 seconds while journey times for general traffic increased by two to three minutes on average.

Overall, these case studies suggest that re-allocating road space to public transport lanes can improve journey times and reliability for buses, which in turn increases patronage. In certain circumstances this can be achieved without compromising journey times for general traffic (most probably through a combination of reducing traffic volumes and encouraging greater use of bus services).

5.3.4 Re-allocation of general traffic lanes to cycle lanes

Fowler and Koorey⁷ measured the effects on cyclists' safety of the re-allocation of road space to a cycle lane in Christchurch, New Zealand. The cycle lane reduced the width of the general traffic lanes by 0.6m and 1.4m in each direction. Vehicle speeds and passing distances were recorded three weeks before and six weeks after the cycle lane was introduced. Mean motor vehicle speeds were shown to have decreased by 0.9 km/hr in the peak and 1.5 km/hr in off-peak periods, indicating a safety benefit. However, the passing distance between motor vehicles and cyclists actually reduced by 1.2m after installation

of the cycle lane – partly as more cyclists had chosen to use the cycle lane instead of cycling on the pavement (based on a small sample of 95 cyclists using the path).

Nilsson⁸ conducted a survey of new cycle lanes (involving re-allocation of road space from general traffic) at various different urban locations in Sweden. In this case, the results indicated that the introduction of cycle lanes did not have a significant speed reducing effect (with reductions on some roads, but increases on others). However, cyclists' opinions were improved by the introduction of the cycle lanes particularly in relation to safety (as a consequence of having dedicated space on the road).

These insights would suggest that narrowing roads to introduce cycle lanes can have the effect of reducing vehicle speeds in some circumstances. Hence there are potential safety benefits. However, further research is required to confirm under what conditions this is likely to happen and why. While on street cycle lanes are likely to improve cyclist perceptions of the cycling environment, the distance between cyclists and passing vehicles will not necessarily increase given greater perceived certainty in drivers' minds over vehicle positioning and potential increases in the number of cyclists opting to cycle on street.

5.3.5 Re-allocation of general traffic lanes to use by high occupancy vehicles

The EU "Increase of Car Occupancy" (ICARO) study^{9,10} included an evaluation of a 1.5km High Occupancy Vehicle (HOV) lane introduced in Leeds in 1998 (the first introduced in the UK) on a main radial approach to the city centre (costing £585,000 at 1998 prices). The lane permits bus, cycles and high occupancy vehicles (carrying two or more people) and operates in weekday morning and evening peak periods. The scheme was intended to benefit the majority of road users given the observation that one third of vehicles (including buses) carried two thirds of passengers. The following impacts were observed^{9,10}:

- Traffic volumes initially reduced (by up to 20%) in the period immedi-

ately after HOV lane implementation, but later increased beyond the 'before' level (likely owing to general traffic growth in the city)

- Average car occupancy on the corridor increased from 1.35 (one year before implementation) to 1.51 (four years after implementation)
- Journey times for high occupancy vehicles reduced by four minutes (comparing data from one year before implementation to data one year after implementation). Notably, non-HOV journey times also reduced by 1 minute.
- Casualties were reduced by 30% in the three year period after implementation.
- Air quality was unchanged.

No other detailed monitoring studies were identified on HOV lane re-allocation schemes during the measure review. Dixon and Alexander¹¹ briefly report on a similar 2+ HOV lane opened on a 1.75km stretch of the A4174 ring road around Bristol (UK) in 1998 (re-allocating road space from general traffic). This contributed to reducing the proportion of single occupancy vehicles from 80% to 70% (though the timeframe was not reported).

Taken together, these insights would suggest that the HOV lane re-allocation schemes can be successful in increasing vehicle occupancies, improving traffic flows and reducing casualty rates.

5.3.6 Evidence on costs and benefits of road space re-allocation schemes

Very little evidence was identified on the monetized costs and benefits associated with the re-allocation of road space (as opposed to the provision of additional public transport, cycle or HOV lanes). Usually such schemes form part of a wider programme of investment in say public transport or cycling infrastructure and are evaluated on this basis. Two modelling studies were identified in the review:

Ang-Olson and Mahendra¹² estimated Benefit Cost Ratios (BCRs) for the re-allocation of a general traffic lane on an arterial route to a Bus Rapid Transit (BRT) lane, based on the modelling of a range

of hypothetical scenarios. The calculation of benefits included change in travel time for drivers and BRT users, change in vehicle operating costs for drivers and fares for BRT users, change in emissions and change in crash costs. These were weighed against construction and operating costs over a 20 year appraisal period. A positive BCR of 1.1 was estimated based on an assumed throughput of 40,000 people per day, but BCRs of less than 1 were found at lower and higher traffic volumes. At lower volumes, the number of BRT users was found to be too low to accrue significant travel time benefits while at higher volumes, delays to vehicles following the reduction in general traffic lanes were shown to outweigh the benefits to BRT users. The authors noted that positive BCRs would be expected if other wider economic benefits of BRT infrastructure (e.g. changing land values and economic activity) had been included.

Daniel and Stockton¹³ estimated BCRs for seven HOV lanes implemented in Texas (USA). Benefits included reductions in person delay, reductions in vehicle operating costs and reductions in accidents. These were weighed against construction costs and maintenance and operation costs over a 20 year appraisal period. Positive BCRs ranging between 7 and as high as 48 were found for all seven HOV facilities. These were then compared to BCRs for a hypothetical alternative option of providing two additional general purpose lanes. In all cases, the BCR for the HOV lane option was found to be higher than the BCR for the general purpose alternative. On this basis they conclude that HOV lanes can be a more cost effective alternative to general purpose traffic lanes.

