THE ROLE OF WALKING AND CYCLING IN REDUCING CONGESTION

A PORTFOLIO OF MEASURES

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DOCUMENT TITLE The Role of Walking and Cycling in Reducing Congestion: A Portfolio of Measures

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About FLOW

Despite the acknowledged benefits of walking and cycling in terms of health, travel-time reliability and cost effectiveness, motorised traffic is still often the main focus of mainstream urban mobility policy. FLOW sees a need for:

- a clear link between (currently poorly connected) walking and cycling, traffic performance and congestion.
- a paradigm shift wherein non-motorised transport, often seen from a transport policy perspective simply as a nice "extra", is placed on an equal footing with motorised modes.
- improving the understanding of walking and cycling measures that have the potential to improve traffic performance and reduce urban congestion.

The mission of the FLOW project is to place non-motorised transport on an equal footing with motorised modes with regard to urban road traffic performance and congestion. It will achieve this by developing a methodology and tools to assess the ability of walking and cycling measures to reduce congestion in European cities.

The FLOW objectives are:

- to define the role of walking and cycling in congestion reduction;
- to develop and apply tools for assessing the congestion-reducing potential of various measures supportive of walking and cycling;
- to increase awareness of the congestion reduction potential of walking and cycling;
- to actively support take-up of congestion reducing walking and cycling measures by public administrations;
- to foster the market for new walking and cycling products and services for congestion reduction;
- to communicate congestion reduction facts on walking and cycling.

FLOW includes six partner cities: Budapest, Dublin, Gdynia, Lisbon, Munich and Sofia. All are employing the FLOW tools and methodology to assess the role of walking and/or cycling in congestion reduction. Within this context, each city is holding a Congestion Busting Forum during the course of the project.

Executive summary

This portfolio of measures describes the actual effects of different types of measures on congestion by presenting case studies of successfully implemented urban measures supportive of walking and cycling. The measures described have helped reduce congestion or at least have increased walking and/or cycling levels without increasing congestion.

In ten of the 20 cases, congestion could be reduced, in eight cases, the measure did not affect congestion or an effect could not be measured. Only two cases showed slight increases in congestion of motor vehicles. Reduction of motor vehicle congestion could be seen in different types of measures: Five of the cases with reduced congestion implemented infrastructure measures, three contained traffic management measures and three mobility management measures.

An important finding is that most of the measures described below were not implemented with the intention of reducing congestion. Almost all cases showed that there are additional beneficial effects, such as a shift to sustainable modes or improved safety. These could be seen simply as “co-benefits” from the perspective of congestion reduction. On the other hand, these effects are interdependent and can help reduce congestion in the long run. Most of the walking and cycling measures described below have the potential to invite behaviour change and improve the modal split of non-motorised modes over time.

THE ROLE OF WALKING AND CYCLING IN REDUCING CONGESTION

A portfolio of measures

01

INTRODUCTION

Introduction

Congestion – mostly understood as the congestion of motorised traffic – is regarded as one of the major problems in urban transport, affecting travel times, the emission of pollutants and noise, and the overall quality of life in cities. Still, this understanding does not show the whole picture. Congestion can be also regarded as a sign of successful economic development, as an OECD/ECMT report states, and it rations scarce space to allow users to reach desired goals in crowded urban areas (OECD/ECMT 2007: 15).

Most existing urban road transport performance analyses do not properly analyse the impact of walking and cycling measures on congestion. Instead, they focus solely on motor vehicle transport performance and either exclude pedestrians and cyclists or include them as disruption factors to motor vehicle traffic. By considering methodologies for putting walking and cycling on an equal footing with motorised transport, the FLOW Multimodal Urban Road Transport Network Performance Analysis Methodology (see FLOW Deliverable D1.1 , http://h2020-flow.eu/methodology) aims to contribute to a more informed technical and public debate on the role of walking and cycling in transport system performance.

The positive impacts of walking and cycling for travellers and cities are widely known and documented (e.g. Ogilvie et al. 2007, Pucher et al. 2010, Goodman et al. 2013). A remarkable body of knowledge exists on how to effectively introduce walking and cycling measures in European cities, but despite these benefits and knowledge, motorised traffic congestion is still the main focus of mainstream urban mobility policy – very often to the detriment of walking and cycling. Although decision makers may well regard walking and cycling measures as a potential means to achieve a number of economic, social and environmental targets, they may be reluctant to implement them because of the fear of more congestion. This portfolio presents information on the potential of walking and cycling measures to relieve urban congestion. Cities are actively seeking information and implementation experience from other cities. However, information available on websites, portals and good-practice guides is of mixed quality (Marsden et al. 2011). In providing more information on the impact of walking and cycling measures, this portfolio aims at contributing to political agenda setting and measure selection.

Attempts to reduce congestion by offering more road capacity can operate as “pull factors”, triggering more motorised transport (i.e. induced demand) and thereby generating further congestion (Litman 2014). By contrast, “push measures” can include a reduction of road capacity in order to provide space for bike lanes or wider sidewalks, eventually leading to less congestion in the long run – through a modal shift towards walking and cycling. Thus, one possible approach to reduce congestion is to change the modal split: reducing motorised transport and strengthening walking and cycling.

Chapter 2 provides some general findings about the role of walking and cycling measures in relieving congestion, based on literature review and an expert survey carried out within the FLOW project. Chapter 3 introduces 20 cases in which walking measures, cycling measures or combinations of measures have been implemented in Europe and abroad. Chapter 3 summarises the effects of the 20 cases and elaborates some general lessons learned.

02

GENERAL FINDINGS ABOUT THE ROLE OF MEASURES SUPPORTIVE OF WALKING AND CYCLING IN RELIEVING CONGESTION

General findings about the role of measures supportive of walking and cycling in relieving congestion

FROM THE LITERATURE

There are very few studies discussing the role of walking and cycling in relieving congestion. Most of the traditional literature on congestion reduction focuses on motorised transport and does not take walking and cycling into account. Neirotti et al. (2014) state that many cities consider introducing ICT-based initiatives to mitigate their congestion problems. Nakamura & Hayashi (2013) review international strategies for low carbon urban transport. They find that many cities consider public transport as a means to relieve congestion and also point to implementation gaps.

In a study on the impacts and costs of congestion relief strategies, Litman (2014) examines which types of measures are most promising in reducing congestion at reasonable costs. The study identifies the improvement of multimodal transport options that include walking and cycling as the most promising measure group due to their relatively lower cost for implementation and potential to influence a mode share shift. In another paper, the author evaluates different walking and cycling benefits and also discusses congestion effects (Litman 2016).

A study by OECD and the European Conference of Ministers of Transport also analysed different congestion reduction strategies (OECD/ECMT 2007). It identifies the strengthening of non-motorised modes of transport, public transport and the implementation of traffic management as effective ways to reduce congestion (OECD/ECMT 2007). Both Litman and OECD/ECTM argue that congestion can be reduced by a modal shift from car to walking and cycling since these modes are more space efficient – as cars need more road space than other modes (Litman 2014).

Compared with strategies such as roadway expansion, the strengthening of walking and cycling is considered more effective in the long-term. By building more and/or wider roads, congestion can be reduced on the short term – only to rise again due to induced traffic that is attracted by the the free flow conditions. By contrast, the effects of promoting walking and cycling through infrastructure measures or mobility management may be small at the beginning, but tend to grow stronger over time (ibid.). Poor conditions for walking and cycling result in low shares for these modes and people tend to use cars even for short trips. Lack of proper walking and cycling conditions can also lead to frictions and safety issues, e.g. when pedestrians cross the road without crosswalks or cyclists have to mix with motorised traffic.

To improve the conditions for walking and cycling in urban areas and to promote a shift to those modes, the studies listed above recommend several measures: the construction and improvement of sidewalks, bike lanes and paths, more convenient road crossings, rephasing of traffic lights, better signing, more and better bike parking facilities, bike sharing schemes, the introduction of lower speed limits or mobility management measures such as outreach and education campaigns and programmes at schools and enterprises (Litman 2014, OECD/ECMT 2007).

Another recommendation is to bundle measures to reduce congestion – if various walking and cycling measures are implemented together, the combined effect tends to be larger than the effect of each single measure would be, if implemented alone. Fietsberaad suggests that a mix of push and pull measures ist most effective to stimulate a modal shift from car to bicycle. Campaigns and infrastructure measures that don't affect car traffic are regarded as less effective than cycling measures that also affect space or priority of cars. The greatest effects could be reached if those are combined with push measures that discourage car traffic, e.g. congestion fees, closing streets for car traffic or removal of car parking. On the other hand, these measures are usually hard to implement politically (Fietsberaad 2010).

Finally, there are several co-benefits of promoting walking and cycling in addition to congestion reduction, namely: less car traffic and more walking and cycling makes transport more affordable, improves personal health, reduces air and noise pollution and is less expensive than car-dominated urban transport (e.g. Nash & Whitelegg 2016, Rudolph et al. 2015).

FLOW EXPERT SURVEY

This positive valuation of measures supportive of walking and cycling is reflected in the outcome of a FLOW expert survey of urban transport practitioners and researchers.[1] Most of those surveyed regard the promotion of walking and cycling as a promising strategy to combat congestion: 87% assigned cycling an important or very important role in reducing congestion and 76% said the same for walking (see Figure 1). They mentioned the potential for a modal shift from car travel to walking and cycling for short distances and the higher space-efficiency of walking and cycling. By contrast, only a minority of them stated that walking and cycling would be implemented often or very often in their country to relieve urban congestion (walking 12%, cycling 27%, see Figure 1). These statements reveal an implementation gap between the potential and the actual application of walking and cycling measures to reduce congestion. It is therefore crucial to provide decision makers and practicioners with more information regarding the positive impacts of walking and cycling on congestion.

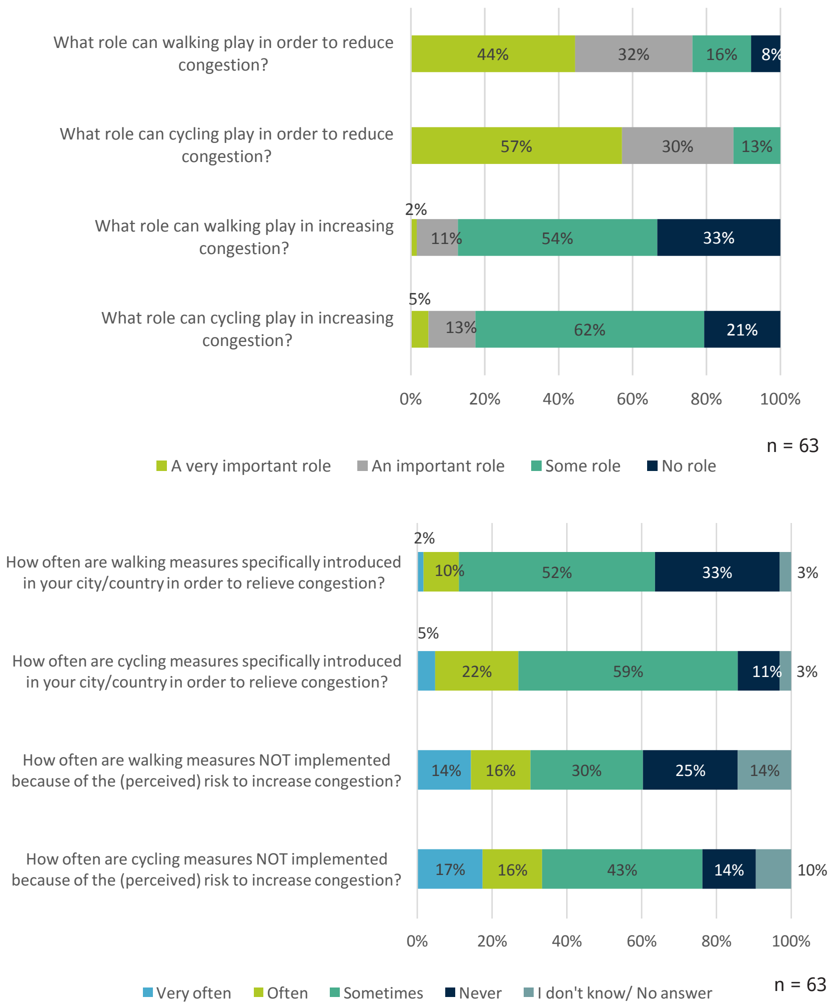


Figure 1: Expert valuation on the impacts of measures supportive of walking and cycling on congestion (above) and their actual implementation (below) Credit: Wuppertal Institut

[1] The survey was designed to discuss advantages and shortcomings of currently existing congestion definitions from a multimodal perspective and to discuss the applicability of performance indicators to describe a multimodal understanding of congestion. The survey was accessible via an online tool and the URL was circulated among 165 (mainly European based) congestion and walking and cycling experts; the invitation to the survey was also published on the FLOW website for two weeks. It was completed by 63 experts from 20 countries. Participating experts represented research institutions (43%), consultancies (28%), public authorities (21%), NGOs and companies (8%).

The experts were also asked for a qualitative valuation on the potential of measures supportive of walking and cycling to affect urban congestion. Most believed that walking and cycling have the potential to reduce congestion. As a central argument, the experts mentioned the higher space efficiency of walking and cycling as compared to car traffic. Still, several mentioned that the congestion impact would strongly relate to the way measures were implemented: a new bike lane that reduces motor vehicle space in an area with dense traffic could potentially increase congestion if it did not trigger a signifianct mode-share shift from car to bike use.

In terms of specific measures, the experts stressed the importance of integrated concepts that were seen as more effective than single walking or cycling measures. Some of the experts also recommended implementing measures supportive of walking and cycling in combination with car-restrictive measures such as raising costs (for parking, car ownership, road tolls etc.), reducing the space provided (for moving and/or parked cars), and reallocating time for the different modes (e.g. by changing the signalling to create longer red phases for cars).

When asked for the reasons why walking and cycling measures are rarely considered as congestion reducing measures in urban transport strategies, the experts mention several aspects. A central argument was the fear of negative impacts on motor vehicle congestion. Some experts mentioned that policy makers are not even aware of the possible benefits from walking and cycling on congestion reduction. Several stated that it would be politically very difficult to introduce any measures that restrict car traffic, while others pointed out that traditional traffic planning, perhaps relies too heavily on transport modelling tools and calculations like Level of Service (LOS), which simply does not allow for the implementation of measures that could potenially reduce capacity and/or impose delays to motor vehicles.

03

CASE STUDIES OF MEASURES SUPPORTIVE OF WALKING AND CYCLING

Case studies of measures supportive of walking and cycling

This chapter examines case studies of measures supportive of walking and cycling that have been implemented in mainly European, but also American cities. The cases have been selected because:

- sufficient data was available to estimate congestion effects, and
- their impact was positive or at least neutral in response to congestion.

The case studies firstly describe the measure and its implementation. The next paragraph describes the purpose of the measure and its actual impacts. In many cases, the main impacts are not congestion related, since most of the measures were not primarily intended to reduce congestion, but to improve walking and cycling conditions. Thus, the monitoring of the measures' effects often did not explicitly include traffic flow or congestion. In these cases, a qualitative assessment by local experts was used to provide insight regarding the congestion impacts. Further paragraphs give an overview of context conditions and additional information.

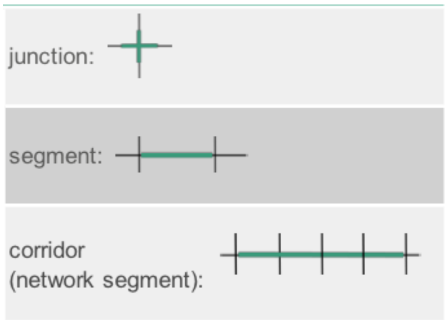
Table 1 gives an overview of the cases, which are categorised in two different ways. The first column (measure type) indicates important types of transport planning:

- Infrastructure measures for moving traffic: these include bike paths on or off the road, sidewalks, bike highways, or pedestrian overpasses.
- Infrastructure for non-moving traffic: this includes stands and garages for bicycles, benches and squares for pedestrians – which are not meant to keep the traffic flowing, but offer a safe and comfortable opportunity to sojourn.
- Traffic management strategies: these direct traffic both by technical measures (e.g. traffic signals) and by regulatory (e.g. access restrictions, HOV lanes, permit-based parking restrictions).
- Mobility management: this includes general campaigns for non-motorised transport, target group specific information and education such as biking classes at school, mobility advice at companies and other forms of individual marketing, and pricing measures like congestion charges.

For each of these measure groups, guidelines and best-practice collections are available to inform policy makers and transport practitioners about state-of-the-art implementation[2].

