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# Evaluating the economic and social impacts of cycling infrastructure: considerations for an evaluation framework

**A report for the Department for Transport**


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# Evaluating the economic and social impacts of cycling infrastructure: considerations for an evaluation framework

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**Technopolis**

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# Introduction

## 1. Introduction

### 1.1 This report

This report presents the results of a study to research the options for robustly evaluating the economic and social impacts of investments in new or improved cycling infrastructure, in a mixture of different types of urban and rural areas.

The report has been written for evaluation practitioners and commissioners, and while it attempts to avoid using evaluation jargon without suitable explanations, the document is rather more discursive than would be appropriate for a more general reader.

### 1.2 Background

The 'Briefing on the Government's Ambition for Cycling' (2013) is a commitment to bring about a step change in levels of cycling across the UK and lists some of the major investments available to support this agenda: close to "£700m was made available through the Local Sustainable Transport Fund, Community Linking Places Fund and Cycle Safety Fund on top of block allocations provided to local authorities" (pp. 4).[1] The briefing document also outlines the rationale for increasing investment in cycling, including amongst other things the desire to reduce congestion, unlock development and support economic growth. The Department for Transport's (DfT) Cycling Delivery Plan (2015) further developed these ideas and set out the government's 10-year strategy, which, amongst other things, commits to double cycling levels overall by 2025.

The UK government as well as local government's investment in cycling infrastructure is part of a wider movement that seeks to improve the urban realm ('green' projects) and overall transport infrastructure – the redevelopment of infrastructure around the Elephant and Castle area in London is an example.[2] Part of this project is the development of segregated cycling lanes, specifically targeted at improving safety for cyclists; the programme as a whole is intended to improve the connectivity of the area. Other major programmes include the HS2 cycle highway and the Cycle City Ambition plans (total investment £148M, more than £10 per capita per year) for Greater Manchester, West Yorkshire, Birmingham, West of England, Newcastle, Cambridge, Norwich, and Oxford.

Currently the average level of cycling in the UK is low relative to the levels seen in many other EU countries. A special Eurobarometer report (2014)[3] found that across the EU28, on average, around 8% of people will use a bicycle as their main mode of transport on a typical day. The survey revealed a wide distribution across countries, with the Netherlands and Demark recording the highest proportions of people using cycling as their mode of transport (at 36% and 23% respectively), three or four times higher than the EU average, while the equivalent figure for the UK was around 3% or less than half the EU average.

[1] www.gov.uk/government/uploads/system/uploads/attachment_data/file/229473/briefing-governments-ambition-cycling.pdf

[2] https://tfl.gov.uk/info-for/media/press-releases/2014/november/elephant-and-castle-consultation

[3] European Commission (2014). Special Eurobarometer 422a Quality of transport.

There are several pockets across the UK where the level of cycling is relatively high, and arguably, the government's various cycling interventions have played a part in increasing the level of cycling. There is also a high degree of variability across areas. For instance, in the Royal Borough of Kingston-upon-Thames, in West London, 4% of residents (of working age, 16-74) cycle to work, while just to the North, in Hillingdon, the percentage is only 1.5%.[4] In Brighton and Hove, during 2005-2008, the city invested in new cyclepaths, parking and improved intersections and the proportion of residents cycling to work increased from 2.7% in 2001 to 4.7% in 2011[5].

As part of its long-term commitment to increase the level of cycling, the DfT seeks to better understand the economic and social impacts associated with investments in cycling infrastructure in order to encourage and shape further investment. However, the Department recognised there was a gap in its current guidance, which do not include recommendations or metrics relating to impacts of the local economy, the health and well being of citizens or on the quality of the local environment.

## 1.3 This study

### *1.3.1 Scope*

The principal objective was to develop an evaluation framework that will allow the DfT and other organisations with responsibility for transport to differentiate and measure the economic and social impacts of cycling infrastructure investment.

The evaluation framework focuses on longer-term impacts and does not propose indicators or data collection strategies for the more immediate effects of infrastructure investment on, for example, levels of cycling. That said, in several cases these important outputs are used as a component within the impact indicators we have suggested. As an aside, our research suggests that local authorities have a keen interest in strengthening and harmonising evaluation for the more immediate effects of their cycling schemes.

The framework provides advice on a robust approach to establish a causal relationship between a cycling investment and specific local impacts, for a range of impact types, including economic, social, distributional and health-related factors. It proposes various strategies for coping with the challenge associated with impact evaluation, which is to credibly distinguish the contribution of an upstream investment in transport infrastructure within wider social conditions that are the product of multiple factors.

### *1.3.2 Area types*

In order to design a generic Cycling Infrastructure Evaluation Framework ('the framework'), the study team considered a cross-section of different area types and cycling infrastructure and have looked closely at current and planned investments in five areas. The list included:

- Areas with higher and lower levels of pre-existing cycling, on the assumption that there is substantial opportunity for increased levels of cycling even in the more active areas and that any methodology will need to be able to attribute an estimate in additional cyclists and cycling to specific waves of infrastructure investment

[4] ONS (2014) "2011 Census Analysis - Cycling to Work" (http://www.ons.gov.uk/ons/dcp171776_357613.pdf)

[5] Idem

- Urban and rural areas, where the profile of costs and benefits may look rather distinct as a result of those particular locational factors (e.g. urban areas will tend to have larger populations with shorter average journey distances and higher levels of traffic congestion, while more rural areas will tend to have better environmental conditions and journey ambiance and possibly more and easier development options)
- Areas that have focused on single major infrastructure projects and areas that have adopted a more broad-based policy, with multiple cycling investments, in order to explore the ease with which one can disentangle the costs and benefits of one intervention from another

We identified five different areas from around the country, which offered the desired mix of types of infrastructure and locational factor: part of the 'green corridor' being developed between Brackley and Buckingham along the High Speed 2 (HS2) rail line, cycling 'superhighways' in and around the city regions of Leeds and Sheffield and the broader portfolios of infrastructure investment in Brighton and Hove and Kingston-upon-Thames.

Table 1 lists the five areas that we considered in developing this evaluation framework, with a brief description of their distinctive features, while Appendix C provides a fuller presentation.