In general, these modelling exercise indicate that BCRs for road space re-allocation schemes are likely to be positive in cases where the benefits of increased person throughput or modal shift can be expected to outweigh the disbenefits of delays to general traffic. Appraising road space re-allocation schemes in isolation from related packages of improvements may produce misleading results, however, if the wider benefits of road space reallocation (in supporting other modes) are not adequately captured.

Methodologies and evidence gaps

Most of the case studies reviewed have tended to rely on reporting the results of before and after surveys which measure performance indicators such as traffic volumes, journey times and casualty rates. In some cases, the context of wider area trends has been qualified, but rarely have statistical analyses been performed to confirm whether the observed trends can be directly attributed to the scheme in question. This is undoubtedly a weakness in the evidence base. A further limitation is that monitoring studies often report quite short term effects (in some cases being limited to a period of several months before or after scheme implementation) and there is limited insight into longer term impacts.

Whilst there are substantial bodies of literature dedicated to bus, cycle and HOV lanes, few sources were found to focus specifically on the effects of the re-allocation of space to such uses (as opposed to the introduction of new lanes which may be additional to general traffic lanes). In particular, very few sources were available on re-allocating road space to HOV lanes and this is an area that certainly demands further research.

5.4 Lessons for Successful Deployment of this measure

5.4.1 Transferability:

There are no systematic reasons to suppose that the findings would not be relevant in other locations. In drawing on over 100 case studies from around the world, the meta-study by Cairns et al^{1,2} offers confidence that restricting road space has the general impact of reducing traffic volumes. With respect to the reallocation of road space to cycle and bus lanes, it is intuitive that providing greater priority to these modes can be expected to improve journey times and increase usage levels. This was confirmed in the reviewed case studies (which are acknowledged to be dominated by UK examples, but also included cases from Sweden, New Zealand and the US) and can be expected in most circumstances. However, an important caveat is that capacity restrictions are likely to reduce speeds and increase journey

times for general traffic (and concomitant increases in emissions) and this can have the unintended consequence of delaying buses in cases where continuous priority lanes have not been implemented. The evidence on the extent to which reallocating space to HOV lanes is an effective means of increasing vehicle occupancy and improving traffic flow is weak and this is an area that certainly demands further research.

5.4.2 Drivers / Barriers:

Gaining support from the public and other stakeholders is crucial to the successful implementation of schemes that seek to reduce road space for general traffic. The study by Universitaet fuer Bodenkultur⁹ suggested that effective consultation and marketing strategies are essential and that efforts should be made to engage with lobby groups (which may be opposed to restrictions in road capacity) including for instance, motoring organisations or local political parties early on in scheme development.

5.4.3 Complementarity:

Restricting capacity for general traffic along specific routes within urban areas is likely to require some degree of area wide traffic management. This may include for example reconfiguring nearby junctions to simplify turning movements or restricting access on alternative routes to prevent 'rat running'. Enforcement, effective signage and scheme marketing are also required. This is particularly the case for novel schemes such as HOV lanes that may be unfamiliar to drivers. The scheme introduced in Leeds, UK was accompanied by a significant information campaign which involved press coverage, posters, leafleting and advance warning signs on approach routes.

5.4.4 Durability:

Poor public support for schemes that appear to be lightly used by buses, cyclists or HOVs (termed "empty lane syndrome"⁹) may result in re-allocated road space later being returned to use by general traffic. This can be avoided by ensuring that there will be a sufficiently visible number of vehicle movements using the re-allocated space during scheme design - For instance, by allowing HOVs to use bus lanes in cir-

cumstances where bus services operate relatively infrequently. Where infrastructure changes are maintained, schemes can be expected to have long term impacts. However, as traffic conditions inevitably change in growing urban areas, the initial benefits seen in terms of journey time savings or traffic flow improvements may begin to be eroded over time requiring ongoing programmes of traffic management.

5.5 Additional benefits

As well as the evidence of economic and financial benefits of interventions discussed above, there are a number of additional benefits that are claimed for policies promoting access restrictions to promote sustainable mobility:

- *Environmental benefits:* These can flow from road space re-allocation when reduced volumes of motorised traffic result in air quality and noise reduction improvements,
- *Health benefits:* Reduced traffic volumes could be an encouragement for higher levels of cycling and walking, with resultant health benefits. Reductions could also lead to fewer road casualties.

5.6 Summary

The case studies reviewed demonstrate that schemes in which general traffic lanes are re-allocated to alternative uses can be expected to meet objectives relating to reducing traffic volumes, improving journey times for the modes given additional priority (bicycles or buses), increasing the use of non-car modes and reducing casualty numbers. Successful deployment requires the support of the public and other stakeholders early on in scheme development. Where possible, priority lanes for buses and cyclists should be continuous to avoid delays both to and within general traffic. The introduction of lanes that are unlikely to be heavily used should also be avoided as these are likely to lack public support following implementation.

Little credible evidence was identified on the monetized costs and benefits of road space re-allocation schemes. This may be a result of such schemes often forming

part of a wider package of measures (for instance improvements to public transport or walking / cycling infrastructure) which are then appraised as a whole.

The evidence base predominantly consists of reports of simple performance indicators from before and after studies. Whilst performance indicators may illustrate apparent trends, these may not necessarily be directly attributable to the intervention in question. This represents a weakness in the literature and indeed in the approaches used to monitor such interventions. Appropriate statistical tests should be used to identify the effects of interventions independent of other factors. Lastly, very few studies were available on the efficacy of re-allocating road space to HOV lanes and this represents an area that certainly demands further research.

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