The second column (system level) relates to the spatial context of the measures. This is relevant for transport performance evaluation. The level can be categorised as (see also image below):

- a junction: a measure example would be the reallocation of green times in favour of pedestrians
- a segment (between two junctions): a measure example would be speed limit between junctions, and
- a corridor (including junctions and segments) or the whole network: a measure example would be a a new bicycle path or a bicycle sharing scheme.



[2] National authorities provide design guides, e.g. The German "Empfehlungen für Radverkehrsanlagen - ERA" (Recommendations for Cycling Facilities).

Measure Type	System Level	Measure	Case	Case Description	Effects
Cycling infrastructure (moving traffic)	corridor	Bike lanes on road narrowing road space for cars	1. NEW YORK: New bicycle lanes	Protected bike lanes on several streets (87 km altogether)	No significant change in traffic volumes; travel time for cars constant or reduced in most cases; reduction of injuries for pedestrians and cyclists
Cycling infrastructure (moving traffic)	corridor	Bike lanes on road narrowing road space for cars	2. BRIGHTON: Lewes Road corridor	Dual carriageway for vehicles was converted into single; wider bike lane introduced	Reduction of car lanes (2=>1) and speed limit; modal shift to bike; only minor increase of travel time
Cycling infrastructure (moving traffic)	corridor	Bike lanes on road not narrowing road space for cars	3. GERMANY: Advisory cycle lanes	Advisory cycle lanes (marked with dotted line, to be used by motorised traffic if needed) were compared with mixed motorised and bike traffic	Higher acceptance by cyclists, reduced use of sidewalk, less severe injuries of cyclists; slightly lower speed of cars compared to mixed guidance
Cycling infrastructure (moving traffic)	corridor	Bike lanes next to road: road space for cars constant	4. GERMANY: Upgrading of cycling facilities following design guidelines	Different types of upgraded bike lanes in Coburg, Mönchengladbach and Gütersloh	Modal shift from motorised traffic to cycling
Cycling infrastructure (moving traffic)	corridor	Fast bike lanes, intersection-free	5. NETHERLANDS: Cycle highways	Additional bicycle highways (675 km)	Modal shift from car and PT to bicycle; decrease of travel times for cars and bicycles
Cycling infrastructure (moving traffic)	corridor	Fast bike lanes, intersection-free	6. RUHR AREA, GERMANY: Cycle highway RS1	Bicycle highway connecting major Ruhr Area cities in an area with lots of commuter congestion	Potential for modal shift from car to bike and pedelec
Walking and Cycling Infrastructure (moving traffic)	junction	Bike lanes and footpaths, narrowing roadspace for cars	7. OXFORD: Roundabout in city centre	Greater cycle and pedestrian priority at the junction, reducing the width of the circulatory carriageway	Modal shift from motorised traffic to cycling, no congestion impacts
Walking Infrastructure (moving traffic)	corridor	Wider footpaths / sidewalks narrowing road space	8. STRASBOURG: Reshaping road space at Pont Kuss	After traffic counts, road space was reallocated: more road space for pedestrians, less for motorised traffic	No increase in vehicle congestion; bridge more attractive for pedestrians
Walking Infrastructure (moving traffic)	corridor	Additional footpaths / sidewalks: pedestrian zones	9. LJUBLJANA – Pedestrian zones in the city centre	The city centre was pedestrianised and then the size of the pedestrian zone was further increased.	A previous decline in walking and increase in car traffic were both turned around; these changes were strongest among city centre residents
Cycling infrastructure (parking and bike sharing)	network	Bicycle parking facilities, e.g. garage, Bike & Ride facilities	10. MÜNSTER Bicycle station	New bicycle parking garage in front of the central train station instead of open-air parking	Increase of cycling and multimodal trips (bike+train); more space for pedestrians

Cycling infrastructure (parking and bike sharing)	network	Bike sharing systems	11. BORDEAUX: Bike Sharing to ease congestion caused by construction works :	Bike Sharing was implemented during the construction of a new tram line, and expanded due to its success	Increase of cycling, reduction of congestion
Traffic management strategies	network	Access restrictions (pedestrianisation; limited traffic zones)	12. BOLZANO: School streets	Restriction for cars in drop-of area around schools:	Possible modal shift and congestion relief
Traffic management strategies	junction	Bike-friendly signalling at junctions	13. COPENHAGEN: Green wave for cyclists	Green wave at the speed of 20 km/h on corridors with altogether 1/4 of the cycling traffic	Increase of cycling traffic on corridor, reduction of cycling travel times
Traffic management strategies	junction	Pedestrian-friendly signalling at junctions	14. LONDON: Pedestrian countdown at traffic signal junctions	Countdown at pedestrian's green phase instead of black out at selected junctions	Better information led to faster pedestrian crossing
Mobility management	network	Congestion charging	15. STOCKHOLM Congestion charge	Charge for motorised vehicles in inner city	Modal shift from car to public transport; no evidence for shift towards walking and cycling
Mobility Management	corridor	Campaigns addressing a specific corridor	16. GRONINGEN: Campaign to promote the use of alternative bike route	A campaign was launched to redirect cyclists from a congested main road to a shorter alternative route	Spatial shift of a relevant share of cyclists to a less congested route, relief in motorised and bike congestion
Mobility Management	network	Image and Information campaigns, marketing for non-motorised transport	17. LONDON: Demand management "Get ahead of the Games"	Advice to switch to walking and cycling and avoid congested roads	Increase of walking and cycling, reduction of car traffic, congestion relief
Mobility Management	network	Site-based travel plans (corporate, school, university, public buildings, hospitals, stadia)	18. GDYNIA: Promotion campaign in kindergartens for walking and cycling	Campaign addresses children and parents; walking and cycling skills and security on the way to kindergarten	Increase in walking and cycling, reduction of drop-off by car
Measures for more than one mode	corridor	Highway removal	19. GHENT: Viaduct deconstruction	Measure mix: Removal of highway, improved walking and cycling infrastructure	Potential impacts: reduction of vehicular traffic, congestion; increase in walking and cycling
Measures for more than one mode	network	walking and cycling concepts	20. BUDAPEST: Comprehensive development of inner city	Measure mix: New bike lanes, Bike sharing system, information	Modal shift towards cycling, no congestion effects observed

Table 1: Overview of case studies. Credit: FLOW project

CASE STUDIES

Cycling and/or walking infrastructure: moving traffic

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1. New York: New Bicycle Lanes

Since 2007 New York City has invested in a number of separated bicycle lanes to facilitate cycling in the city. There are 87.2 kilometres of protected bicycle lanes in New York City (2015) and 28.6 kilometres more to be installed in 2016. A separated bicycle lane is a physically marked and separated lane dedicated for cycling that is on or directly adjacent to the roadway but typically excludes all motorised traffic with some sort of barrier (plants, curbs, parked cars or posts to separate bike and motorised traffic).

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

In 2014 New York analysed road segments with at least 3 years of data after building a cycle lane (New York City Department of Transportation 2014), crashes with injuries have been reduced here by 17%. Pedestrian injuries are down by 22%. Cyclist injuries show a minor decrease even though bicycle volumes have significantly increased. Total injuries have dropped by 20%.

The average risk of a serious injury to cyclists in New York decreased by 75% from 2001 to 2013 (New York City Department of Transportation 2016). Cyclist injury risk has generally decreased on protected bicycle lane corridors as cyclist volumes rise and cyclist injuries decrease.

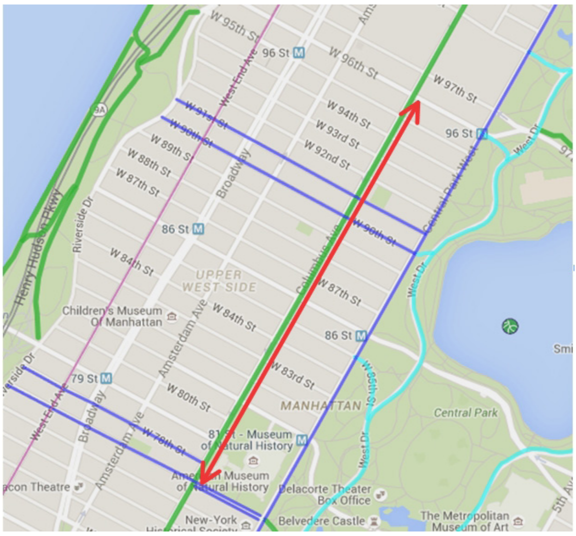
Figure 2: Protected cycle lanes in Manhattan. Source: New York City Department of Transportation (2014).

CONGESTION-RELATED IMPACTS

Before the implementation of the measure, the fear for more congestion was stated in the public discourse. Rather than increasing delay for cars, the protected bike lanes on Columbus Ave in Manhattan, for example, actually improved travel times in the corridor. According to city figures (New York City Department of Transportation 2014) the average car took about four-and-a-half minutes to go from 96th to 77th streets before the bike lanes were installed in 2010-2011, and three minutes afterward—a 35% decrease in travel time. This was true even as total vehicle volume on the road remained pretty constant (Peters 2014).

For cars, better traffic flow comes partly as a side benefit from a safety feature added with the bike lanes. Cars turning left now have pockets to wait in—so they're less likely to hit a cyclist riding straight, but they also stop blocking traffic as they wait.

Travel speeds in the Central Business District, where Columbus Avenue is, have remained steady as protected bicycle lanes were added to the roadway network. Travel times on Columbus Avenue have improved while vehicle volumes remain constant. First Avenue travel speeds remained level through the project area. Travel times on 8th Avenue improved by an average of 14% (New York City Department of Transportation 2014).



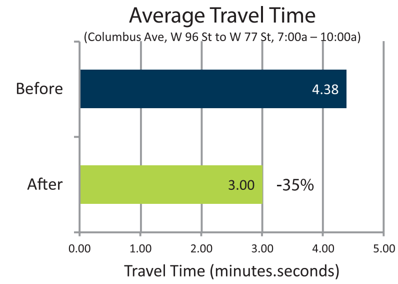


Figure 3: Analysed road segment; average travel time before and after the implementation. Source: New York City Department of Transportation (2014).

According to data from New York City the introduction of the Prospect Park West bike lane (Brooklyn) caused only mild congestion, meaning it might be just a little difficult to switch between lanes, but not so bad that traffic would have to slow down (Ferro 2014). "There has been no change in traffic volumes or corridor travel times. Prospect Park West remains the fastest route through Park Slope" (New York City Department of Transportation 2011)[3].

CONTEXT CONDITIONS

Since 2007, the New York City Department of Transportation has installed over 48 kilometres of protected bicycle lanes throughout the city, including several parking protected bicycle lanes on various avenues in Manhattan (1st & 2nd Avenues, 8th and 9th Avenues, and Broadway). Altogether NYC has more than 1,600 kilometres of bike lanes (2015).

Cycling in New York City is associated with mixed cycling conditions that include a dense urban structure, relatively flat terrain, congested roadways with "stop-and-go" traffic, and streets with heavy pedestrian activity. The city's large cycling population includes utility cyclists, such as delivery and messenger services; cycling clubs for recreational cyclists; and, increasingly, people using their bike for commuting, shopping and other everyday purposes.

While New York City developed the country›s first bike path in 1894, and recent trends place the city «at the forefront of a national trend to make bicycling viable and safe,» competing ideas of urban transportation have led to conflict, as well as ongoing efforts to balance the needs of cyclists, pedestrians, and cars (Wikipedia 2016).

ROLE OF MEASURE BUNDLES

By reducing pedestrian and cyclist injuries and easing car congestion, protected bike lanes are good for everyone—not just riders.

For cars, better traffic flow comes partly as a side benefit from a safety feature added with the bike lanes. Cars turning left now have pockets to wait in—so they're less likely to hit a cyclist riding straight, but they also stop blocking traffic as they wait.

FURTHER INFORMATION

Ferro, Shaunacy (2014). No, Bike Lanes Don't Cause Horrible Congestion. http://www.fastcodesign.com/3029015/terminal-velocity/no-bike-lanes-dont-cause-crazy-congestion

Johnson, G. and A. Johnson (2014). Bike Lanes Don't Cause Traffic Jams If You're Smart About Where You

[3] The question of increased congestion caused by new bike lanes has been a common point of contention with local community boards in New York City. One particularly noteworthy example includes the introduction of the 2.9 km protected bicycle lane at Prospect Park West in Brooklyn in June 2010 (Johnson/Johnson 2014)

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2. Brighton: Lewes Road Corridor

Brighton is a city of over 280,000 located on the south coast of England. Brighton and Hove City Council applied for funding through the Local Sustainable Transport Fund for a package of measures to be implemented on the Lewes Road corridor and surrounding residential areas.

The Lewes Road corridor is one of three key arterial routes into the city, and links two universities (25,000 students) and the AMEX stadium with the city centre. The Lewes Road corridor was targeted because the corridor was characterised by traffic congestion, poor air quality, high accident rates, high traffic volumes, and acted as a barrier between neighbourhoods as well as to local economic growth.

The overall package of measures included both smarter choice interventions and infrastructure improvements. Key changes to the infrastructure included:

- Conversion of a 4.5 km long section of dual carriageway into a single carriageway for general traffic alongside a dedicated bus lane with a widened cycle lane.
- Changes to fourteen bus stops with cycle lanes passing behind to remove conflicts.
- Reconfiguration of signalised junctions and additional pedestrian and cycle crossing facilities to reduce the barrier created by the street.

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

The defined aims of the Lewes Road corridor scheme were (1) to encourage greater use of more sustainable forms of travel, (2) to reduce the speed and volume of traffic using Lewes Road, thereby improving local air quality and reducing carbon emissions, (3) to reduce the severity and number of accidents taking place on Lewes, and (4) to provide additional safe crossing opportunities for pedestrians and cyclists.

Monitoring surveys were carried out prior to construction during Oct/Nov 2012 and were repeated in Oct/Nov 2013. The post-construction data was collected within 4-6 weeks of the scheme opening, and further monitoring is planned to assess the longer term travel behaviour impacts.

Table 2 summarises the significant mode shift towards cycling and public transport on the corridor generated by the package of measures introduced.

Transport mode	Before (2012)	After (2013)	Change
Daily cyclists (two-way flow, 0700-1900)	2,085	2,383	+298 (+14%)
Annual bus passengers (services using Lewes Road)	15.3m	16.4m	+1.1m (+7%)
Daily cars and freight and vehicles (two-way flow, 0700-1900)	18,377	16,035	-2,342 (-13%)
Daily taxis (two-way flow, 0700-1900)	542	762	+220 (+41%)

Table 2: General impacts of Lewes Road Corridor in Brighton. Source: Brighton and Hove City Council

Changes in pedestrian flows along or across the Lewes Road corridor were not measured as part of the monitoring.

CONGESTION-RELATED IMPACTS

The monitoring surveys also captured changes in journey times along the corridor as summarised in the following table.

Time period / direction (all times in mm:ss)	Transport mode	Before (2012)	After (2013)	Change
Morning peak (0700-1000) northbound	Cars	12:11	12:20	+00:09
	Buses	11:16	10:53	-00:23
Morning peak (0700-1000) southbound	Cars	14:01	15:06	+01:05
	Buses	12:05	10:38	-01:27
Evening peak (0700-1000) northbound	Cars	13:18	13:09	-00:09
	Buses	09:30	10:59	+01:29
Evening peak (0700-1000) southbound	Cars	12:41	14:09	+01:28
	Buses	10:58	10:39	-00:19

Table 3: Congestion-related impacts of Lewes Road Corridor in Brighton. Source: Brighton and Hove City Council)

The increases in journey time for general traffic are all below 90 seconds, and are significantly lower than the traffic model predictions of increases of 3-5 minutes. It should be noted that the changes in journey times reflect both the reallocation of carriageway space but also a reduction in speed limits on the corridor.

Monitoring was also carried out on residential side streets and two parallel main routes. No significant changes in two-way traffic flows on these roads were observed.

Monitoring also measured queue lengths at side streets adjoining Lewes Road as a further measure of congestion. The surveys highlighted no significant change or reduced queues, except for one side street with slight increases.

ROLE OF MEASURE BUNDLES

The transformation of the Lewes Corridor highlights how physical changes in infrastructure supported by a package of smarter choice measures can improve conditions for sustainable modes of transport and encourage mode shift. It is noteworthy that the traffic modelling undertaken prior to construction appears to have under-estimated the resulting mode shift and over-estimated the detrimental impact on general traffic.

A second phase of the Lewes Road scheme was implemented in 2014 at the Vogue gyratory. The additional monitoring undertaken after the completion of these works in 2015 relates to slightly different road sections from the 2013 report.

All documents available at http://www.brighton-hove.gov.uk/content/parking-and-travel/travel-transport-and-road-safety/lewes-road-transport-improvements.