Table 1: Overview of the 5 cycling infrastructure programmes selected for review

| **Area and programme** | **Description of the scheme's overall objectives** |
|---|---|
| HS2 corridor cycleway and the Buckinghamshire priority link (Brackley-to-Buckingham) | Increase cycling via the creation of a cycleway of a world class standard that broadly follows the high speed 2 (HS2) railway network, and increasing cycling in between Brackley and Buckingham, providing a linear park and traffic free route and a safe place to learn to cycle again as well as popularising cycling more generally |
| Leeds and the CityConnect Programme (Leeds-Bradford Cycle Super Highway) | CityConnect will make it easier and safer to get around on foot and by bike giving residents better access to their local area, increasing travel options and reducing road congestion |
| Sheffield and the South Yorkshire cycle action plan | To achieve a modal shift away from vehicle use in order to release highway capacity, thereby reducing lost productive time and $CO_2$ emissions and improving air quality. To increase levels of active travel contributing to healthier lifestyles, quality of life and tackling social exclusion, obesity and health inequalities |
| Kingston-upon-Thames 'mini-Holland' programme | Make cycling in the Borough more convenient, better connected and safer, making cycle travel appeal to many more people more often; seen as an enjoyable, safe, practical and accessible everyday option for more people, including older and disabled people, children and families; reduce congestion by encouraging more people to cycle, freeing up road space for those making journeys for which the car or bus is the only sensible option |
| Brighton & Hove's cycling strategy | Maximise the role of cycling as a transport mode, in order to reduce the use of private cars, improve health and reduce social exclusion; Develop a safe, convenient, efficient and attractive transport infrastructure which encourages and facilitates walking, cycling and the use of public transport and powered two-wheelers, and minimises reliance on, and discourages unnecessary use of private cars |

### *1.3.3 Development of Logical Frameworks for the different types of areas*

On the basis of our desk research and targeted interviews, we developed a Logic Model for each of the five areas, to distinguish the specific objectives of each programme and the related outputs, outcomes and impacts. In addition to the five 'focus' areas, we also prepared logic models for the following cycling infrastructure programmes:

- HS2 corridor (Brackley-to-Buckingham)
- Leeds and the CityConnect programme
- Sheffield and the South Yorkshire Cycle Action Plan
- Brighton & Hove's Cycling Strategy
- Kingston's 'mini-Holland' project
- Norwich and Cycle City
- Hillingdon Uxbridge Cycle Scheme

All of these Logic Models are presented in Appendix C for reference. The Logic Models were used to help define a menu of expected benefits, and in particular the spectrum of wider impacts. Note that economic impacts are not prominent in the rationale for any of these five schemes.

Table 2 compares and contrasts the balance of programme objectives for each of the five areas. The analytical table is sorted, in descending order, by the degree to which each objective type is a primary or secondary objective (or not an objective). It is immediately clear from the analysis that all five programmes have targeted reduced congestion as a primary objective. It is also evident that all five have some level of interest in improving the safety of cycling, generating positive health outcomes and improving accessibility.

There is more variable interest in the three other objective categories identified, with the overall profile reflecting the particularities of each of the five schemes. For example, the bid for Kingston-upon-Thames mini-Holland does include 'absenteeism' or 'time-saving' as a specific objective. The HS2 Brackley-to-Buckingham plan focuses on increasing cycling among non-cyclists, by creating traffic-free routes (safety) and generally improving the attractiveness of the area, which resonates most strongly with safety, health and accessibility. There is no specific mention of improved journey times anywhere in the programme documents, reflecting the focus on utility and leisure.

Programme documentation gives some attention to wider social benefits, and especially the anticipated improvements in the health of citizens resulting from a more active lifestyle. There are also references to improvements in the attractiveness of the areas where investments are being made, and the potential benefits for local people and possibly visitors.

Table 2: Comparison of five cycling programmes' principal and other objectives

| | Brackley and Buckingham | Leeds-Bradford | Sheffield and South Yorkshire | Kingston-upon-Thames | Brighton and Hove | Star Count |
|---|---|---|---|---|---|---|
| **Decongestion ❖** | ** | ** | ** | ** | ** | 10 |
| **Safety** | * | ** | * | ** | ** | 8 |
| **Health ❖** | * | * | ** | * | ** | 7 |
| **Accessibility** | * | ** | * | ** | * | 7 |
| **Journey Ambiance ❖** | ** | - | - | ** | ** | 6 |
| **Time-savings ❖** | - | - | ** | - | * | 3 |
| **Absenteeism ❖** | - | - | * | - | - | 1 |
| **Star Count** | 7 | 7 | 9 | 9 | 10 | |

Key: ** = principal objective; * = additional objective; - = not specifically indicated as an objective of the strategy/programme
❖ Indicators that are part of the WebTAG principles for active travel schemes

*1.3.4 Interviews with programme managers and cycling experts*

In order to confirm the Logic Models and to refine our understanding of the programmes we organised a series of semi-structured interviews with programme representatives, which allowed us to:

- Gather additional (unpublished) information about each of the schemes and about pre-existing levels of cycling in the areas
- Better understand the kind of performance targets that have been set, the choice of objectives (economic, social, health, etc.) and key performance indicators (metrics) they are working with as well as a brief overview of their monitoring activities
- Better understand the current evaluation plans and ambitions to track policy outcomes and measure impact of schemes on various kinds of benefits
- Gauge interest in evaluating wider social and economic impacts

At present, the focus of these programme evaluations is on the operational level and the more direct effects of the investments. Social and economic impacts are not a primary focus,[6] and while there is interest in measuring those wider effects, there is much greater interest in developing metrics, tools and reference data for their more immediate objectives (there are in fact several other DfT initiatives concerned with providing advice on how to improve measurement of these more immediate outputs and outcomes).

[6] Sustrans has a long track record in monitoring and evaluating cycling interventions and frequently works on measuring the effectiveness of a wide range of cycling interventions. As part of its mandate for national and local governments, Sustrans is engaged in preparing a broad range of policy and impact case studies. However, these studies focus on output and outcomes of cycling interventions rather than on measuring wider economic and social impacts. On occasion, Sustrans commissions social and economic impact assessments and otherwise has an interest in health, congestion and air pollution.

Several interviewees said it would be beneficial to have a tool that is specifically designed for the evaluation of investments in cycling to complement the tools available for the evaluation of other modes of transport, to better capture particular nature of cycling interventions.

It was noted by one contributor that the lack of evidence on the economic and social benefits of previous cycling interventions had weakened the implementation of cycling interventions in the past.

Overall, interviewees agreed that the creation of an evaluation toolbox for cycling would be a valuable means by which to gather more and better evidence for internal communications (e.g. business case development) at local councils, communication with potential investors and for communication with the wider community of stakeholders. A wider set of recommendations is presented in Appendix A.

*1.3.5 Identification and selection of relevant indicators and data sources*

On the basis of the information collected, we developed comprehensive lists of possible indicators for both programme outcomes and impacts. In policy evaluation, outcomes refer to the direct effects of the programme on target beneficiaries, while impacts refer to the effects on the wider population including those individuals that are not direct beneficiaries[7].

As a case in point, the Leeds-Bradford Cycle Superhighway will create a segregated cyclepath (the programme output) that is expected to improve the safety of cyclists using the new infrastructure, as compared with safety levels of the pre-existing provision and resulting in proportionately fewer accidents and injuries involving cyclists (outcome). There are other outcomes expected to follow from the introduction of this greatly improved provision, beginning with an increase in the proportions of the two cities' residents that cycle, whether for commuting or utility purposes. The impacts of the cycle superhighway are rather more far-reaching and ambitious and include possible improvements in the economic opportunities for Bradford's citizens – through improved affordable access to the larger and more economically dynamic Leeds metropolis – and improved economic development in Bradford.

The indicators are intended to capture the degree to which the cycling interventions have a long-term effect on the target beneficiaries and impact on the wider community (cyclists and non-cyclists).

Consideration of the five programmes' various outcomes and impacts reveals an important temporal dimension, which will need to be taken into account with any evaluation. In general terms, the programme output (new or improved infrastructure) is delivered within several months, or a few years for the larger and more complex schemes, while the programme outcomes (e.g. increased levels of cycling) will tend to develop over a period of one or two years, while some of the wider socio-economic impacts can be expected to unfold over a longer period still. The timeframes may differ across impact types too: the economic gains to the local economy that follow a substantial increase in overall levels of cycling should be realised in a broadly similar period to the increase in cycling levels while the impact on the community's overall health may not reveal itself for several years after the creation of the new infrastructure. The beneficial effects of a more active lifestyle on the prevalence of type II diabetes or coronary

[7] This terminology is sometimes used with a different connotation. Some guidelines state that the difference between 'outcomes' and 'impacts' mainly lies on the time it takes for potential positive effects of an intervention to materialise. Under this approach, 'outcomes' is used to denote short to medium-term effects and 'impacts' to denote longer-term effects.

disease or COPDs could take many years to reveal themselves among the overall population, as the increase in cycling is likely to be concentrated on those age groups that are 5-10 years away from the peak period of risk for these chronic conditions, as people move into middle age.

For practical reasons, individual cycling infrastructure schemes tend to emphasise the achievement of programme outcomes, rather than wider socio-economic impacts, for example, promising to reduce congestion or increase tourism and visitors. However, our interviews confirm these outcomes are understood as having potentially important impacts on public health (e.g. reduced traffic congestion helping to lower NOx emissions, improve air quality and reduce the incidence of respiratory disease) or the local economy (e.g. improved cycle access and parking encourages residents to stay local; while improved environment and reduced congestion can attract more inward visitors spending money). It is also clear that individual programme outcomes may contribute to the realisation of more than one type of social or economic impact (e.g. an improvement in the volume and quality of a city region's cycle network can produce health benefits from more active lifestyles, economic benefits from encouraging people to stay local and distributional benefits through more and better affordable access to the greater metropolitan area).

*1.3.6 Approach to reviewing literature*

There is a growing body of research internationally that explores the costs and benefits of public support for cycling[8]. The majority of studies focus on establishing the short-term gains of cycling interventions, while a small minority seek to assess the effect of cycling interventions on specific economic and social aspects. We have borrowed from this diffuse literature to provide a more comprehensive overview of the options available to assess economic and social impact of investment in cycling infrastructure.

We identify a range of preferred measurement options by considering, in the first instance, the degree to which different methodological approaches are likely to be robust when applied to the kinds of infrastructure investments under consideration here. We have also given some thought to a series of more practical issues, such as the amount of primary data collection that may be required, the likely time taken for impacts to be seen, implementation costs, in order to come to a final recommendation as to the most suitable methodology.

We have used the literature to expand on the methodological issues associated with the measurement and attribution of net effects within each of eight reasonably discrete types of impact. The eight impact types were derived from our review of the five selected infrastructure strategies and programmes, described above, and are shown in the table.

[8] Stantec Consulting (2011) Vancouver Separated Bike Lane Business Impact Study. Report dated July 20 2011; Shiff et al. (2013) Bike Lanes and Housing Prices. Report to Commerce 407: Real Estate Economics. Shanghai University of Finance and Economics; Cambridge econometrics (2014). Measuring the Gross value Added of cycling and walking projects

Table 3: Overview of key impact categories

| Impact category | Description |
|---|---|
| Expanding the local economy | Cycling infrastructure encourages residents to shop locally to a greater extent |
| Better cities and neighbourhoods:<br>• output / employment<br>• rental income | Cycling infrastructure improves neighbourhoods through better connectivity, improved environments and more dynamic local economies |
| Decongestion and improved connectivity: labour market impacts | Cycling infrastructure reduces congestion and improves connectivity within an area bringing benefits to local labour markets |
| Social inclusion: access to key services | Cycling infrastructure reduces congestion and improves connectivity within an area bringing benefits to local labour markets |
| The cycling economy:<br>• output / employment<br>• designers, engineers and contractors | Cycling infrastructure investments will boost the local cycling economy |
| Health impacts: increased physical activity | Cycling infrastructure increases the proportion of citizens that exceed the Chief Medical Officer's guidelines on regular physical activity and thereby improving health and wellbeing |
| Air quality | Cycling infrastructure supports modal switching, improves air quality and reduces the proportion of citizens suffering from respiratory disease |
| Absenteeism | Cycling infrastructure supports modal switching among commuters and improves the general health and wellbeing of the workforce and reduces days lost on unplanned absences |

For each of these strands it is possible to discern socio-demographic and distributional effects of cycling interventions, such as the effect of a programme on encouraging non-cyclists to embrace a more active life-style, on different age groups, on the male/female population, on populations with different income distributions, etc. For example, the health outcomes of cycling interventions will differ substantially across age groups.