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Brighton and Hove City Council (2012). Lewes Road Improvements: Second Stage Public Consultation, Consultation Report published spring 2012. Brighton.

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3. Germany: Advisory Cycle Lanes

Street space in urban areas needs to accommodate various motorised and non-motorised user groups. Oftentimes the available street space is not sufficient to consider the full desires of all user groups in total. Thus the design of urban cross-sections is often a compromise.

For example, due to limited street space it is often not possible to provide exclusive cycling infrastructure such as cycle paths or cycle lanes. In such cases, cyclists may either be guided onto advisory cycle lanes or into traffic with motor vehicles. Motorised vehicles are allowed to use advisory lanes in case of opposing traffic and without endangering the cyclists.

Advisory lanes consist of replacing a painted line down the middle of the street with dashed lines on the sides of the street indicating 1.5 metre “bicycle advisory lanes” (see Figures 4 and 5). Motor vehicles travel down the middle of the road unless there is oncoming traffic, in which case they are allowed to move over to the advisory lanes – as long as they do not endanger any cyclists in the lane.

Figure 4: Advisory cycle lanes along an urban road section.
Credit: IVAS

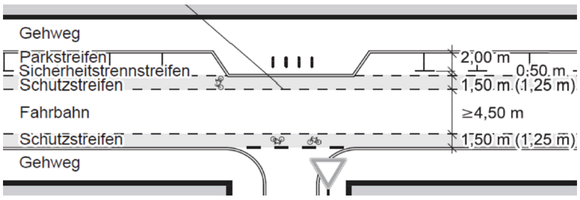

Figure 5: Advisory cycle lane / "Schutzstreifen". Source: ERA 2010

Advisory cycle lanes are an appropriate measure to provide cycling infrastructure on narrow urban roads instead of guiding cyclists into a lane shared with motor vehicles. Thereby, advisory cycle lanes can be applied to close gaps in the existing cycle network as an effective measure to improve attractiveness of urban cycling.

The impact of "advisory cycle lanes[4]" and the "mixed guidance of cyclists and motorised road users" on road safety and traffic flow was investigated in a German comparison study (BASt Report V 257). The study was conducted in several cities and comprised 40 road sections and two before and after studies. The impact of the cyclists on the motor vehicle traffic flow was simulated by the microscopic modelling programme VISSIM (PTV AG). Detailed information about the results of this study are available in the BASt research report V 257 which can be downloaded directly on the BASt website (http://bast.opus.hbz-nrw.de/).

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

Advisory cycle lanes should be more attractive for cyclists than sharing a lane with motor vehicle traffic. Furthermore, advisory cycle lanes should attract cyclists to ride on the provided cycling facility on the road instead of using sidewalks or footpaths. Thereby conflicts with pedestrians may be avoided.

The main outcome of the comparison study between "advisory cycle lanes" and "mixed guidance of cyclists and motorised road users" is as follows:

- The acceptance of cyclists to ride on the road is higher on roads with advisory cycle lanes than where they must share a lane with motor vehicles. Thus fewer cyclists use road side infrastructure (sidewalks and footpaths) in case of available advisory cycle lanes due to higher acceptance. In this way conflicts between cyclists and pedestrians beside the carriageway can be avoided.
- The severity of road accidents involving cyclists is lower on roads with advisory cycle lanes than on roads where cars and bicycles share a lane.
- The travel speed of motorised road users on roads with advisory cycle lanes is slightly lower than on roads where cars and bicycles share a lane.

CONGESTION-RELATED IMPACTS

The increased application of advisory cycle lanes may contribute to higher acceptance of cycling at network level – especially in the case that existing gaps in the cycle network can be closed by this measure. Higher acceptance of cycling on a network level may contribute to improved attractiveness of cycling for users and thereby foster a modal shift from motorised transport to cycling, and mitigate overall congestion.

The impact of the measure "application of advisory cycle lanes" on modal shift, congestion, and other indicators/parameters depends mainly on the local situation and may significantly differ in case-to-case application. For this reason, the impacts of the measure on the abovementioned indicators/parameters cannot be estimated as a general rule.

CONTEXT CONDITIONS

An attractive and safe cycling network is one main precondition for the promotion of cycling in urban areas. The application of advisory cycle lanes is an appropriate measure to close existing gaps in the cycle network – especially in the case of narrow roadways.

FURTHER INFORMATION

German Road and Transportation Research Association – FGSV (2012). Guidelines for the Design of Urban Roads 06 (RASt 06), Edition 2006 - English Translation, Cologne.

German Road and Transportation Research Association – FGSV (2010). Empfehlungen für Radverkehrsanlagen (ERA) [Recommendations for cycle facilities], Cologne.

Ohm et al (2015). Führung des Radverkehrs im Mischverkehr auf innerörtlichen Hauptverkehrsstraßen [Cycling in mixed traffic on the carriageway of urban main roads], BASt Report V 257. Bergisch Gladbach.

[4] Dutch guidelines are stricter than those in Germany. Apart from the 'suggestion lanes', which have no legal meaning, the Netherlands also has cycle lanes separated from the car lane by a dashed line. The measure gains legal meaning through bicycle signs, so parking and stopping in the bicycle lane are strictly forbidden. Crossing or driving in a cycle lane is permitted when necessary. New guidelines advise a width of at least 1.70 metres to accommodate overtaking, a dooring zone of 0.50 if next to parking spaces and red colouring. If the cycle lane is separated from the car lane by a continuous line, cars are not allowed to cross over and travel in the cycle lane. Surveys from the 80s conclude that no cycle lanes at all can be safer than cycle lanes that lead cyclists to ride in the dooring zone. (CROW 2015: Aanbevelingen fiets- en kantstroken; CROW 2006: Ontwerpwijzer fietsverkeer)

4. Germany: Upgrading Cycling Facilities Following Technical Design Guidelines

Urban cycle networks should ensure that cyclists can use their bicycle from origin to destination. Many cycling facilities are in poor condition and/or they do not fulfil minimum technical design requirements. Particularly the width of cycling facilities (e.g. cycle paths) is often insufficient to comfortably accommodate users. In this case, upgrading existing cycling facilities according to the (safety) requirements of technical design guidelines may contribute to higher attractiveness of cycling, as cyclists will feel more comfortable and may travel at higher speeds on these higher quality cycling facilities.

The objective of a German research project was to quantify the impact of upgraded cycling facilities in urban areas on the modal split, the number of trips and the environment.

The impact of "Upgrading of cycling facilities according to technical design guidelines" was investigated in three German cities: Coburg, Gütersloh and Mönchengladbach. The characteristics and pre-conditions related to cycling differed in the three cities significantly (e.g. modal split, scope, and quality of existing cycling infrastructure, "cycling culture" affecting attitudes, and mobility behaviour, topographical and climatic conditions). Given this diversity the research project results should be considered a best practice-example which gives an idea of the impact of upgrading cycling facilities.

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

The measure evaluated consisted of the upgrading of cycling facilities following technical design guidelines. Existing cycling facilities in the urban road network are often not consistent with current design standards. The width of existing cycling facilities is often too narrow which may lead to low travel speeds and lower usage. The main objective of this measure was to upgrade the existing cycling facilities according to the technical design guidelines and thereby to improve existing cycling facilities (e.g. by increased width, see Figure 6 to Figure 8).

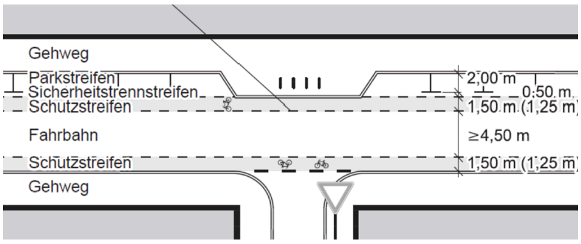

Figure 6: Advisory cycle lane / Schutzstreifen. Source: ERA 2010

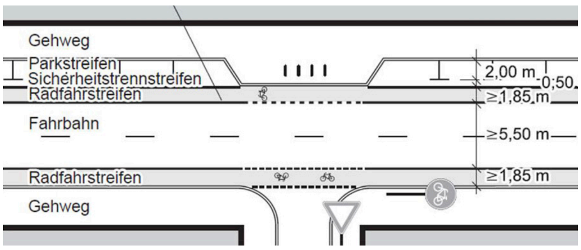

Figure 7: Cycle lane / "Radfahrstreifen". Source: ERA 2010

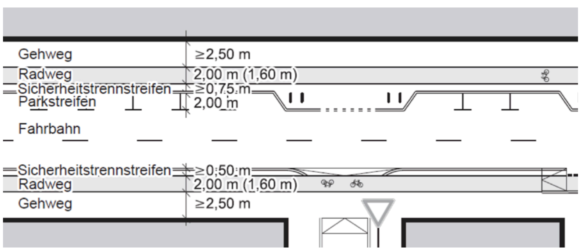

Figure 8: Cycle path / "Radweg". Source: ERA 2010

One main impact of upgrading cycling facilities in urban areas to be consistent with technical guidelines was increased travel speed for cyclists and thereby shorter travel times of urban cycle trips, which may also lead to a shift in modal split from motorised transport to cycling.

The impact of the measure was simulated using the macroscopic modelling programme VISUM (PTV AG) for the three pilot-cities. Results of the study show a clear shift of modal spilt from motorised transport to cycling as well as a reduction in total trips by motorised transport modes. The effects were more pronounced in the case of local traffic (i.e. the origin and destination of the trip were both inside the city) than on trips originating and terminating outside the city. Figure 9 to Figure 11 present selected results for Gütersloh.

More detailed information about the study results is available in the BASt research report V 227 (http://bast.opus.hbz-nrw.de/).

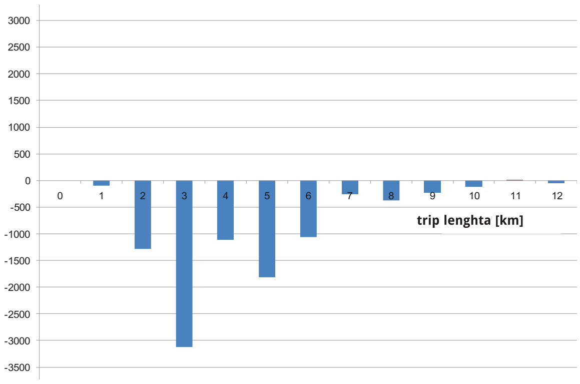

Figure 9: Reduction of daily trips (motorised transport) related to the scenario "Upgrading of cycling facilities according to technical design guidelines", pilot-city: Gütersloh. Source: BASt report V 227

Figure 10: Reduction of traffic volumes (motorised transport) in the road network related to the scenario "Upgrading of cycling facilities according to technical design guidelines" (Outcome VISUM-simulation; displayed traffic volumes > 1,000 veh/d), pilot-city: Gütersloh. Source: BASt report V 227

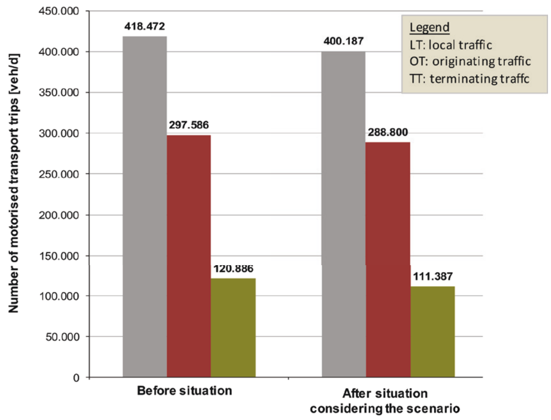

Figure 11: Number of daily trips (motorised transport) in the road network – comparison of before and after situation, pilot-city: Gütersloh. Source: BASt report V 227

CONGESTION-RELATED IMPACTS

Research results show clearly that an "Upgrade of cycling facilities in urban areas according to technical design guidelines" may lead to a shift of modal split from motorised transport to cycling in urban areas and thereby to a reduction in daily trips by motorised transport modes and thereby reduce congestion.

The measure's impact on the number of daily trips by motorised transport is shown in figures 9 to 11 for the city of Gütersloh. Here the measure led to a reduction of 4% on the number of total trips by motorised transport modes in the urban road network. The reduction on local traffic was 8%, which was higher than on originating and terminating traffic (in total: 3%; see figure 11).

The direct impact of the measure on congestion was not estimated in the study. But it can be assumed that a reduction of daily trips by motorised transport modes caused by a modal shift from motorised transport to cycling is directly interrelated with a reduction of congestion in cases where the measure did not reduce capacity for motorised transport modes.

CONTEXT CONDITIONS

The study was conducted in three German cities (Coburg, Gütersloh and Mönchengladbach). Results of the study should be considered as a best practise example providing an estimate of the potential impact of upgrading cycling facilities following to technical design guidelines.

ROLE OF MEASURE BUNDLES

The positive impact on the modal shift and reduction of daily trips by motorised transport can be increased by implementing additional supporting measures as part of a measure bundle. These may include measures such as:

- closing existing gaps in the urban cycle network by implementing new cycle facilities (advisory cycle lanes, cycle lanes, cycle paths),
- providing interchanges between cycling and public transport (e.g. cycle parking facilities), this may attract people to use cycles also for longer trips (e.g. trips with a length of > 5 km),
- providing a bike sharing system,
- conducting cycling awareness campaigns with focus on local conditions which may encourage residents to change mode from motorised transport to cycling.

FURTHER INFORMATION

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5. Netherlands: Cycle Highways

The physical size of cities is expanding due to population growth. Since the 1960s much of this growth has taken place in suburbs. These suburbs offer more space for cars and at the same the larger distances created by this space increase the demand for car use. One of the consequences of this focus on car use is congestion, especially during rush hours (7 – 9h and 16 – 18h).

To make a smoother bicycle connection between the suburbs or nearby villages and the city, the Netherlands have started to build cycle highways. A cycle highway is a large, non-stop, asphalted, and well-designed off-road cycle path. These cycle highways are especially interesting for cyclists using electric bicycles (the market share of e-bikes in the Netherlands is growing quickly; it increased from 3% in 2006, to 19% in 2013 and 28% in 2015). (ANWB 2014, Rai Vereniging 2016)

The Goudappel Coffeng study (Fietsberaad 2011) calculates with a model study that cycle highways allows for a shift away from car trips and public transport towards cycle trips. The use of electric bicycles makes that even more people prefer to cycle than to take the car or public transport. This means a relief for the heavily trafficked roads in the Netherlands, thereby saving time for other car users. The result is that nationwide, thousands of hours in cars are saved every day

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

Cycle Highways (snelfietsroutes) have the purpose to reduce car congestion around Dutch cities by tempting car drivers living within 15 km from work to commute by bicycle (Fiets filevrij 2016).

The study shows a big potential for cycle highways. A cycle highway increases the travel speed by bicycle from 15 km/h to 18 km/h, and from 18 km/h up to 24 km/h for e-bikes.

Goudappel Coffeng concludes that the planned additional 675 km cycle highways and an increased use of electric bicycles in the Netherlands, will have a positive effect on mobility in the whole country. Cycle highways influence the choice of the route, the choice of destination (where do I work or shop?) and the choice of transport mode (car, public transport or bicycle).

The positive effects are not limited to mobility, but include the economy (accessibility), the population's health and healthcare costs, the environment and the climate.

CONGESTION-RELATED IMPACTS

The Goudappel Coffeng study used traffic modelling to examine the effects of additional cycle highways on modal shift in the Netherlands. It calculates a decrease of traffic jams in the Netherlands with 3,8 million hours per year when building 675 km more cycle highways. Travel time by car decreases even more, with 9.4 million hours, when combined with electric bicycles.

You can find these figures more detailed in these tables from the Goudappel Coffeng study:

Change % in number of trips	With cycle highways	With cycle highways & 50% electric bicycles
Car	- 0.7%	- 1.6%
Public transport	- 0.9%	- 2.7%
bicycle	+ 1.3%	+ 3.3%

Table 4 Change in number of trips by cycle highways. Source: Goudappel Coffeng

Saving in hours of travel time by car per day	With cycle highways	With cycle highways & 50% electric bicycles
Morning rush hour	7,000	17,400
Evening rush hour	7,900	19,600
Total	14,900	37,000

Table 5 Travel time savings (car) by cycle highways. Source: Goudappel Coffeng

	With cycle highways	With cycle highways & 50% electric bicycles
Saving in hours of travel time by car per year	3.8 million hours	9.4 million hours
Saving in € (value of time = €10/hr by car)	€40 million	€100 million
Catchment area (accessibility of city centre within 45 minutes)	550,000 inhabitants	800,000 inhabitants

Table 6: Economic benefits due to travel time savings. Source: Goudappel Coffeng

CONTEXT CONDITIONS

The programme for cycle highways started in 2006 as part of a programme to reduce car congestion. It started with five routes, but the programme was extended in 2008 and 2010.