### *1.3.7 Development of an evaluation framework*

The remainder of this document discusses the methodological requirements and data availability for each impact type in turn, before concluding with a proposal for an evaluation framework that encompasses each economic and social impact. The framework is intended to help guide future evaluations in assessing the impact of any cycling infrastructure programme. As such it offers some flexibility in terms of both the scope of the research and the various objectives of specific infrastructure programmes and budget.

# 2. Cross-cutting evaluation issues

## 2.1 The challenge of achieving attribution

One of the most challenging aspects of any evaluation is to be able to demonstrate a credible and robust causal link between an intervention and the final 'observed' impacts.

That is to say, to be able to (i) discern the extent to which any positive change in the desired economic and social impacts can be attributed to the policy or programme under review and to (ii) estimate the size of the effect that is wholly attributable to the intervention. This attributable impact is sometimes referred to as the level of 'additionality' of a policy or programme.

The robust assessment of the attributable impact is challenging for several reasons:

- Cycling infrastructure investments are non-random. An intervention is targeted on specific areas where it is judged to be most useful and its design will in turn reflect the particular needs of a given settlement or topography. It is also common for investments to be made in areas where further economic growth is expected, and the infrastructure seeks to exploit or otherwise facilitate that potential. There is therefore a pronounced risk in an impact evaluation of confounding the realisation of (externally driven) growth with the provision of the new infrastructure
- Causality may be bi-directional. Cycling infrastructure may lead to economic growth, but equally economic growth may lead to expansion through inward migration and an increase in the working population and cyclists
- Infrastructure programmes tend to produce multiple impacts that unfold over an extended period of time, which means evaluators must research several different types of impacts some years after the commissioning of the new infrastructure and possibly at several points in time to account for the different time taken for impacts to be seen, across different impact types (e.g. economic versus health-related effects)

There are several established evaluation methodologies available to control for or minimise the sorts of challenges and biases referred to above and to help cope with the non-random nature of cycling interventions. An overview of those different methodologies, including a presentation of the strengths and weaknesses for the evaluation of cycling infrastructure, is presented in Appendix E.

## 2.2 Measuring net impact

There are other measurement challenges associated with the need to measure 'net impact,' whereby the quantum of additional attributable impact must be adjusted up or down to take account of changes triggered in the wider economic system. There are two issues that appear to be particularly prevalent among cycling infrastructure schemes:

- Displacement: the extent to which positive (economic) effects in one area are displacing economic activity from another contiguous area, instead of creating wholly new economic activity in the overall system. Take for example an increase in footfall that is associated with improvements in cycling infrastructure. A robust study will take into account the extent to which an increase in footfall and expenditure in one local area is driven by equivalent reductions in footfall and expenditure in one or more other areas within the same city (see also Section 3.2).
- Leakage: the extent to which a given impact has materialised outside of the area of interest. For example, an increase in cycling is likely to increase demand for new bikes and servicing,

and while that may expand the local cycling economy in some degree (through local retailers and repairers), some of the benefit will be derived by online retailers based in other regions or countries and overseas manufacturers (the UK has a very small bicycle manufacturing base) (see also Section 3.6)

In most cases, it will be rather challenging to arrive at an accurate quantitative estimate of displacement and leakage, however, even where definitive measurements prove to be infeasible, the issues must be addressed, at least in qualitative terms, as part of the narrative of the evaluation or final evaluation of impact.

## 2.3 Spatial definition of treatment areas

Cycling infrastructure investments are made in a wide range of geographies, and there will be a need to give some thought to the definition of the so-called, 'treatment' area.

Deciding upon the unit of analysis is important for defining the comparison areas and also the data collection strategy.

This is partly a question of form, as to whether the infrastructure might best be described as a network extending across a large geographical space, or the improvement of a single major intersection or terminus, or a linear route connecting multiple places. Many cycling investments are linear developments that extend across territorial boundaries, and it can be challenging to define an appropriate catchment area(s) where a majority of the scheme's impacts may be anticipated (e.g. Leeds-to-Bradford cycle superhighway). The areas can be more or less extensive. A good example of an extensive area is the planned investments to construct the cyclepath between Brackley-to-Buckingham.

In other cases, local authorities are making multiple investments throughout a city or region to improve the overall connectivity of the area, which again can look very different from one scheme to another (e.g. Kingston or Brighton & Hove).

The challenge of variable geometry is compounded by the geographical 'smallness' of the schemes and their concordance with existing data sources and the spatial or territorial units they work with. Within the UK, official statistics work within two related classification systems, which are the Nomenclature of Territorial Units for Statistics (NUTS) and the local administrative units (LAUs). The NUTS areas are defined by Eurostat and are fairly granular, with NUTS 3 being the lowest administrative level, comprising for example counties and unitary authorities. The UK's LAU system adds a further level of detail to this, with LAU Level 2 encompassing data on more than 10,000 electoral wards across the country (these are amended annually to reflect administrative boundary changes). Unfortunately, the majority of the official data sources of relevance to the issues at hand here are based on sample surveys that are statistically robust at the national and regional levels. They do not have sufficient data observations to be used reliably at the level of a local authority district or electoral ward, which is the kind of geographical granularity that is necessary for the evaluation of cycling infrastructure. The few surveys that do have the requisite detail (e.g. UK Census) tend to be carried out very much less frequently, which brings its own challenges.

In practice, each impact evaluation will need to take a view on the most appropriate definition of the administrative geography, seeking a balance between choosing a large enough area to encompass the new infrastructure, while trying to avoid such a large geography that the anticipated impacts will be very much harder to detect within the larger system and very much more likely to be affected by external factors. The choice will also be contingent on the scale of the investment too.

Finally, the data concordance issues have led us to conclude and recommend that any impact evaluation will need a major programme of primary research.

## 2.4 Selection and use of comparison areas

We have recommended the use of comparison areas as a centrepiece of our research methodology for every impact category, in order to attribute and quantify an investment's net effects.

The selection of appropriate comparison areas will need to be done by local authorities and their evaluators on a case-by-case basis, given the fact that each infrastructure programme will have its own functional and architectural features and will be implemented in a particular geographic setting that may not be easily or automatically matched with comparable areas (e.g. topographical, infrastructural, demographic and industrial factors) without the equivalent cycling infrastructure. There may be a case for developing a different control strategy for different impact categories, reflecting the nature and geographical particularities of for example improved social inclusion through access to key services as compared with more attractive neighbourhoods and economic regeneration.

In most cases, we have recommended that impact evaluations should include two or more comparison areas within their study design, in order to cope with the difficulties of the matching process. We have furthermore recommended selectively including targeted research within the larger city or region to test for issues like intra-regional displacement.

The selection process will need to be carried out ahead of the commissioning of the proposed new or improved cycling infrastructure, and will also need to consider planned future investments in an effort to avoid choosing comparators that are expected to benefit from substantial infrastructural investment of their own in the near future.

## 2.5 Accounting for complementary developments

In most of the cases we examined, we found several other policy initiatives and complementary developments that would be expected to have some effect on the kinds of impacts of interest here. That could be an inward investment by a major multinational or the construction of a new railway station or the creation of a new public health campaign locally to encourage more active lifestyles. These local developments will also take place against the backdrop of national or international developments, whether that is changing oil prices or revisions to the corporation tax rate.

In preparation for any impact evaluation, the local authority or evaluation team will need to research the very many external factors that may have a bearing on the effects of the investment. This will always need to be specific to the time and place, and should produce a longer rather than a shorter list of possible external influences. Each of those factors will need to be described and the potential kinds of influence characterised and a decision taken as to whether and how it should be controlled for within the overall impact evaluation methodology. This will be a narrative based, qualitative exercise in the main, however, for some of the bigger 'risk' factors, it is likely the evaluators will need to bring the variables formally within the study design.

One of the other effects that funders may want to disentangle, is the contribution to measured impacts that may be attributable to one cycling infrastructure investment as compared with another in the same area. This is a major methodological challenge that will not be overcome easily or definitively without very costly research. The pragmatic solution will be a twofold response:

- Clarity about the primary objectives of different cycling schemes, so that major investments in new junctions, for example, may emphasise safety and public health issues, while more linear schemes connecting different areas of the city may focus on economic and employment effects. In time, it may be possible to develop some normative descriptions or labels for types of schemes, which make clear that this kind of intervention will be used to deliver on one or two types of economic impact and not others.
- The other practicable response to dealing with such portfolio effects is to use the results from city-wide monitoring systems – and evaluations of each scheme's outputs and outcomes – to 'claim' a certain proportion of measured impacts. For example, if one cycling scheme is shown to have catalysed inward investment by a great of new businesses, where other parallel cycling investments are found to have had a more limited effect on business formation, one might reasonably associate the majority of new business formation in the area with the scheme that had generated the greatest proportion of this kind of outcome

## 2.6 The need for baseline and monitoring data

Any impact evaluation will be greatly strengthened by a before and after analysis, with a thorough baseline analysis being carried out during the preparatory phase of the development programme, collecting information about every type of impact foreseen. In all cases, the baselines and evaluations will need to include comprehensive data collection on levels of cycling (which relates to the scale of outcomes foreseen) and ideally some view on the quantum and quality of new infrastructure (objective measures of features and capacities, but also possibly perception studies to understand users' and prospective users' views of safety, directness, comfort, etc.).

In all cases, the cycling infrastructure investments we looked at will take several months or years to progress from the planning stage to commissioned facilities, and most are expected to produce changes in levels of cycling over a period of time, with the effects on local businesses, tourism, congestion, air quality, and so on all tracking those changes in behaviour. The desired impacts, in terms of improved economic dynamism or improved public health, will unfold over even longer periods. This temporality means impact evaluations need to be carried out at several points in time, ideally, and not just 6-months before commissioning and 6-months after. In many cases, it will be necessary to look again at the situation after a year or two and again 3-5 years later. It will also help greatly, if the funders have set up a continuous monitoring system to, track performance over time, for 5-10 years, if not permanently. The impact evaluation process will benefit greatly from the quality of the monitoring process.

While this paper focuses on impact evaluation, it should be noted that each of the proposed impact evaluation methodologies assumes there will be an underpinning monitoring and evaluation process to provide the necessary reference data on programme outputs and outcomes. If there is no established view of an investment's more immediate achievements, this will need to be included within the impact evaluation process, which will add time and cost, and weaken robustness.

# 3. Types of economic and social impact and evaluation approaches

## 3.1 Introduction

This section provides recommendations for what is effectively an evaluation framework for each of the eight impact categories listed in Section 1.3. For each category we provide:

- An overview of the impact category along with a description of the programme theory or chain of cause and effect (Logic Model) that link the improvements in cycling infrastructure with the impact category under description
- The particular research questions that should be used to inform the impact evaluation
- The suggested metrics to address those research questions and a brief overview of potential data sources (more information on data sources is provided in Section 4)
- Advice and recommendations as to the most robust evaluation methodology and in some cases the best available affordable alternative. We have graded these methodological options using the 5-point Maryland Scientific Methods Scale (SMS),[9] where level 1 on the Maryland Scale is the minimum acceptable standard (e.g. a before and after evaluation of the target beneficiaries) all the way through to Level 5, the 'gold standard' (e.g. explicit randomisation into treatment and comparison groups). The non-random nature of most cycling infrastructure investments largely prohibits the use of Level 5 methodologies
- Advice on any relevant time considerations and the expected scale of impact and ease of measurement in different settings

We finalise each sub-section with a conclusion on the feasibility of measuring impacts.

Table 4 provides an overview of the information provided in this section and Section 4 (Data Sources), with each row presenting a broad impact category and our suggestions on performance measures (metrics), and secondary data sources.