The study makes use of the Dutch National Traffic Model, starting from the base year 2008 and makes a prognosis for 2020 if 675 km additional cycle highways would be built and half of the Dutch population would own an electric bicycle.

ROLE OF MEASURE BUNDLES

The study shows that cycle highways can significantly increase the share of people cycling. This potential is realised because a cycle highway increases the travel speed by bicycle from 15 km/h to 18 km/h.

Cycle highways reach their full potential when combined with electric bicycles, because the average travel speed for commuters changing from an ordinary bike to an e-bike increases from 18 km/h to 24 km/h.

This increase in speed means that the journey time decreases and/or the travelled distances increase. The bicycle becomes an attractive mode of transport, with advantages over public transport and individual motorised transport, especially because most suburbs or nearby villages are situated between 3 and 20 km of the city centre.

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ANWB (2014). Populariteit e-bike groeit verder. http://www.anwb.nl/fietsen/nieuws/2014/maart/ebike-steeds-populairder.

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Rai Vereniging (2016). Kwart meer e-bikes verkocht in 2015. Press release, 4 April 2016. https://www.raivereniging.nl/artikel/persberichten/2016-q2/0404-kwart-meer-e-bikes-verkocht-in-2015.html.

6. Ruhr Area: Cycle Highway

In the Ruhr region of Germany, the first section of a Radschnellweg (bicycle highway) has opened in what will eventually become a 100 km connection between Duisburg and Hamm, passing through several other cities along the way including: Mülheim, Essen, Gelsenkirchen, Bochum, Dortmund, and Unna. The long-distance bicycle path will be fully separated from vehicular traffic, running partly on disused railway tracks, as well as making use of bridges and overpasses. The path will measure four metres wide in order to provide sufficient space for cyclists to ride comfortably and pass when necessary.

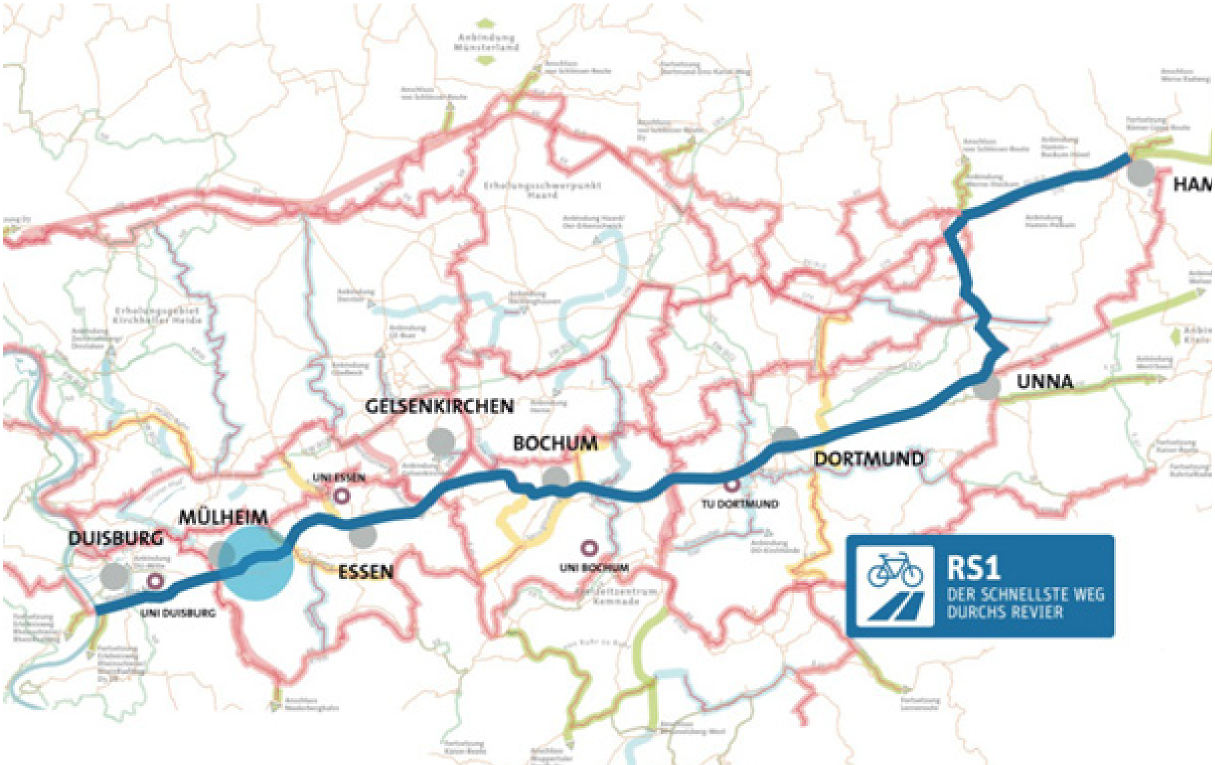

Figure 12: Map of the Ruhr Radschnellweg RS1. Credit: RVR

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

The Ruhr Radschnellweg RS1 is being implemented for the purpose of providing intercity cycling infrastructure for commuters and recreational cyclists. The facilities are expected to relieve overall traffic (for cyclists, vehicles and public transport) via increased cycling capacity and opportunity for a mode share shift. The actual impacts of the measure have not yet been determined as the project is still in the early phases of implementation.

CONGESTION-RELATED IMPACTS

The Radschnellweg project is being implemented by the local authority with the aim to provide cycling infrastructure for both inter-city commuters and recreational cyclists. The hope is that providing sufficient cycling facilities will impact travel decisions and catalyse a mode-shift away from privately owned vehicles. Today the majority of people who travel by bicycle are typically making shorter distance trips (e.g., within more densely developed urban centres). These regional bicycle highways are designed to provide a viable option for longer trips between cities and have proven successful in other parts of the world, such as the Netherlands. These regional cycling routes also invite increased opportunities for electric bicycles which have shown increased popularity particularly for longer-distance trips, and hold potential for expansion as a result of this new infrastructure being provided. E-bikes allow for longer distance trips to be made in shorter times and hold potential to attract a wider demographic of commuters who may not have otherwise chosen the bicycle as their preferred mode of choice.

Based on a traffic demand projection study, it is estimated that the Ruhr Radschnellweg could remove up to 50,000 vehicles from the road on a daily basis (WDR 2016) which could mean benefits not only for cyclists but drivers as well in reducing congestion. The total cost of the plan has been projected at €180 million, but this investment is minimal in comparison to standard roadway projects that cost on average €8.24 million/km in Germany (World Highways 2010).

ROLE OF MEASURE BUNDLES

The aims of this project are to provide infrastructure for inter-city cyclist commuting as well as recreational cycling activities in order to reduce overall congestion on roads and railways, improve air and environmental quality, as well as increase associated public health benefits.

CONTEXT CONDITIONS

The Ruhr region is the most densely populated area of Germany, making it an ideal location for implementing a Radschnellweg project. The bicycle highway will connect many of the cities in this region, interspersed with forest and farmland, within approximately a 30-minute cycle distance of each other. It is exactly these types of relatively highly populated, poly-centric areas that may be best served by bicycle connections as viable commuter links that can ideally free-up capacity on already congested road and railways.

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WDR (2016). Radschnellweg: Eine Vision nimmt Formen an. http://www1.wdr.de/mediathek/video/sendungen/lokalzeit-ruhr/video-radschnellweg-eine-vision-nimmt-formen-an-100.html.

World Highways (2010). European highway construction costs evaluated. http://www.worldhighways.com/sections/eurofile/news/european-highway-construction-costs-evaluated/.

7. Oxford: The Plain Roundabout

In Oxford, an estimated 75,000 cycle journeys are made each day with a consistently high proportion of journeys made into the city centre. One of the main routes into and out of the city centre is the Plain roundabout, a busy 5-arm roundabout with high bus flows and a history of cyclist casualties, which makes it off-putting for less experienced riders. The Plain roundabout already carries a large number of cyclists (around 8,500 two way cycle movements are made to and from The Plain in a twelve hour period; however this could be much greater. The roundabout is well known as a deterrent to many people who might otherwise make the relatively short journey into and beyond the city centre or the railway station. From 2014-2015 the Plain roundabout was rebuilt as part of the city government's Cycle City Ambition Fund

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

The aim of the scheme is the improvement of the attractiveness and safety of The Plain roundabout for cyclists and pedestrians by reducing the width of the circulatory carriageway and tightening entry radii to the roundabout, thereby slowing vehicle speeds. The new layout also provides greater cycle and pedestrian priority at the junction, notably a cycle filter lane for cyclists travelling eastbound and an enlarged pedestrian area. It is principally intended to deliver cycling and pedestrian related improvements as opposed to traffic flow improvements.

The goal of the scheme is to remove one of the main barriers to increased cycling into and out of Oxford city centre.

Figure 13: Impression of the new roundabout. Credit: The Urbanists/Oxfordshire County Council

CONGESTION-RELATED IMPACTS

A comparison between 2014 (pre scheme) and 2015 (post scheme) indicates a decrease in motor vehicle (primarily car) numbers and an increase in cycle numbers.

Evidence comes from pre and post scheme vehicle counts. However, the scheme is still relatively new and therefore it is too early to draw any meaningful conclusions. Further monitoring will be undertaken to determine whether the trends of the first year are carried forward. See Table 7 for results of the survey.

	Motorised vehicles	Cycles
2014	20,319	8,789
2015	19,616	11,227
Comparison	-703	+2,438

Table 7: Results of the Oxford scheme

ROLE OF MEASURE BUNDLES

Oxfordshire County Council has a strategic aim of providing an exemplary complete cycle network for Oxford that everyone knows about and is confident to use.

Encouraging greater levels of cycling as a result of the improvements implemented at The Plain roundabout fit with key objectives of the Council's Local Transport Plan relating to sustainability and health as well as developing and increasing cycling and walking for local journeys, recreation and health.

The proposed scheme at The Plain is expected to increase cycling by around 20% (from around 4,700 cyclists in an average 12 hour weekday period to around 5,700). It is hoped that it will act as a catalyst for future investment in cycling.

CONTEXT CONDITIONS

The Plain roundabout and its immediate approaches are a key junction acting as a gateway to the city centre for approximately 70% of the city's population.

Following Stage 1 (the roundabout); Stage 2 of the implementation is expected to involve further improvements to roads adjacent to the roundabout such as Longwall Street junction with High Street in the west, London Place/Marston Road junction along St Clements and Union Street junction along the Cowley Road. These approaches are also viewed as unwelcoming to cyclists and pedestrians in their current state. The ambition of the scheme as a whole is to open up a significant area of the city to more cycling.

FURTHER INFORMATION

Oxfordshire County Council (2015). LTP Volume 4: Cycle Strategy and Rapid Transit Strategy. https://www.oxfordshire.gov.uk/cms/sites/default/files/folders/documents/roadsandtransport/transportpoliciesand-plans/localtransportplan/ConnectingOxfordshireVol-4CycleBusStrategies.pdf.

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8. Strasbourg: Reshaping Road Space at Pont Kuss

Historical city centres with major tourist attractions attract a large number of pedestrians. Often the street space allocated to pedestrians is insufficient and cannot serve the needs of the increasing pedestrian demand. Furthermore, walking as a distinct transport mode is often neglected in the strategic planning process.

In 2012 the city of Strasbourg, France announced a ten year (2011-2020) plan called Plan Pieton, whose aim is to improve the situation of pedestrians (Communauté Urbaine de Strasbourg 2012 in: Kretz et al 2013), as well as to carry out an integrated, multimodal planning approach, where all modes of transport – pedestrians, cyclists, motorised individual traffic and public transport – are considered at the same level of detail.

One part of the strategy was the reallocation of public space on Pont Kuss, the bridge over the Ill River connecting the central station with the Old Town. The bridge is currently one of the city's pedestrian hotspots, due to the adjacent tram station and cafes in the vicinity of the bridge. Traffic counts show very high pedestrian demand throughout the day and particularly during the rush hours, but there are only moderate vehicular traffic volumes. These counts show that while 1850 pedestrians shared two sidewalks (each with a width of 2 m), only 250 vehicles per hour were using the two traffic lanes.

The measure consisted of re-designing the roadway cross-section to reduce this imbalance in the distribution of travel demand and supply: one lane was taken away from cars and given to pedestrians. This measure was complimented by modifying the traffic signal programmes in favour of pedestrians. Prior to the implementation of the project, an integrated, multimodal microscopic simulation was carried out, in order to estimate the impacts of space reallocation on the traffic flow. Figure 14 shows the traffic situation before and after implementation.

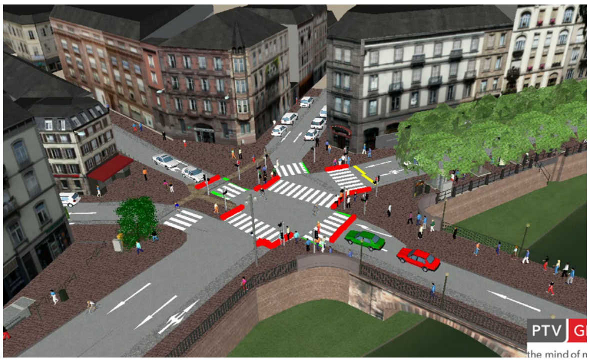

Figure 14: Traffic on Pont Kuss before (left) and after (right) the implementation of walking measures. Source: Kretz et al 2013

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

This plan considered all transport modes within a multimodal transport model, and therefore considered the whole transport system together. The reallocation of public space resulted in safe infrastructure for pedestrians, but also for vehicular traffic; since through the re-design, both motorised and non-motorised traffic are given sufficient space. Pedestrians coming to and from the tram station no longer walk in the roadway travel lanes while avoiding or overtaking other pedestrians; hence reducing potential danger for accidents or traffic flow disturbance, as it was the case prior to the implementation.

The share of walking is still high in the inner city, in fact the bridge redesign has been made it even more attractive for tourists and locals alike, and is now able to bear higher pedestrian traffic volumes as a result.

CONGESTION-RELATED IMPACTS

The effect of the measure – improved traffic flow – was analysed by microscopic transport modelling of different scenarios and these results of microsimulation were confirmed by on-site validation process and local experts´ estimates.

Despite the fear expressed before the measure was implemented that reducing the roadway capacity would cause vehicular traffic flow to collapse, it has been demonstrated that the measures in favour of pedestrians not only improved the situation for pedestrians, but also reduced waiting- and travel times for public transit. The simulation results showed that waiting time of pedestrians at crossings dropped significantly (after changing the signal plans, waiting times were less than 60 or at some crossings, even 30 seconds, whereas prior to the implementation, these values were greater than 60 seconds). The travel times for some bus lines were reduced significantly (by 40%) on certain sections. At the same time, reduced capacity for car traffic did not result in remarkably lower speeds, as depicted on Figure 15.

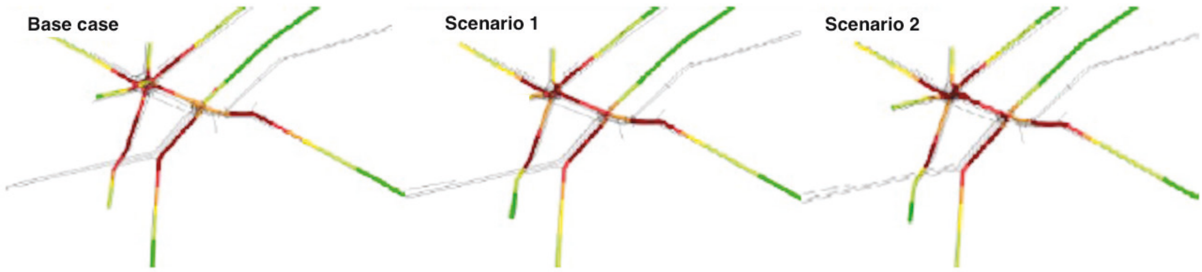

Figure 15: result of traffic assignment of base case (left) and 2 scenarios with improvements (right): speed-based LOS for vehicles. Source: Kretz et al 2013

ROLE OF MEASURE BUNDLES

The Kuss Bridge improvement measure was implemented within the framework of the Plan Pieton. This citywide strategic plan set the following ten strategic goals (Communauté Urbaine de Strasbourg 2012 in: Kretz et al 2013):

1. Promote (the relevance) of walking.
2. Redistribute the street space in favour of pedestrians.
3. Reduce conflicts between pedestrian and bike traffic.
4. Apply instruments of city and regional planning to pedestrian traffic.
5. Assign at least 1% of the budget of any major project to pedestrian issues.
6. Improve ways to schools and promote walking to school (Pedibus).
7. Reduce separating impact of arterials.
8. Arrange road nodes pedestrian-friendly.
9. Create new pedestrian links along waters to close gaps in the pedestrian network.
10. Create a Réseau Piéton Magistral (Major Pedestrian Network)

CONTEXT CONDITIONS

Historic cities may provide the most clear examples showing the necessity for integrated and balanced planning, but considering the rapid urbanisation process today (United Nations 2012 in: Kretz et al 2012), it becomes clear that integrated planning designed to provide equal rights for pedestrians and by that motivate and promote walking – the most space-efficient way of movement – is desirable for the whole urban area.