Table 4: Overview of key metrics and data sources by impact category

| Impact category | Metrics | Data sources |
|---|---|---|
| Expanding the local economy | • Change in footfall at retail and leisure outlets<br>• Change in trade for businesses<br>• Creation of new businesses<br>• Attraction of visitors | • Traffic counts<br>• Business surveys<br>• Intercept surveys (i.e. surveys with visitors or pedestrians)<br>• ONS Retail Sales Inquiry |
| Better cities and neighbourhoods:<br>• output/employment<br>• rental income | • Changes in property prices<br>• Changes in rent<br>• Change in population size<br>• Inward investment and new business formation | • Land Registry<br>• Estate agents and mortgage providers<br>• UK national population census / ONS estimates on population |
| Decongestion and improved connectivity: labour market impacts | • Change in average journey times<br>• Modal switch to cycling<br>• Change in hard to fill vacancies<br>• Change in unemployment levels | • ONS vacancy survey<br>• UKCES employer surveys<br>• ONS reports on unemployment |
| Social inclusion | • Change in average travel time for access to key services | • DfT accessibility statistics for essential services |

[9] www.le.ac.uk/oerresources/criminology/msc/unit8/page_05.htm

| Impact category | Metrics | Data sources |
|---|---|---|
| The cycling economy:<br>• output / employment<br>• designers, engineers and contractors | • Sales / employment among civil engineering contractors for cycling infrastructure<br>• Sales / employment among local bike shops<br>• Sales / employment among manufacturers of bikes and components<br>• Sales / employment among cycle hire / coaching / leisure businesses | • ONS business inquiry<br>• Trade statistics<br>• CTC cycling charity<br>• VisitEngland annual GB Travel Survey (including information on 'cycling' tourism) |
| Health impacts: increased physical activity | • Change in the proportion of citizens exceeding the CMO's advice on physical activity<br>• Change in the incidence of and costs associated with diabetes | • Hospital Episodes Statistics (HES)<br>• Data on GPs from Quality and Outcomes Framework (QOF) |
| Air quality | • Change in levels of NOx and particulates<br>• Change in proportion of citizens with respiratory conditions<br>• Change in the cost of treating respiratory conditions | • Air Quality monitoring data from UK Automatic Urban and Rural Network (AURN)<br>• Hospital Episodes Statistics (HES)<br>• Data on GPs from Quality and Outcomes Framework (QOF) |
| Absenteeism | • Changes in days lost by employers due to sickness absence among staff<br>• Change in psychological wellbeing among employees | • Labour Force Survey<br>• Understanding Society Survey<br>• Hospital Episodes Statistics (HES) |

## 3.2 Expanding the local economy

### *3.2.1 Overview*

The provision of new cycling infrastructure has been shown to have a positive effect on the local economy, in part by increasing footfall in retail and leisure outlets in the areas close to the new infrastructure.

Studies suggest changes can be expected in terms of the volume of people entering a shop or café in a given area and also the amounts they spend (average value transaction).

Where studies find increased footfall, this seems to mostly reflect an increase in the number of generated trips (the ease of cycling with the provision of new infrastructure encourages existing cyclists to make additional utility trips or some non-cyclists to cycle rather than walk or drive). According to Clifton at al.[10] cyclists tend to spend less per visit, but make more visits than visitors travelling by other means. Clifton et al. also report positive economic impacts of new cycling facilities in attracting recreational cyclists, both tourists and visitors who come to the area specifically for the improved cycling facilities and local recreational cyclists. Studies suggest the results are not always positive however, and appear to be contingent on scheme design and pre-existing conditions, with some investments having been found to reduce footfall as a result of reduced parking and increased congestion for drivers. Certainly negative impacts were found in a study in Vancouver,[11] though the short timeframe from implementation to the evaluation (6 months) meant there had been limited opportunity for businesses to adapt to the new 'cyclist' markets. Nevertheless, there is at least the potential for substantial additional retail activity within an area, as a result of new infrastructure and upgraded facilities. Hence clearly additional evidence in this area is required.

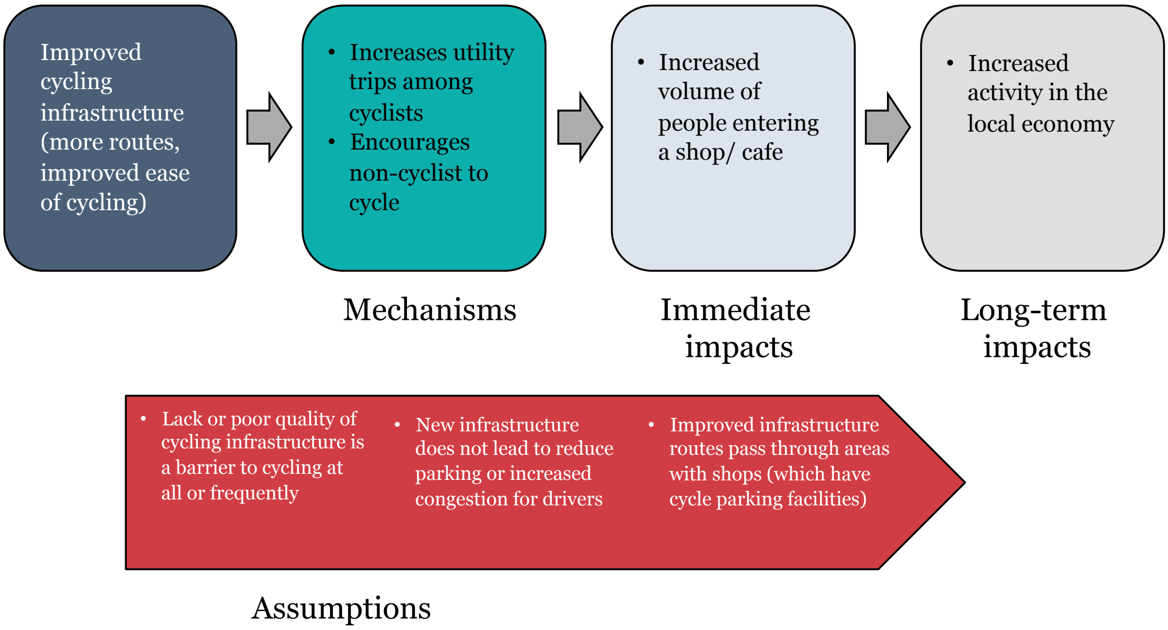
Figure 1 shows a simple schematic representation of the Logic Model that links the programme output ('improved cycling infrastructure') with programme outcomes and longer-term impacts,

[10] Clifton, Morrisey and Ritter (2012) Business Cycles, Catering to the Bicycling market. TR News 280 pp26-32.

[11] Stantec Consulting (2011) Vancouver Separated Bike Lane Business Impact Study. Report dated July 20 2011.

as well as the assumptions that lie behind that expected chain of cause and effect. In this instance, we assume that more and better cycling infrastructure will increase levels of cycling and, assuming the new infrastructure has good connections with local shops and restaurants, increase the numbers of people that choose to shop locally rather than driving to more distant retail outlets or other destinations. All things being equal, we would expect this intensification to increase activity in the local economy. There are various possible confounding factors, including the potential for new cycling infrastructure being implemented in busy urban environments reducing facilities and creating bottlenecks in the wider transport network and causing increased congestion for all parties and actually reducing activity in the local economy. There is also the potential for displacement of activity from extra-urban and rural locations, with no effective net increase in the level of activity within the wider regional economy.

Figure 1: Logic Model – Expanding the local economy




*3.2.2 Research questions*

An evaluation aimed at understanding and testing this type of impact should consider the following research questions:

- Have the improvements in cycling infrastructure led to an increase in footfall in the local area?
- Have the improvements in cycling infrastructure led to an increase in economic activity in the local economy?
- To what extent is any observed change in economic activity in the local economy attributable to the new cycling infrastructure?
- To what extent is the change in footfall and expenditure in the area around the new cycling infrastructure accounted for by equivalent changes in footfall and expenditure in one more other areas within the city or wider metropolitan area?

### *3.2.3 Metrics and data sources*

The principal metric would ideally be local Gross Value Added (GVA), derived from an estimate of the annual net increase in retail sales within the economy that is attributable to the investment in new cycling infrastructure.

We can envisage two specific metrics that capture the impact of improvements in cycling infrastructure and its use on local residents, consumers and retail and leisure businesses.

- Change in footfall at retail and leisure outlets adjacent to cycle facilities, and city wide
- Change in trade for businesses located adjacent to cycle facilities, and city wide

These metrics will need to be populated with data from specifically commissioned studies.

There is no national dataset that one might use to distinguish changes in footfall and retail trade at the geographical scale that would be needed in order to evaluate the impacts of even large cycling infrastructure investments. The ONS monthly Retail Sales Inquiry (RSI) has a national sample size of 5,000 businesses, all registered for VAT or PAYE, which is too small to be useful at the level of a single cycling programme or even at a local authority level.[12] The index does however report trends in various retail segments over time at regional levels, which would be a useful source of contextual data, helping to explain some of the trends observed in local retail surveys.

Retail consultancies routinely count footfall (and sales) in their clients' stores, but these are proprietary services with bespoke specifications and the data are confidential. There is substantial development underway in people-counting techniques, using the unique IDs in mobile devices, to dramatically reduce the cost of this kind of performance monitoring and make it affordable to a majority of retailers. It is conceivable that this technological development could be piggy-backed by local authorities in the not too distant future, but for now, more traditional survey techniques will continue to be required. The use of mobile devices for tracking will also struggle to distinguish customers' modes of transport, for now at least.

Local authorities already commission surveys and site visits to measure footfall at key points in towns and cities as part of their transport planning activities, and may run similar kinds of research for larger retail developments. However, these surveys tend to be ad hoc in nature and focus on a particular development or planning proposal. The timing, geographical scope and data coverage may not be sufficiently aligned with new cycling infrastructure investments to provide a useful source of secondary data.

### *3.2.4 Robust evaluation approaches*

Expanding the economic output of an area typically requires either an expansion in the local population or the retention and attraction of sales income that would otherwise have been expended in another region or country.

#### ***Primary data collection***

Primary research will be necessary to detail the impact of improved cycling infrastructure on the local economy. Such primary data would include:

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[12] http://www.ons.gov.uk/ons/about-ons/get-involved/taking-part-in-a-survey/information-for-businesses/a-to-z-of-business-surveys/monthly-business-survey--retail-sales-index/index.html

- *Footfall:* Footfall counters (and traffic counts)
- *Trade:* Interviews with businesses
- *Footfall and trade:* Intercept surveys with 'consumers'

The surveys would need to be targeted on firstly the streets of primary interest in the immediate vicinity of the new cycling facilities, and secondly in a number of matching comparison areas.

The **count surveys** would focus on both cycling and pedestrian traffic with the automatic counters likely to be able to only measure cycling traffic, though some technologies exist for measuring pedestrian traffic too.

In fact, there are several continuous **automatic cycle counters** (ACC) techniques, which provide direct observation data that can be triangulated against telephone and household interview data respectively13. Pedestrian traffic may need to be measured manually.

The **interviews with businesses** would be used to obtain data (metrics) on business performance e.g. turnover before and after the commissioning of the new infrastructure. Such data are commercially confidential, so there will be a need to convince businesses of the value of participating in the area-wide survey and the fact that the individual data would remain private. In the business survey there would also be a need to obtain information about other possibly confounding factors that might affect business performance: the type of business, what it sells, changes in opening hours, staffing levels, use of new business performance technologies, changes in management, other types of business investment, composition of customers (with a possible focus on cyclists) etc.

Over time, it is likely that businesses in the vicinity of the cycle facilities will change; some businesses will close and new ones will open. Part of this will be due to the natural churn in the local economy and part could be influenced by the cycling facilities – which may alter trade and/or change the nature of the types of businesses that are most profitable. It will therefore be important to monitor changes in the mix of businesses within the vicinity of the cycling facilities, possibly working with the local authorities 'business rates' department to obtain an annualised view of the nature and extent of changes in the area in question as compared with the wider city or region.

Finally, **intercept surveys** are important to identify how 'consumers' have travelled to the locality: by bike, car, bus or some other form of transport. Consumer behaviour can also be elicited through the intercept survey: particularly spend patterns, frequency of visits and purpose of visit. The intercept survey may be implemented using a number of methods, for example face-to-face interviews in the immediate vicinity or through online panels, which sample surrounding areas (Johnson et al, 2014[14]).