With the successful implementation of this pioneer project, pedestrians have been made as visible as motorised traffic, and at the same time, it has been proven that implementing measures in favour of walking does not result in an increased level of motorised congestion. In this way, the historic cities become trendsetters and point to the future of city and traffic planning to create safe and liveable city streets.

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9. Ljubljana: Pedestrian Zones in the City Centre

Ljubljana is the capital of Slovenia with about 281,000 inhabitants and an important cultural, trade and scientific centre. The Ljubljana city centre has a relatively high urban density with 27,000 people living in an area of five km^2. The city centre faces an increasing number of daily commuters which contributes to air pollution, noise and congestion problems (CIVITAS ELAN n.y.).

In 2007, the city centre was closed to all motor vehicles and this designated ecological zone has been gradually enlarged. Today, it covers an area of more than 10 hectares (City of Ljubljana 2016). Within the CIVITAS-ELAN project (2008-2012), Ljubljana implemented further measures to promote non-motorised transport modes in order to tackle congestion and improve the modal split ratio between car traffic and environmentally friendly modes of transport, like reduced speed zones, the reduction of available parking spaces in the city centre and the introduction of one-way streets. In 2013, a core part of Slovenska Street, a main traffic artery in the city centre that is usually heavily congested (EUROCITIES 2014b), was closed to motorised vehicles and is now accessible only for pedestrians, cyclists and public transport.

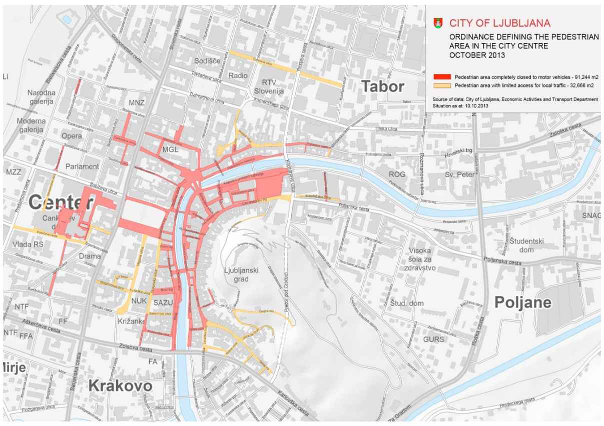

Figure 16: Ecological zone in Ljubljana: The area marked in red indicates the pedestrian-only area with a total ban on motorised traffic in the city centre. Delivery times are between 6 and 10 am. The area marked in yellow indicates the pedestrian area with restricted local traffic in the city centre. Credit: City of Ljubljana 2016

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

Pedestrian zones in the city centre of Ljubljana were extended in order to encourage non-motorised mobility, to avoid congestion in the city centre and to transform the city “that was once overcrowded with cars” into “a pleasant public space and an attractive setting for a variety of social, cultural and sports events” (City of Ljubljana 2016 & 2013, EUROCITIES 2014a).

As a result of giving more priority to pedestrians and the modification of the traffic regime in favour of environmentally friendly modes of transport, a decreasing mode share of pedestrians (27% in 1994, 19% in 2003) could be increased (25% in 2013) and an increasing mode share of car traffic (42% in 1994, 58% in 2003) could be decreased (51% in 2013) city-wide (data from Ljubljana city administration). The effects of an increased share of walking and a decreased share of car use are stronger among the inhabitants living in the city centre: Walking increased from 33% in 2003 to 53% in 2013, car use decreased from 47% to 19%.

Figure 17: The city centre of Ljubljana before and after the creation of the ecological zone. Credit: picture above: M.Fras/D.Wedam, picture below B.J.Jersic/V.Kontic

CONGESTION-RELATED IMPACTS

Evidence about the effects of the introduction and enlargement of the pedestrian zones in the city centre are is not available. However, since the modal split of car use decreased in Ljubljana from 2003 to 2013 and even stronger among the inhabitants living in the centre of Ljubljana, it can be assumed that the introduction and enlargement did not have a negative effect on congestion but rather contributed to a relief in road traffic.

CONTEXT CONDITIONS

Ljubljana succeeded in transforming itself from a previously car dominated city to a city with a focus on pedestrians, cyclists and public transport. Large amounts of public open spaces were renovated, creating qualitative gains for the citizens living in Ljubljana. This was one reason for the European Commission to award Ljubljana the European Green Capital in 2016.

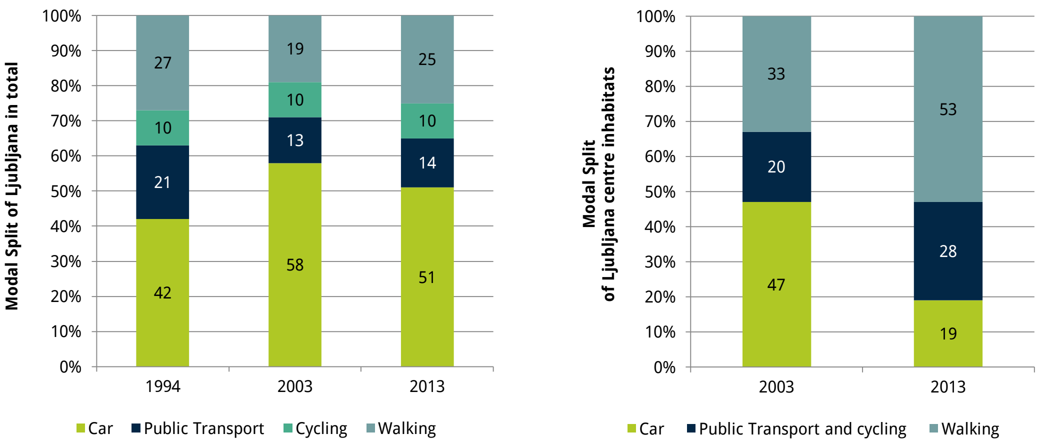

Figure 18: Modal split of Ljubljana in total between 1994 and 2013 Source: information provided by the city administration of Ljubljana) and modal split of Ljubljana centre inhabitants between 2003 and 2013. Source: City of Ljubljana 2014, p. 7

ROLE OF MEASURE BUNDLES

The introduction and enlargement of the pedestrian zones in the city centre were accompanied by complementary measures for improving traffic flows in the city centre and to ensure accessibility.

To reduce traffic in the streets around the city centre, an inner ring road was completed with the opening of the new two-level Fabiani Bridge in 2012. The entire lower deck of the bridge is exclusively for cyclists and pedestrians. For compensating reduced parking in the city centre, additional park & ride facilities were created.

As an additional measure to provide better accessibility to the city centre, Ljubljana also offers a fleet of four Kavalir (Gentle Helper) electric vehicles for free transport available to anyone who has difficulty walking within the pedestrian zones. The e-vehicles travel at a speed of 25 km/h and can carry five passengers.

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CASE STUDIES

Cycling infrastructure: parking and bike share

10. Münster: Bicycle Station (Bike + Ride)

Münster is a well-known German cycling city. As a result of a long-term cycling promotion policy consisting of various infrastructure components (e.g. primary and secondary cycle networks), as well as traffic management and services, the modal spilt for cycling has risen from 29.2% in 1982 to 39.1% in 2013.

With more than 105,000 cyclists per workday, bicycle parking is an important infrastructure element at public transport stops, work places, shopping facilities etc.

The main challenge was providing sufficient bicycle parking at the central station, being the main interchange for commuters: here the parking situation was so bad, that walking paths on the station forecourt (Berliner Platz) where blocked by parked bicycles forcing pedestrians to walk on the street. To remedy this situation and to regain the space for other uses (e.g., benches and street furniture), a two-story bike station with space for 3,300 cycles and various services – e.g. lockers, bicycle wash and repair service - was built in 1999. The underground bicycle station can be reached by one big ramp or two stairways, one leading directly into the central station and the second into the adjacent pedestrian area (see Figure 19). Costs for parking range from €0.70 per day to €7 per month and €70 per year.

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

One year after the bicycle parking facility opened, 80% of its capacity was already being used by 2,900 annual ticket holders, with an additional 100 to 400 daily tickets sold (depending on season and weather).

A survey conducted in October 1999 showed that 26% of the bike station users didn't use the bike to go to the train station before (Blomeyer & Milzkott 1999). 33% of bike station users now use their bicycles more often than before, whereas 63% show the same use patterns and only 4% use it less than before. Extrapolated to the whole user segment, this would mean that the bike station has motivated around 520 additional people to use their bicycle.

After the opening of the bike station, bicycle parking on the forecourt was banned completely and the space was re-designed for more recreational use.

Few years later, illegally parked bicycles again became a problem in adjacent side streets near the train station. Thus in 2005, the area at the back of the

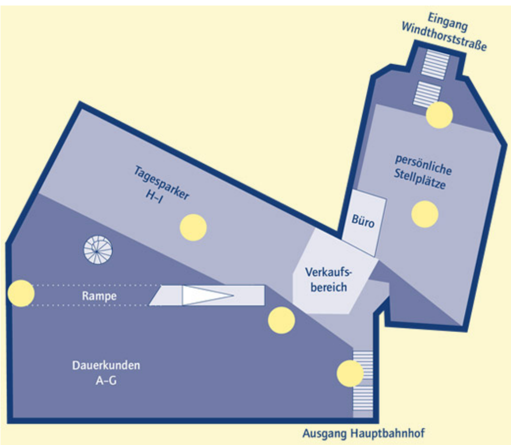

Figure 19: "Left: Sketch of Münster bicycle station. Source: http://www.muenster.de/stadt/radstation/; Right: Picture of the bicycle station Credit: Rüdiger Wölk, Münster

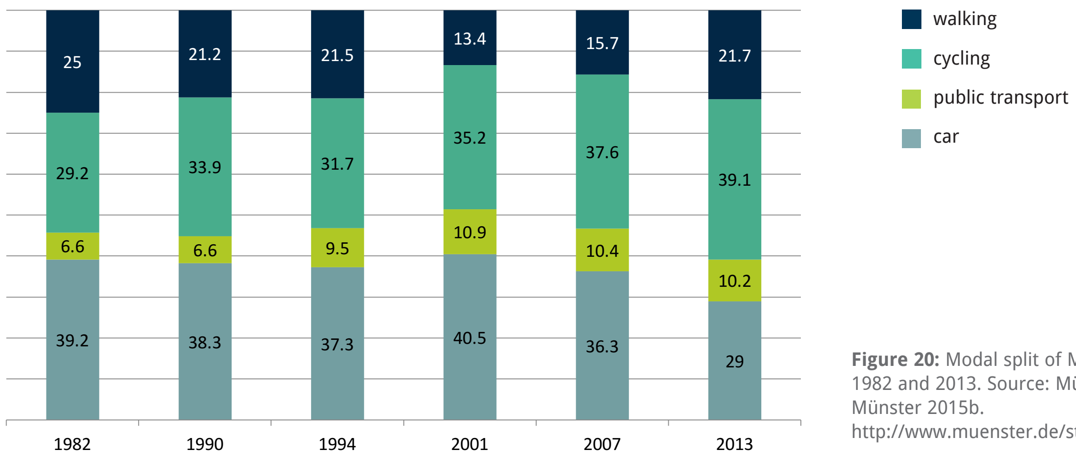

Figure 20: Modal split of Münster between 1982 and 2013. Source: Münster 2016, Münster 2015b. http://www.muenster.de/stadt/radstation/

main station was also re-designed and fitted with 790 additional bicycle parking facilities.

CONGESTION-RELATED IMPACTS

Since the main goal of building bike stations is to provide secure bicycle parking as one element of an attractive cycling infrastructure, the impacts of this measure on congestion were not evaluated in Münster. In the above mentioned survey not even the question "what mode of transport the people used, that didn't take the bike earlier" was raised. Thus the impact of this measure on congestion is not clear.

Nevertheless since the modal split of cars decreased slightly between 2001 and 2013 (Figure 20), it can be assumed that the bike station had no negative effect on congestion.

CONTEXT CONDITIONS

The example of Münster shows that by putting in place high quality bicycle infrastructure as well as regulations and enforcement, the proportion of cyclists can be increased significantly. Hence the infrastructure provided must be a well-meshed mix of various components. Furthermore, the bicycle network needs to be integrated into an overall transport strategy that also enables the combination of different sustainable transport modes (e.g. interface between cycling and public transport).

ROLE OF MEASURE BUNDLES

The provision of adequate parking facilities for bicycles is seen as one important component of high quality cycling infrastructure in Münster. Hence besides the bike station at the main station, Bike+Ride facilities are provided at several points within the city. In addition, bus stops, especially suburban ones, are equipped with racks, significantly increasing the catchment area of the buses.

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11. Bordeaux: Bike Sharing to Ease Congestion Caused by Construction Works

From the 1960's until the 1990's, Bordeaux was congested and air quality was poor: almost no one rode bicycles in the city during that time. The tramway had been removed from the streets around 1958. A turning point came with the election of Alain Juppé as Mayor in 1995: he decided in 1997, after much debate, to put 44 km of tram lines back in the streets.

Construction of the tramway (phase 1) started in 2000 and lasted until 2005. For about 3 years, the whole centre of the city was blocked, inaccessible for cars and congested on the remaining routes. During this time people started turning to the bicycle for their daily trips and the city of Bordeaux started lending bicycles for long term use. The lending programme was a success. Around 4,000 bicycles were available for citizens free of charge for periods from one week to one year. In 2010 the Bordeaux bike share system VCub started, replacing the original fleet of Mairie de Bordeaux bikes (Belhocine 2015).

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

Purpose of the measure was to keep Bordeaux accessible during the construction works of the tramways.

Thanks to the success of bike lending during the construction work, the city of Bordeaux continued the measure even when construction was complete and organised La Maison du Vélo to manage the system.

The bike lending scheme also gave Bordeaux the idea to implement a public bike sharing system. Starting in the beginning of 2010, the VCUB bike sharing programme has also been a success. The Bordeaux bike share counts 1,700 bikes at 166 stations: 99 are located in Bordeaux (every 300 to 500 metres) and 40 in the wider region. According to Bordeaux Métropole, bikes are used an average of 6.7 times per day. Today, Bordeaux Métropole is opening more stations and is trying to improve the VCub+ system, which allows users to rent a bike for up to 20 hours. This measure targets workers in the area who cannot have their own bike because of a lack of parking spots in their homes. In Bordeaux, the share of VCub users represents only 8% of the bicycle users. VCUBs are also mostly used by tourists.

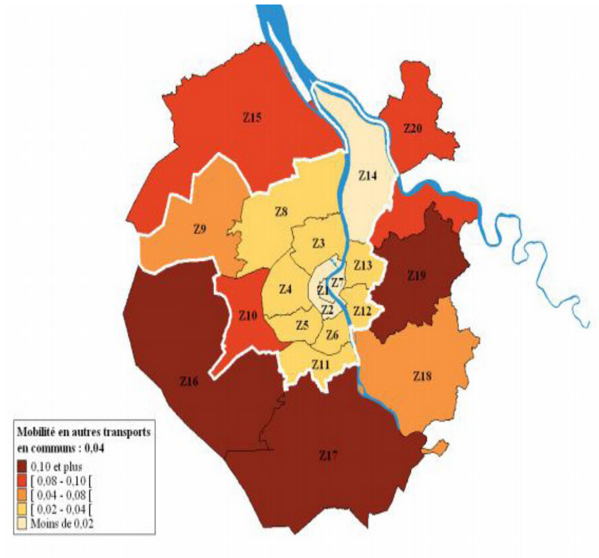

Figure 21: Bicycle trips in the Bordeaux metropolitan area. Source: Enquête Ménage Déplacements 2009

CONGESTION-RELATED IMPACTS

The impact has been important for the city centre. The bike appeared to a lot of inhabitant as the only viable mode of transport in a city crowded with cars and construction sites. From 1998 until 2009, Bordeaux saw small positive changes in modal split:

- Car use decreased from 64% to 59% (down to 40% in the city centre)
- Public transport grew from 9% to 10%
- Cycling grew from 1-2% to 4% (and 9% in the city centre)
- Walking increased from 22% to 24%

The bicycle mode split results vary depending on the location. The share grew rapidly from 1-2% to approximately 9% in the city centre. On the other hand, the modal share in the periphery of the metropolitan area is lower. As shown on the map below, there are massive discrepancies between bicycle use in the centre of Bordeaux and the other nearby cities within the Bordeaux Métropole.

CONTEXT CONDITIONS

Bordeaux and its city center succeeded in transforming a previously car dominated city to a city with a focus on pedestrians, cyclists and public transport. First of all, the political choice to put the tramway back on the streets shows a will to limit the use of cars in the centre. Moreover, the whole centre was pedestrianised which made using bicycles safer. This is why the modal split is higher in the centre city than in the rest of the Métropole. In order to complement these measures and to provide better accessibility to the city centre, there are at least 22 park & rides in Bordeaux Métropole allowing users to leave their car in a safe parking and take public transport.

ROLE OF MEASURE BUNDLES

The case of Bordeaux shows that in a context of massive congestion and traffic, people turn to the easiest, cheapest and most practical transport modes they have. A city can help its residents make such a choice by providing inexpensive – or free – bicycles for long-term use. However, it is important to note that such measures may be best implemented in relatively dense urban areas, as city sprawl can deter inhabitants from using bicycles to get around when distances are too far.

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CASE STUDIES

Traffic management strategies

12. Bolzano: School Streets

Measures to reduce the number of parents driving their children to school can have a tangible impact on reducing peak congestion. There are a variety of examples of school travel planning measures that can be adopted to encourage children and their parents to switch to non-car transport modes for travel to school. The School Streets project in Bolzano is a particularly successful example.

Bolzano is a city of over 100,000 people located in Southern Tyrol in Italy. The concept of School Streets was introduced at primary schools in Bolzano in 1989 as a means to ensure the safety and transport autonomy of children around the school and to relieve urban traffic at peak times.

In schools where many parents drop off and pick up children by car, it is common to encounter congestion, indiscriminate parking and conditions that discourage parents from allowing their children to walk or cycle to school. The concept of School Streets involves a time restriction of vehicular access to specific streets around a school for 15 minutes during peak times for children arriving and departing from school, effectively preventing parents from dropping off and picking up children at the school gates. Exemptions to the temporary vehicle restrictions include bicycles, disabled drivers and access for local residents.

Figure 22: School Street in Bolzano. Source: https://www.vcoe.at/news/details/autofreie-zone-vor-der-schule

The concept of School Streets has been tested in other locations around Europe. For example, East Lothian Council in Scotland announced in 2014 that it was trialling school peak-hour vehicle restrictions in Haddington to improve the safety of children.

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

Bolzano has been successful in encouraging school travel by active modes and public transport through a number of initiatives. 2008 data on the modal split of trips to primary school shows that 80% of pupils travelled to school by public transport, on foot or by bike. However, there is no before-after data to assess the impact of the School Streets project specifically, or to disaggregate what proportion of the modal split could be linked to this measure.

CONGESTION-RELATED IMPACTS

While there is no direct evidence proving the congestion impacts of the School Streets, it is possible to contextualise the contribution of the sustainable primary school mode share on the traffic network. The Municipality of Bolzano has approximately 6,000 children of primary school age so the 80% non-car modal split equates to around 4,800 person trips, or about 8% of the total daily volume of vehicle trips within the city area of Bolzano which equates to around 60,000 according to the Urban Mobility Plan.

CONTEXT CONDITIONS

The total daily volume of trips in Bolzano is around 150,000 of which the majority (90,000) are vehicle trips to and from Bolzano. Some traffic congestion is experienced in the peak periods and in the event of incidents. The Urban Mobility Plan notes that trips from the surrounding area into the city remained stable between 2002 and 2009.

Bolzano is a relatively compact city with a high walking (29.5%) and cycling (29%) mode share of trips made by residents. The Urban Mobility Plan published by the Municipality of Bolzano aims to achieve more efficient use of the public space available, and places great emphasis on the cycle network as a means of delivering efficient and accessible mobility for its citizens.

ROLE OF MEASURE BUNDLES

The School Streets concept involves not only the timed closure of streets around schools, but also a wider educational programme to encourage children to get into the habit of travelling to school in a safe and autonomous way. Safe pedestrian behaviour forms part of the curriculum at the beginning of primary school and before starting secondary school, children also learn how to use bikes.

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13. Copenhagen: Green Wave for Cyclists

In 2007 the City of Copenhagen established the first green wave for cyclists on Nørrebrogade in order to reduce travel time for cyclists. Since then, the concept has been extended to other major arteries in the city, where cycle traffic volumes are significant. Currently, about 80,000 cyclists use the green wave corridors each day, which is roughly 26% of the bicycle users entering the city centre. Within the green wave, the traffic lights are coordinated for cyclists riding at a speed of 20 km/h.

The average speed of bicycle users in Copenhagen is about 16 km/h. Setting the green wave at a speed of 20 km/h is meant to encourage slower cyclers to go a bit faster, but also to encourage faster cyclists to slow down since faster cyclists can create safety problems on Copenhagen's cycle tracks, which are heavily used during rush hour. The green wave cycle tracks are equipped with green LED lights which indicate to cyclists if their speed is appropriate to reach the next green light. In the morning rush hour, the green wave is implemented all the way into the city. In the afternoon it is reversed so bicycle users can flow home smoothly. A green wave traffic sign and the green LED lights are shown in Figure 23.

Figure 23: Left - Green wave sign Copenhagen Source: Hoegh 2007b), Right – Green LED lights. Source: Rambol 2016

Currently, Copenhagen is testing a pilot project involving a detection system on Østerbrogade. This green wave 2.0 will detect bicycle users approaching an intersection. If there are five or more people cycling roughly together, the light ahead will stay green until they pass through the intersection.

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

The green wave improves bicycle traffic flow, thus reducing travel time for cyclists. Another impact is the increase of cycling traffic – on Nørrebrogade, the first green wave arterial with over 35,000 bicycle users a day, bicycle traffic has increased by 15% since the green wave was first implemented. Here the hourly demand in the morning peak almost exceeds capacity and therefore can have the adverse effect – slowing down cyclists. Hence the City of Copenhagen is widening this corridor as an accompanying measure.

CONGESTION-RELATED IMPACTS

Before implementing the green wave in Nørrebrogade, a pilot study was conducted in 2004, with a provisional green wave at 13 signalised intersections. Measure of travel times, speeds and number of stops made by bicycles and cars in the morning peak hours showed that the cycle trip to the city centre became faster: the average speed increased from approximately 15 km/h to almost 21 km/h. At the same time, car traffic towards the city centre was almost unaffected, with an average speed before the green wave project being 22.34 km/h and after 22.36 km/h [4], meaning that that the green wave for cyclists neither increased congestion for cars nor relieved it. Consequently, the green wave was implemented in Nørrebrogade and other corridors. Table 8 shows a comparison of before and after implementing the green wave.

Today Copenhagen reports that “the large number of bicycles, for example, makes it easier for necessary basic motor transport such as tradesmen, goods transport and buses to get through more easily.” (City of Copenhagen, 2015). On the other hand, “the growth of bicycle traffic means that capacity is strained in many sections where bicycle traffic is heaviest. Cycle track congestion impedes cycling, increases travel times and results in a feeling of insecurity.” (City of Copenhagen, 2015). Therefore Copenhagen is

For bicycles:		**Saved stops**	**Saved min./sec.**
To centre in the morn-ing	Green wave	1	0
From centre in the morning		1	0:30
From centre in the afternoon	Green wave	1	0:48
To centre in the afternoon		0	0:30

For cars:		**Saved stops**	**Saved min./sec.**
To centre in the morn-ing	Green wave	6	2:29
From centre in the morning		1	0:35
From centre in the afternoon	Green wave	3	1:13
To centre in the afternoon		0	0:36

Table 8 (top) – Results after implementation of green wave for cyclists, **(below)**: Results for cars after implementation of green wave. Source: Hoegh 2007a continually expanding the cycling infrastructure so it can handle the growth of bicycle traffic and especially the peak hour volumes.

CONTEXT CONDITIONS

Copenhagen has set a goal of becoming CO_2 neutral in 2025. This requires bold and innovative measures. At the same time, there's a strong focus on quality of life: Copenhagen wants to demonstrate how green solutions can be smart, clean and efficient.

Copenhagen is known for its bicycle culture: 42% of all trips happen on bike today. But the ambition is that more than 50% of all trips should be taken by bike. Transport is still one of the biggest contributors to CO_2 emissions and other types of air pollution, while car ownership is still increasing. In several streets, air pollution is above EU limits.

ROLE OF MEASURE BUNDLES

The green wave is only one of many design and infrastructure elements that support Copenhagen's success as a bicycle friendly city. Figure 24 illustrates the increase of cycling traffic that has taken place as a result of this bundle of measures. The increase in demand that the green wave projects triggered was addressed with the widening of cycling tracks along the green wave routes (e.g., bicycle traffic has increased by 15% on Nørrebrogade since implementation of the green wave. Creating more space for bicycle users is important to avoid adverse effects of increased demand on traffic flow.

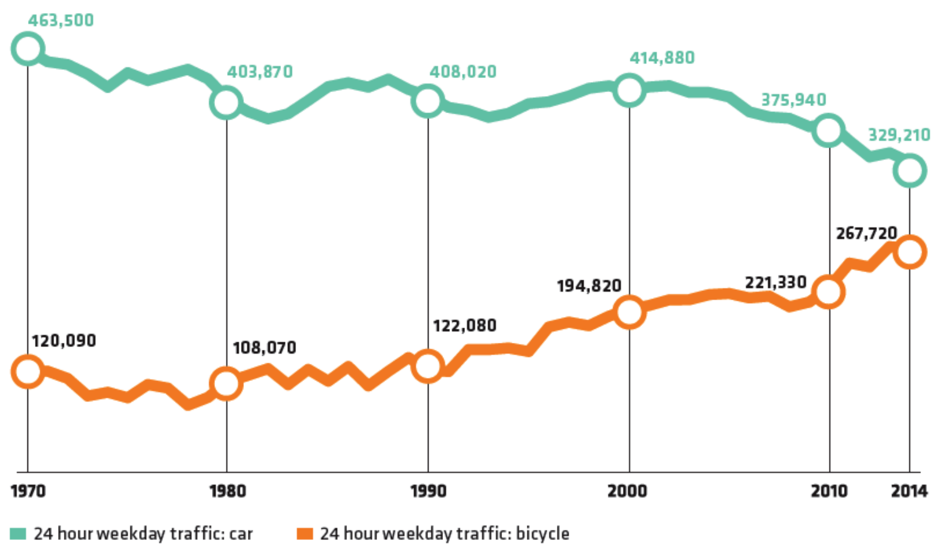

Figure 24: 24 hours weekday traffic entering and leaving the city centre. Source: City of Copenhagen 2015

FURTHER INFORMATION

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14. London: Pedestrian Countdown at Signalised Junctions

Signalised junctions in London are characterised by high intensity of both pedestrian and vehicle traffic. There is always the risk that pedestrians will enter a crossing at any time, even if the red signal is displayed. What is more risky is that the signal phases for pedestrians are designed in such a way that after a green signal appears, there is a "blackout" phase where neither a green nor a red signal is displayed. Thus, some pedestrians feel unsafe crossing the road because of the lack of information about when motorised traffic will receive the green light.

Because the blackout phase is not fully understood by pedestrians, Transport for London introduced eight trial sites for Pedestrian Countdown at Traffic Signal Junctions (PCaTS); with the intentions to make them feel safer and more confident while entering the crossing,

On selected junctions, the countdown timers were installed on pedestrian signals to show the time left until the start of the red light. These devices helped pedestrians see how much time they had to safely cross the road and how they should adjust their walking speed. They also provided information to those who had not started crossing the road that there was insufficient time to cross.

The junctions were filmed to examine pedestrians' and drivers' interactions and pedestrian perception surveys were carried out using face-to-face questionnaires to gather further information. Research was conducted before and after introducing PCaTS to assess their impacts on users' behaviour.

Figure 25: Pedestrian countdown at signalised junction in London. Credit: Transport for London (TfL)

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

The studies demonstrate that the majority of pedestrians liked the countdown more than the blackout phase: 83% of all pedestrians in the final ex-post study, 94% of mobility impaired pedestrians and 79% of children. PCaTS was preferred over standard crossings by 69% of mobility impaired pedestrians and 56% of children, who directly experienced both types of crossing. At all sites there was an increase in the percentage of participants stating that they felt safer using the crossing in the "after" survey. The average increase was from 73% (before) to 91% (after) across all sites. Furthermore, in the separate survey of children and mobility impaired pedestrians, 83% of children and 71% of mobility impaired stated that they felt safer with PCaTS. At the same time, about 20% of participants felt less rushed while crossing the road.

CONGESTION-RELATED IMPACTS

The countdown timers enabled pedestrians to cross the road more efficiently and with a feeling of safety; and as they could now make more confident crossing choices, it was also possible to slightly lengthen green light time for motorised traffic as well.

The "after" study showed that the re-timing element of the PCaTS package of measures (increasing green time for vehicles) resulted in reduced delay for drivers. When averaged over a one hour period, the additional green time available to traffic ranged from just over 40 seconds to several minutes. Thereby average vehicle delay decreased between 2 and 8 seconds at different junctions. Furthermore, vehicles started to move forward slightly earlier at the majority of sites, up to a maximum of 0.7 seconds in the "after" surveys. Thanks to reducing driver delay and queue lengths, the examined junctions were less congested.

These measures are useful to understand the potential motorised traffic benefits of the PCaTS package and its impact on reducing congestion.

CONTEXT CONDITIONS

In London a high percentage of pedestrians cross the road on the red light, possibly inducing conflicts between vehicles and pedestrians. The blackout phase is used less often by pedestrians for entering the crossing even though there is typically enough time to walk across the road at ease. Trials show that the countdown phase is much more comfortable for pedestrians than the blackout phase; however, it can also be stated that PCaTS may not discourage people from illegally crossing the road on the red light.

ROLE OF MEASURE BUNDLES

PCaTS is one of the measures included in the Mayor's Transport Strategy (MTS) for smoothing traffic flow, since it has the potential to improve junction efficiency and help optimise the allocation of "green time- between pedestrians and road traffic.

This trial has demonstrated that the PCaTS package can deliver benefits to both traffic and pedestrians.

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CASE STUDIES

Mobility management

15. Stockholm Congestion Charge

Stockholm, with nearly 1 million citizens, is the most populous city of Sweden and its metropolitan area has a population of over 2.2 million. Stockholm's city centre faces the problem of a large number of daily vehicle commuters who contribute to air pollution, noise and congestion problems.

To solve this problem the Swedish Government implemented a "congestion tax" following a long debate and a referendum in the Municipality of Stockholm. The congestion tax requires the drivers of most vehicles entering the city centre (which includes Södermalm, Norrmalm, Östermalm, Vasastaden, Kungsholmen, Stora Essingen, Lilla Essingen and Djurgården) to pay a fee between certain hours. The measure includes ITS infrastructure (e.g., automatic license plate recognition cameras). All the tax income is returned to the Stockholm region for investments in public transport and road improvements.

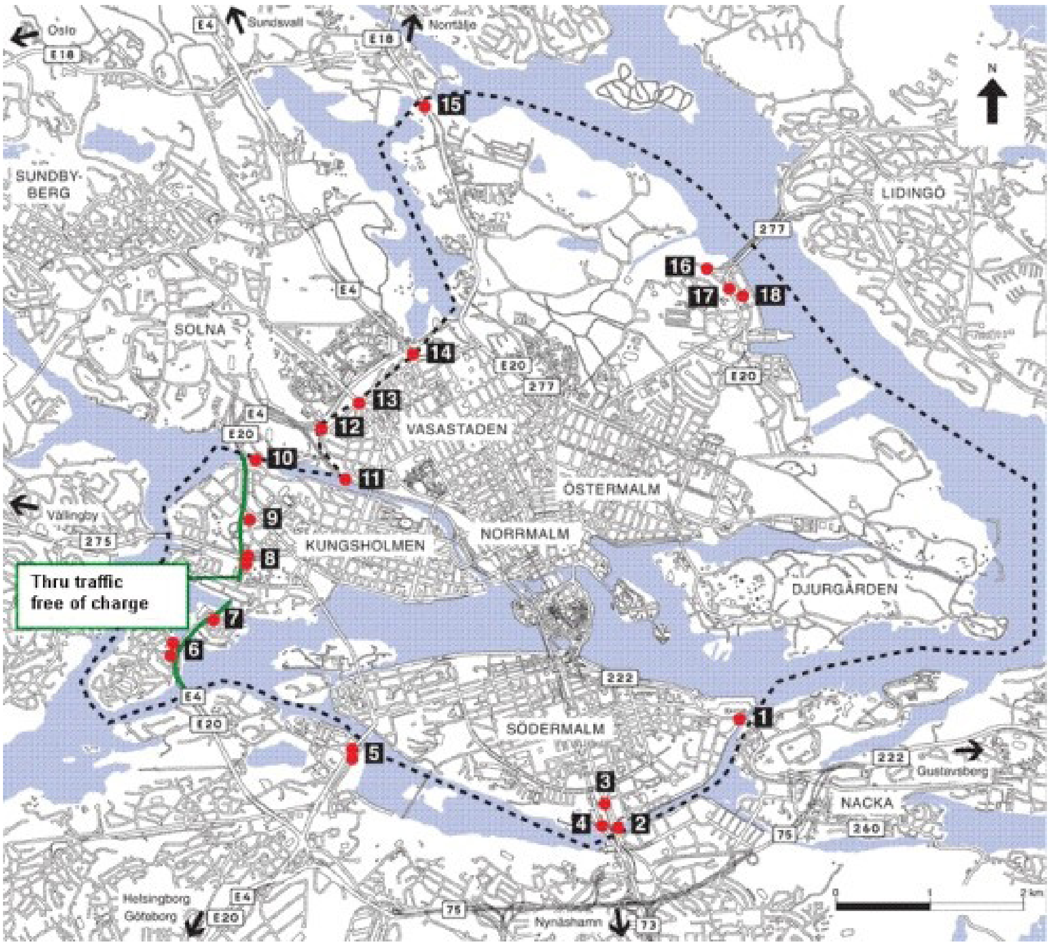

Figure 26: Map of the congestion charge area and gates around Stockholm. Source: Swedish Road Administration

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

The following traffic changes were observed as a result of charging drivers to enter the Stockholm city centre:

- Overall traffic to and from the city centre declined by 10-15% (with declines ranging from 9 to 26% in different sectors).
- The worst queues in and near the city centre decreased by 30% and more.
- The biggest decline was during the afternoon peak period. Traffic also declined in the evening after the charge period ended.
- There was a 14% reduction in vehicle miles travelled (VMT) in the charged zone and one % reduction in VMT outside the zone.
- There was an increase in travel time reliability and traffic volumes on most congested roads dropped by 20-25%.
- Public transportation use increased by 6-9%, though this increase could not be entirely attributed to congestion charges. It appears that fewer than 50% of car users who gave up trips during the charge period shifted to public transport. Some changed their time of departure to avoid paying the fee.
- No significant increase was observed in cycling, carpooling or telecommuting.

CONGESTION-RELATED IMPACTS

There is evidence regarding the effects of motorised traffic on congestion and air pollution. Evidence on modal shift to public transport should be researched in more detail. No evidence of modal shift to cycling and walking occurred.

CONTEXT CONDITIONS

Stockholm's congestion charging programme succeeded in decreasing the level of congestion in the city centre. The public attitude towards the congestion charge changed after the implementation: the majority opposed the idea of congestion charge before it was implemented, after the trial period of one year the people voted in favour of the measure in a referendum.

ROLE OF MEASURE BUNDLES

The Stockholm congestion charging programme consisted not only by congestion charges but also of an extension of public transit services. The extended services were motivated partly to meet increased demand for public transport, and partly by a political will to show “carrots” and not just “sticks”. Drivers switching from car to public transport meant that the number of passengers in the transit system increased by around 4-5%. Crowding in the public transport system, measured by the number of standing passengers, increased somewhat in the metro but decreased on the commuter trains, most likely thanks to expanded public transport capacity. Reduced road congestion in and around the city centre led to increased speeds and punctuality for bus services. In Stockholm, the charges were to a certain extent marketed as “environmental” charges, and voters' environmental concern was an important factor explaining the acceptability of the charges.

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16. Groningen: Campaign to Promote the Use of an Alternative Bike Route

Groningen is a well-known cycling city in the north of The Netherlands. It has a population of 200,000 and houses two large universities with more than 50,000 students. 50% of the citizens are below the age of 30. Since the city's 1970 "traffic-circulation plan", cycling has become the most important type of transport. This plan divided the inner city into four areas. Cars weren't allowed to cross the border directly from one part to another. This made it faster to cycle within the city than to take a car – and thereby making car travel less attractive. Today, no less than 60% of all traffic movements are made by bicycle; and both cycling and the number of inhabitants in Groningen continue to grow.

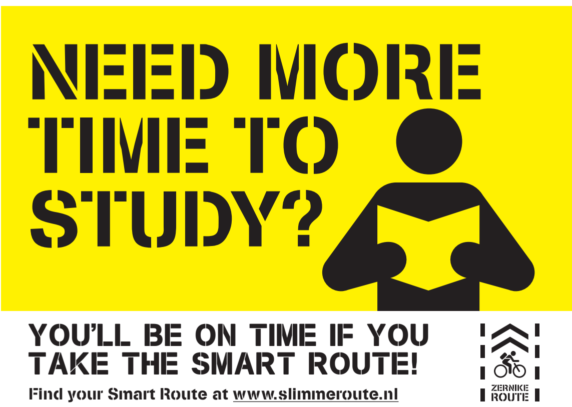
Groningen is expected to grow to over 225,000 inhabitants by 2025. This growth challenges the city's traffic system because some parts of the cycling system have reached capacity causing issues with congestion and safety. Instead of investing in more infrastructure, the city ran a campaign to encourage cyclists on a particular route to use alternative, less busy, routes. One of these routes connects the Zernike Campus in the north with the city centre and districts in the south, where a large number of the students live. For this route two nearby alternate routes were signed and marketed as "smart routes". The routes were promoted at the start of the new semester because the first year students were the main target of the campaign. The action also included:

- Developing campaign material with input from a focus group and a communications bureau
- Producing a simple map illustrating the alternative routes
- Sign posting and marking on the road to indicate "smart routes"
- Campaign promotion during student introduction week including use of website, social media, message boards, distribution of leaflets and water bottles
- Competition to win a bike for submission of best comments or tips about the smart routes with award presented by the alderperson of Traffic and Mobility at a ceremony attended by the media

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

Groningen's campaign aimed to shift a share of the cyclists from the Zonnelaan route to two alternative routes during peak times. An evaluation of the campaign showed that it was successful in achieving the following results:

- 4% shift of cyclists to the alternative routes.
- 79% of those surveyed were familiar with the campaign and 20% of those had changed their cycling route as a result.



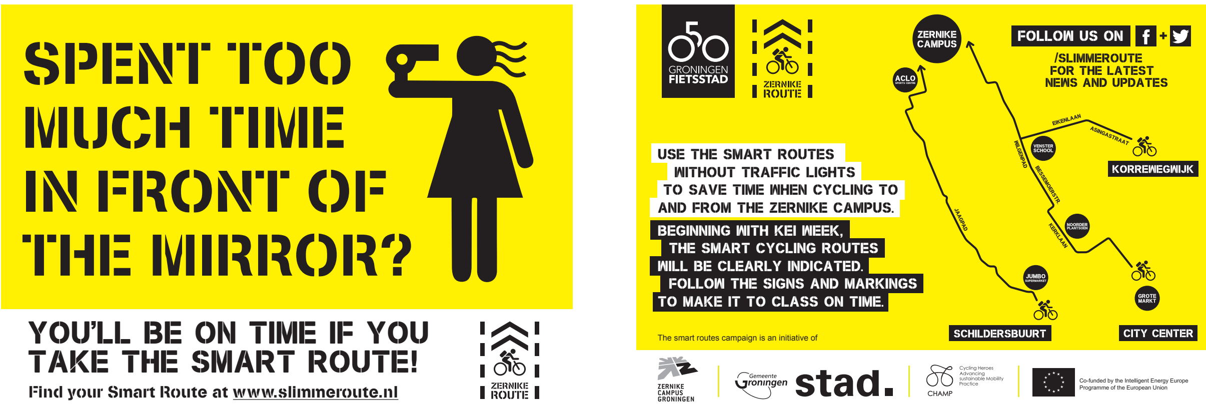


Figure 27: Smart routes campaign material. Credit: City of Groningen / CHAMP

- The campaign was well received by the students, educational institutions, media and politicians.
- The campaign will be repeated next academic year.

It's not evident how much shifting of cyclists was expected at the start of the study.

CONGESTION-RELATED IMPACTS

The Groningen campaign could slightly reduce the congestion of motorised traffic. The vehicular traffic crosses the cycle path; due to the lower number of cyclists on this route, the car traffic flow has improved according to city officials.

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17. London: Demand Management "Get ahead of the Games"

The 2012 Olympic and Paralympic Games created an enormous logistical challenge for London as host city. Transport for London was aware that enhanced transport services and operational performance on the networks would be insufficient and therefore put in place a programme of Travel Demand Management (TDM) called "Get ahead of the Games" to address expected increases in transport demand.

Travellers in London were encouraged, through the 'Get ahead of the games' campaign, to adapt their travel to relieve pressure on travel hot spots by reducing the amount they travelled, by re-timing journeys so as to avoid the busiest times on the networks, by re-moding to other less busy modes of transport, and by re-routing, to avoid the busiest locations. These four actions were called the 'four Rs'.

This awareness campaign aimed to meet one of London's commitments during the Games: guarantee that athletes, fans and Londoners on their everyday routes could travel with reliable journey times.

Figure 28: Example of the Get Ahead of the Games marketing materials. Credit: ODA / TfL

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

As an indicator of walking levels in Greater London, pedestrian flows across the Thames in Greater London were around 8-9% higher during the Olympic and Paralympic games than would otherwise have been expected.

Cycling numbers across the Thames in Greater London during the Olympics was about 12% higher, and during the Paralympics was 25% higher than would otherwise have been expected. Equivalent values for crossings in Central London were 25 and 36% higher respectively. The time profile of cycling journeys was closely comparable to that more usually observed, suggesting that cycling was preferentially used as a means of travel to work during the Games. Across summer 2012, 20% more cyclists were observed on major roads in London than would otherwise have been expected. The recently-extended Barclays Cycle Hire scheme saw 43% more hires than would otherwise been expected during the Olympics, and 30% more hires over the Paralympics.

CONGESTION-RELATED IMPACTS

Motorists and businesses successfully adjusted the times at which they travelled to avoid the busiest times and places on the road network. Across Greater London there was proportionately less traffic during the morning peak and mid-day periods, balanced with more traffic in the late evening and overnight periods. Although relatively small in magnitude for general traffic, this change was crucial in relieving pressure at the most critical points on the road network, particularly in Central and Inner London where it also combined with reductions in the absolute volume of traffic.

Indeed, another important aspect is that during the Olympics, 77% of the London travelling population made some form of change to their normal travel patterns. Part of the population decided not to make one of the journeys they would normally make, others changed their time of travel, their mode or their route.

CONTEXT CONDITIONS

Traffic conditions on many of the major roads that made up the Olympic Routes could be described as “unstable” prior to the interventions. During the Olympic period, conditions on the Olympic Route Network itself could be described as “stable flow”.

	Olympics	Transition	Paralympics
2011 equivalent	91.2%	91.8%	89.2%
2012	91.1%	92.0%	89.5%

Table 9: Journey time reliability for general traffic. Percentage of normalised journey segments completed within 5 minutes of a nominal average time. Source: TfL Surface Transport

ROLE OF MEASURE BUNDLES

The 'four Rs' campaign succeeded in changing Londoners' travel behaviour and had a positive impact on congestion and travel time during the Olympics. The traffic flow on the Olympic Route Network was considerably better than under normal conditions as demonstrated by the fact that the journey time targets were met. The evidence also shows that traffic flows on the rest of the road network as a whole were also better as a result of lower background demand (around 10% less traffic entering Central London).

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18. Gdynia: Campaign Promoting Walking and Cycling in Kindergartens

Gdynia has a population of 250,000. Fifty percent of its residents are regular car users. Awareness raising campaigns have been undertaken regularly since 2009 to promote safe and sustainable mobility in the city. Traffic safety around schools and kindergartens is also an important issue in Gdynia.

The promotional campaign "Odprowadzam Sam" has taken place every spring (1st April – 30th June) since 2012. In 2015, 26 kindergartens with 2,300 pupils were involved. The aim of the action was to promote the choice of sustainable modes of transport among the youngest traffic participants and their parents. Therefore, parents were encouraged to walk their children to the kindergarten or choose public transport or bicycle.

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

The main target of the campaign was to reduce the number of trips to kindergartens by car and increase traffic safety around the kindergartens. Based on previous editions of the campaign, the expected results of its implementation were an increase in the use of sustainable modes of travel to kindergartens and a decline in traffic in the vicinity of kindergartens. Additionally, educational classes about road safety and environmental protection have been carried out in the kindergartens, which registered first for the campaign. To verify the actual result of the campaign, its participations were surveyed before and after it.

The number of children participating in campaign	Number of children surveyed before the action	Number of children surveyed after the action
2,301	1,282	1,353

Table 10: The number of participants/children surveyed in the campaign

The results of before and after survey are presented in Figures 29 and 30. Change in both travel behaviour and preferences testify to refer the children's attention on alternative to cars ways of traveling (especially walking).

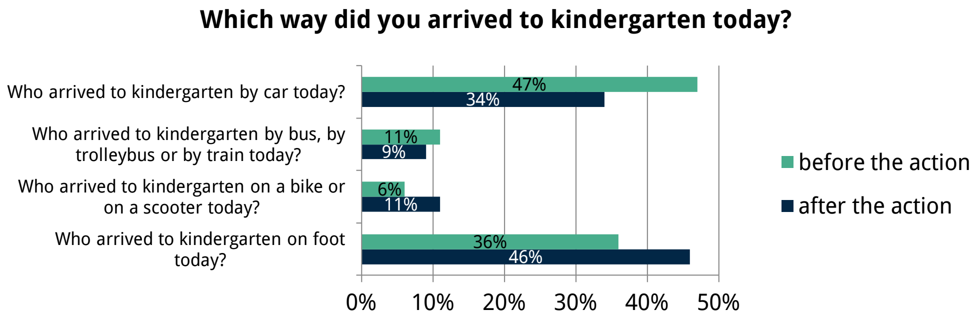

Figure 29: Change in travel behavior of children as a result of the campaign

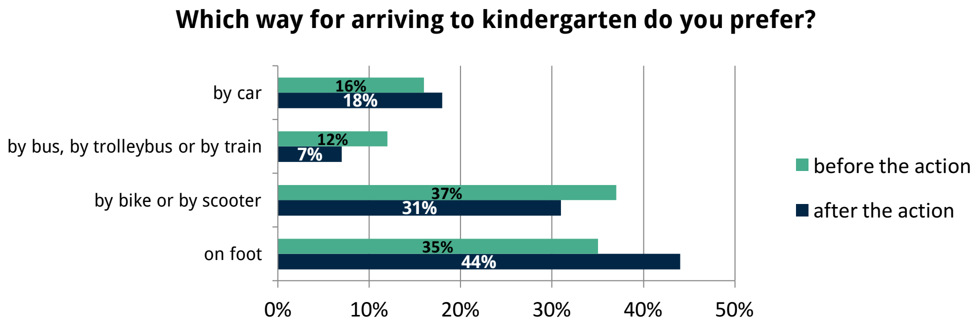

Figure 30: Change in travel preferences of children as a result of the campaign

CONGESTION-RELATED IMPACTS

There were no traffic surveys before and after the campaign to estimate changes in traffic conditions, but at the end of the action, teachers were asked to fill out the survey about the campaign carried out in their kindergarten. The results were satisfactory. As teachers stated in the survey, in all kindergartens car use decreased by about 13% and trips by foot increased by 10%. It can be a reason that most of them noticed that fewer cars were parking in the kindergarten's neighbourhood and conditions for all modes were improved. Bike and public transport use were at comparable levels before and after the campaign, both about 10%.

CONTEXT CONDITIONS

There were no significant changes in traffic conditions on the major roads in Gdynia. Traffic conditions and safety were improved in the vicinity of kindergartens.

ROLE OF MEASURE BUNDLES

As part of the Intelligent Energy Europe SEGMENT project (2010-2012), Gdynia has gained significant experience in elaborating and running tailored marketing campaigns using the segmentation methodology. Gdynia has used this experience in implementing dedicated campaigns on walking and cycling among school and kindergarten pupils since 2012. The measures are part of the assumptions of the Sustainable Urban Mobility Plan which is being developed in the project CIVITAS DYN@MO. The SUMP is a continuation and extension of the plan developed in the years 2008-2015 in the framework of the EU project BUSTRIP.

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CASE STUDIES

Measures for more than one mode

19. Ghent: B401 Viaduct Removal

Ghent has over 250,000 inhabitants, of which 72,500 are students, making it the largest student community in Flanders, Belgium. The city land area measures approximately 156 km^2 in total.

The urban highway B401, leading from the crossing of two major highways (E40 and E17) straight into the city centre of Ghent, was constructed in the early 1970s. The city's 2003 Sustainable Urban Mobility Plan (SUMP) raised the question of the future need for this vehicular viaduct. It has been proposed to remove this section of highway, either partly or entirely, in order to drastically reduce the number of vehicles entering the city centre. This measure could be a great leap forward regarding congestion mitigation, pedestrian and bicyclist safety improvements, and improved environmental quality for the city.

As an alternative to this single major arterial road, the traffic could be diverted to the city's ring road (R40), which could then distribute the urban traffic to a variety of destinations around the city.

Ghent is studying the impacts of this project in cooperation with the Flemish road administration and public transport company. The results of these reports will be used to help inform an overall vision for the future planning of the site and its surrounding neighbourhoods with the goal of helping support the creation of a more liveable city.

Figure 31: Ghent B401 viaduct. Credit: Willemen Groep

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

The demolition of the B401 viaduct proposal is still in the planning and projection evaluation phase. However, the actual impacts could include a redistribution of vehicular traffic from this main location to the surrounding (R40) ring road, opportunities for improved urban design including public pedestrian space and bicycle lanes, as well as the external impacts of public health, environmental quality, and economic value of the surrounding properties for real estate and local businesses.

CONGESTION-RELATED IMPACTS

The removal of the B401 elevated highway would eliminate a major source of vehicular traffic directly into the city centre by rerouting vehicles to a ring road for more evenly distributed traffic access. This would reduce congestion and improve air and environmental quality, as well as provide safer conditions for cycling and walking. The removal of the highway would also free up valuable land for new uses, such as a public park, bicycle infrastructure, and public transit routes with connection to the city centre. Similar benefits have been achieved from motorway removal projects in other cities including San Francisco and Seoul.

ROLE OF MEASURE BUNDLES

The success of these measures will require cooperation between local and regional authorities throughout the planning process. The public engagement process will also invite participation from community stakeholders to contribute to identifying local issues, and offer ideas for the future adaptation to their city.

CONTEXT CONDITIONS

The current state of the B401 viaduct includes relatively high levels of vehicular congestion, particularly during rush hour and peak hour commuting times. As opposed to widening the highway and expanding capacity to invite more vehicles, the city of Ghent is taking a more comprehensive approach in considering the redistribution of traffic to other roads and focusing on improving urban quality of life in conjunction with access to more active modes, such as cycling and walking, to move throughout the city.

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20. Budapest: Comprehensive Development of a Bike-Friendly Inner City

Budapest is the seventh largest city in the European Union; it has a population of 1.7 million inhabitants.

Cycling is increasingly popular in Budapest and the length of cycle lanes are increasing steadily as well. In the first SUMP-based transport development strategy of Budapest called BMT Balázs Mór Plan, the city set a goal of 10% modal share for cycling by 2030. The current level of cycling mode share is 2.3%. In order to achieve this goal, BKK launched its MOL Bubi public bike sharing system and implemented a series of projects designed to make conditions more conducive to cycling in the city.

The Bubi system was opened in September 2014 with 1,100 bikes and 76 docking stations. In 2015 the system was extended by 22 stations, after a first successful period of operation.

In an effort to support the bike sharing system and cycling in general, BKK is redesigning the city centre road network to be more bike-friendly. Several cycling measures have already been implemented, including: bike lane network expansion, bike boxes at signals and junctions, traffic calming schemes and contraflow bike lanes on one-way streets (64 one-way streets have been opened for cyclists from both directions). In 2014, the length of the total bicycle network was 288 km; which has effectively doubled over the last 17 years. Furthermore, bicycle racks have been installed at main stations and public buildings to improve parking and reduce bicycle thefts.

Despite the recent developments, in many areas of Budapest there is still insufficient cycling infrastructure including network gaps. Moreover, vehicle congestion and high parking demand in the city centre are also issues that still need to be resolved.

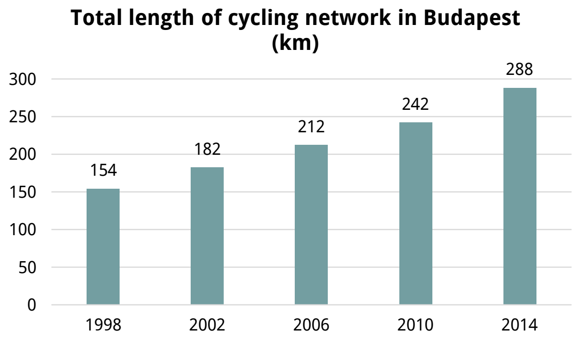

Figure 32: Development of cycling network in Budapest. Source: BKK 2014

Figure 33: Bike lane in Budapest. Credit: BKK (Centre for Budapest Transport)

PURPOSE OF THE MEASURE AND ACTUAL IMPACTS

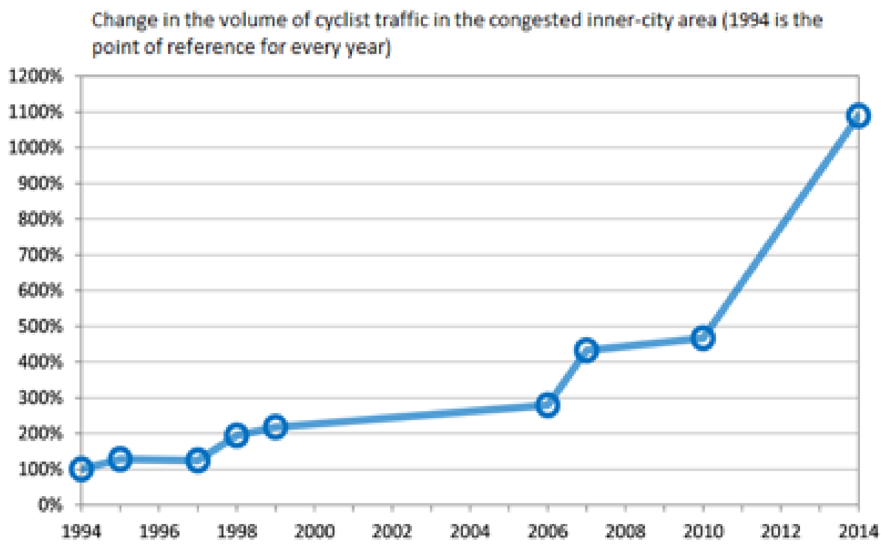

Figure 34: Change in the volume of cyclist traffic in the inner city. Source: BKK 2014

Figure 34 shows growth of cycling traffic in Budapest since 1994. During the last two decades, the volume of cycling traffic has grown by 1,000%. This currently means roughly 100,000 daily cycling trips in Budapest. The big boom started in 2010, at the same time when BKK was established and started to implement cycling measures. Budapest also invests in cycling education, since BKK participates in IEE STARS project, which is focussing on empowering schools (pupils, teachers and parents) to engage in cycling. The booming number of cyclists, the increasing length of cycle routes, investments and development in the cycling infrastructure and education, and the installation of the MOL Bubi public bike sharing system all have positive impacts on the proliferation of cycling, and are expected to help support reaching the city's 10% modal share for cycling by 2030.

CONGESTION-RELATED IMPACTS

There has not been a quantitative evaluation on the impacts of cycle measures on congestion, but the effect is palpable. According to the results of a local expert questionnaire, it can be concluded that the cyclist traffic flow has improved at network level, at intersections and at road segments as well. Regarding the effect on the motorised traffic, the opinions are mixed. The effect is low on the main roads, while on local roads and intersections, the effect varies depending on the specific location. In most cases, the traffic has been calmed after implementing the new cycling infrastructure.

CONTEXT CONDITIONS

Budapest is on track to become a cycle friendly city with reasonable cyclist mode share. The development of cycling facilities over the past several years has been significant in improving safety and offering opportunities for active mode choices. If this trend continues, the 10% cyclist modal share until 2030 is certainly reachable.

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04

CONCLUSIONS

Conclusions

The cases described in this portfolio illustrate how measures supportive of walking and cycling can be implemented without creating additional congestion, and under certain circumstances can even reduce congestion. In ten of the 20 cases, congestion was reduced, in eight cases, the measure did not affect congestion or no effect could be measured. Only two cases showed a slight increase in vehicle congestion. Congestion reduction could be seen in different types of measures: five of the cases with reduced congestion used infrastructure measures, three contained traffic management measures and three were mobility management measures.

Table 11 summarises the results of the case study examples.

Measure Type	Case	Kind of intervention	Effects on...	Impacts on traffic flow of motorised traffic	Co-Benefits / Remarks
Cycling infrastructure (moving traffic)	1. NEW YORK: New bicycle lanes	Additional cycling infrastructure	network	positive	increased traffic safety, modal shift towards cycling
Cycling infrastructure (moving traffic)	2. BRIGHTON: Lewes Road corridor	Smarter choices interventions and infrastructure adjustments, including the conversion of a dual carriageway into a single carriageway for motorised traffic	network	slightly negative	increased traffic safety, modal shift towards cycling
Cycling infrastructure (moving traffic)	3. GERMANY: Advisory cycle lanes	Infrastructure adjustment	segment	slightly negative: lower speed, depending on circumstances	increased traffic safety, modal shift towards cycling
Cycling infrastructure (moving traffic)	4. GERMANY: Upgrading of cycling facilities following design guidelines	Infrastructure adjustment	segment	positive	increased traffic safety, modal shift towards cycling
Cycling infrastructure (moving traffic)	5. NETHERLANDS: Cycle highways	Additional cycling infrastructure	segment	positive	positive benefit-to-cost-ratio
Cycling infrastructure (moving traffic)	6. Ruhr Area, Germany: cycle highway RS1	Additional cycling infrastructure	network	positive	Shift towards cycling on inter-city commuting

Walking and Cycling infrastructure (moving traffic)	7. OXFORD: Roundabout in city centre	Greater cycle and pedestrian priority at the junction, reducing the width of the circulatory carriageway	junction	neutral	less casualties
Walking Infrastructure (moving traffic)	8. STRASBOURG: Reshaping road space at Pont Kuss	reallocation of public space	segment	neutral	increased safety and reduced travel time for pedestrians
Walking Infrastructure (moving traffic)	9. LJUBLJANA: Pedestrian zones in the city centre	Extension of pedestrian zones	network	neutral	modal shift towards walking and cycling
Cycling infrastructure (parking and bike sharing)	10. MÜNSTER Bicycle station	Additional parking facilities for bicycles	network	neutral	modal shift towards cycling
Cycling infrastructure (parking and bike sharing)	11. BORDEAUX: Bike sharing to ease congestion caused by construction works :	Bike Sharing was implemented during the construction of a new tram line, and expanded due to its success	network	positive	modal shift towards cycling
Traffic management strategies	12. BOLZANO: School streets	Timed restriction of vehicular access to specific streets	segment	positive	increased travel safety
Traffic management strategies	13. COPENHAGEN: Green wave for cyclists	Rephasing of traffic lights	segment/ network	neutral	Reduces travel time for cyclists
Traffic management strategies	14. LONDON: Pedestrian countdown at traffic signal junctions	Rephasing of traffic lights	junction/ network	positive	The countdown timers enabled pedestrians to cross the road quicker
Mobility management	15. STOCKHOLM Congestion charge	Congestion charge	network	positive	modal shift towards public transport
Mobility Management	16. GRONINGEN: Campaign to promote the use of alternative bike route	Campaign promoting cycle infrastructure	segment	slightly positive	no other effects measured

Mobility Management	17. LONDON: Demand management "Get ahead of the Games"	Campaign for all travellers for reducing, re-timing, re-moding and re-routing during Olympic Games	network	positive	Travel time reliability for athletes
Mobility Management	18. GDYNIA: Promotion campaign in kindergartens for walking and cycling	Promotion campaign for walking and cycling in kindergartens	network	neutral	Modal shift towards walking, increased traffic safety
Measures for more than one mode	19. GHENT: Viaduct deconstruction	Infrastructure removal	network	expected to be neutral	increased travel time for motorists likely
Measures for more than one mode	20. BUDAPEST: Comprehensive development of inner city	Comprehensive infrastructure improvements for cycling, infrastructure adjustments for motorised traffic	network	neutral	modal shift towards cycling

Table 11: Impacts of the interventions in the case studies

The selected cases show that it is possible to take concrete measures to promote walking and cycling without needing to fear causing congestion. On the contrary, some even reduce congestion. A clear message is that, to be successful, the measures must be carefully designed with respect to specific traffic situations and implementation conditions.

In several cases, additional bike lanes or broader sidewalks were implemented while narrowing the space for cars (e.g., New York, Strasbourg). These case studies indicate that this can work without causing additional congestion if road width and speed limits are adjusted accordingly. In cases with additional walking or cycling infrastructure that doesn't affect road space (e.g., cycle highways in the Ruhr Area or The Netherlands), congestion relief effects were observed or expected. Promotion campaigns that attempt to influence a change of routes or travel times (e.g., Groningen, London Olympics) showed positive effects on traffic flow. The same could be observed for other traffic management measures such as the access restrictions in Bolzano School Streets or changed pedestrian signalling in London.

COMPARABILITY ISSUES: DIFFERENT MEASURES, TRAFFIC SITUATIONS AND DEFINITIONS OF CONGESTION

The measures were implemented to address different aspects of walking and cycling (infrastructure changes, traffic management, mobility management), and their potential congestion effects can occur at the level of junctions, segments or the whole network.

Furthermore, the interpretation of the outcomes depends on the definition of congestion in each case. For example, a reduced speed (either for motorised traffic, due to a modal shift, for walking and cycling compared with motorised traffic) could be considered a negative impact on traffic flow, but as long as it does not exceed a certain threshold, a reduced speed does not necessarily mean increased congestion.

Finally, there is no commonly accepted standard for defining multimodal congestion. Such a definition would answer the question of how to evaluate a slightly reduced traffic flow for cars in combination with an improved traffic flow for walking and cycling. Thus, it is difficult to compare the effects of the measures in the different cases.

THE ROLE OF CO-BENEFITS

Another relevant aspect that can be seen in the case studies is that most of the measures were not implemented with the goal of reducing congestion. This is one reason why it was difficult to quantify congestion reduction in many cases; congestion was not the main focus and therefore not an important element of the measure evaluation. But there is another reason why it is hard to measure congestion changes after the implementation of measures supportive of walking and cycling: while many infrastructural changes lead to changed capacities for car traffic or for walking and/ or cycling, most of the measures also lead to modal shifts that cannot be observed immediately, but take some time to occur and are not visible in a short-term ex-post evaluation.

Almost all of the cases show that there are also other benefits such as modal shift or improved safety. On the one hand, these could be seen as simple "co-benefits" from the perspective of congestion reduction. On the other hand, these effects are interdependent and serve to help reduce congestion in the long run. Most of the measures examined can support behaviour change and improve the modal split of non-motorised modes over time. The literature also suggests that a modal shift from car traffic towards the more space-efficient modes of walking and cycling has the potential to reduce congestion.

Measures that reduced dangerous interactions between non-motorised and motorised traffic and increased safety in terms of reduced casualties (e.g. the cases with wider bike lanes and sidewalks, access restrictions, longer pedestrian traffic light phases) make pedestrians and cyclists feel safer and in doing so also help to promote a modal shift.

TRANSFERABILITY OF THE RESULTS

To understand the transferability of the positive results of the cases described in this portfolio, it is necessary to look at the context conditions where measures were implemented.

The case studies show that it is important to integrate measures into a broader concept. To raise the modal share of walking and cycling and reduce car traffic in order to reduce congestion, improvements like bike lanes on a single road segment or pedestrian friendly signalling at a single intersection are not sufficient. Instead, these measures need to be accompanied by consistent networks of footpaths and bike lanes and other measures, including campaigns for walking and cycling, traffic restrictions and speed limits for motorised traffic, changes of signalling, better quality walking and cycling infrastructure, bike parking facilities and others, depending on the specific situation in the city. Therefore it is highly recommended that cities integrate walking and cycling planning and measures into comprehensive transport plans (like in Copenhagen or Münster).

For cities with low levels of walking or cycling that want to make a start, it can be helpful to implement adaptable infrastructure in the beginning. Starting with reversible, low-cost measures like painted bike lanes (like in Budapest) offers the possibility to learn from trial-and-error and provides flexibility if traffic changes don't meet the predictions.

In low-speed environments (either by speed limits like in Brighton or by reshaping of the road space like in Strasbourg or in Oxford) many benefits come together: The flow of motorised traffic is smoother, speed differences between motorised and non-motorised traffic are lower and thus there is a better chance for self-regulation of traffic without the need for separated infrastructure like bike lanes. Additionally, with lower danger of severe accidents, walking and cycling become more attractive.

05

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