### *Accounting for displacement*

The better studies attempt to estimate the 'net additional impact' of new infrastructure on economic activity overall and in particular the extent to which an increase in footfall and expenditure in one local area is accounted for by equivalent reductions in footfall and expenditure in one or more other areas within the same city. In other words, these studies estimate and account for 'displacement effects' within their final estimates.

[13] http://www.urbantransportgroup.org/system/files/general-docs/PTEG%20Monitoring%20and%20Evaluation%20Guidance%20Document%20FINAL.pdf See page 88-91

[14] http://www.greenerjourneys.com/wp-content/uploads/2014/07/Buses_and_the_Economy_II_main_report_july.pdf

Where such controls have been carried out, researchers have found some degree of displacement in the wider economic area with a measurable proportion of 'additional' customers diverting from other areas (e.g. cycle commuters decide to follow a new route to work, cyclists decide to shop in the new location). Understanding displacement effects will be important for future evaluations, and a robust assessment will need to look beyond the city boundaries given the importance of out-of-town facilities and online shopping, both of which constitute large sources of economic output and employment for UK businesses.

***Other relevant considerations***

Increased footfall may benefit certain types of businesses more than others, with smaller retailers, cafés and restaurants tending to benefit to a greater extent than larger centres. Retailers such as supermarkets, may find that an increase in footfall is also accompanied by a reduction in the average value of transactions, resulting from restrictions on what cyclists can carry on their bikes per trip.

It is also likely that journey purpose will have a major bearing on whether an increase in footfall is translated into a positive change for business. It is possible that significant increases in utility cycling could impact negatively on footfall in out-of-town shopping centres, where people are more easily able to satisfy their leisure and entertainment ambitions locally.

It is also important to understand whether the new infrastructure will act as an attractor to an area or simply provide a better thoroughfare encouraging more people to pass through an area en route from one place to another. Clearly, without the accompanying places and spaces to allow people to easily break their journeys, a new cyclepath is less likely to produce increased footfall.

***Attaining different levels of robustness***

The surveys and data described will only lend itself to analysis at the Maryland Scale Level 1 (see appendices). There are likely to be high levels of displacement within the wider economic area in question, possibly attracting 'new' customers from other contiguous areas or even out of town, while also possibly pushing 'existing' customers to make greater use of other locations where it is easier to drive and park.

Comparisons with footfall and trade in one or two comparison areas, that differ primarily in terms of their cycling infrastructure, will give some form of counterfactual giving a more robust evaluation at the Maryland Scale Level 2. The comparison areas should exhibit similar properties in the relevant dimensions as to the study area: namely, demographics, income and importantly the distribution of retail and leisure outlets. More robust evaluations at the Maryland Level 3 would also be possible, but the lack of official datasets that provide comprehensive, time series data would require very much more extensive primary data collection locally and possibly regionally, to derive statistically robust results. The data collection costs may be prohibitive due to the volume of data required.

At the Maryland Scale Level 3, it is likely that a Differences in Differences (DiD) methodology is likely to be most feasible with the 'dose' represented as crow fly distance from the cycling facilities in the before and after situations (see also the discussion below on house price DiD analysis).

*3.2.5 Time considerations*

In order to obtain a robust impact estimate there is a need to commence data collection and or ascertain secondary data availability before the intervention.

The footfall metrics can be collected any time before constructions as they are not expect to start adjusting until (or after) construction begins. Due to the disruption associated with construction, the construction period should be avoided for the surveying and collection of data for these metrics.

One would expect that metrics on footfall would respond relatively quickly to changes in cycling infrastructure. It would be helpful if an initial evaluation could be run say 6-12 months after opening and again after 2-3 years.

#### *3.2.6 Use in different settings*

This approach is likely to work best where the infrastructure investments are wide-ranging and extensive, and sit within a reasonably busy area of mixed use, with plenty of retail and leisure outlets. It is less clear that impact on retail trade would be a worthwhile focus for some of the more linear infrastructure programmes, particularly in more rural areas, which seek to improve connectivity between towns and villages, primarily for leisure cyclists.

#### *3.2.7 Conclusion: feasibility of measuring impacts*

Prior evidence suggests that it is sensible to expect a positive impact of improved cycling infrastructure on the footfall and trade within the catchment area.

Existing data sources do not provide enough information to conduct a robust evaluation; hence primary data collection would be needed. A great deal of effort will need to be dedicated to deal with issues of displacement and the uneven distribution of effects across types of businesses. Consequently, it would be possible to collect some relevant data (through the suggested surveys), but rather costly and difficult to achieve a higher level of robustness.

### 3.3 Better cities and neighbourhoods

#### *3.3.1 Overview*

With regards to the extent that cycling interventions can help to create better cities and neighbourhoods, the hypothesis to be evaluated is that the interventions help to make an area more attractive for people to live in and for businesses to locate to.

Better places and spaces may also reveal themselves in changes in citizens' sense of well-being, however, our focus here is on economic impacts, which are most likely to be reflected in changing demographics and changes in property prices and rents. These latter economic indicators are effectively barometers of 'success' or 'failure' as they represent a capitalisation of benefits into the land price. They are not usually desired outcomes in their own right.

Positive impacts in prices would for example reflect increased convenience and desirability, and negative impacts would possibly reflect the possible diseconomies of noise and pollution from increased motor vehicle congestion in situations where cycle paths reduce space for other road users. Studies suggest there is a risk of major investments actually reducing land prices in the immediate vicinity of the new infrastructure; this appears to be more likely with segregated cycle paths, with the more elaborate schemes tending to be more intrusive. There is a proximity issue here too: a recent study in Vancouver[15] for example found a small but statistically significant positive effect on house prices (+3%) within 0.5 km of one cycling facility (over and above the 30% increase in house prices for the whole city, in the period) and a possibly small negative

[15] Shiff et al. (2013) *Bike Lanes and Housing Prices*. Report to Commerce 407: Real Estate Economics. Shanghai University of Finance and Economics

effect on house prices within 0.1 km of the facility. A review of the economic impact of a second cycleway, which runs through an area in Vancouver with fewer residential properties, suggested there had been a negative impact on prices more generally.

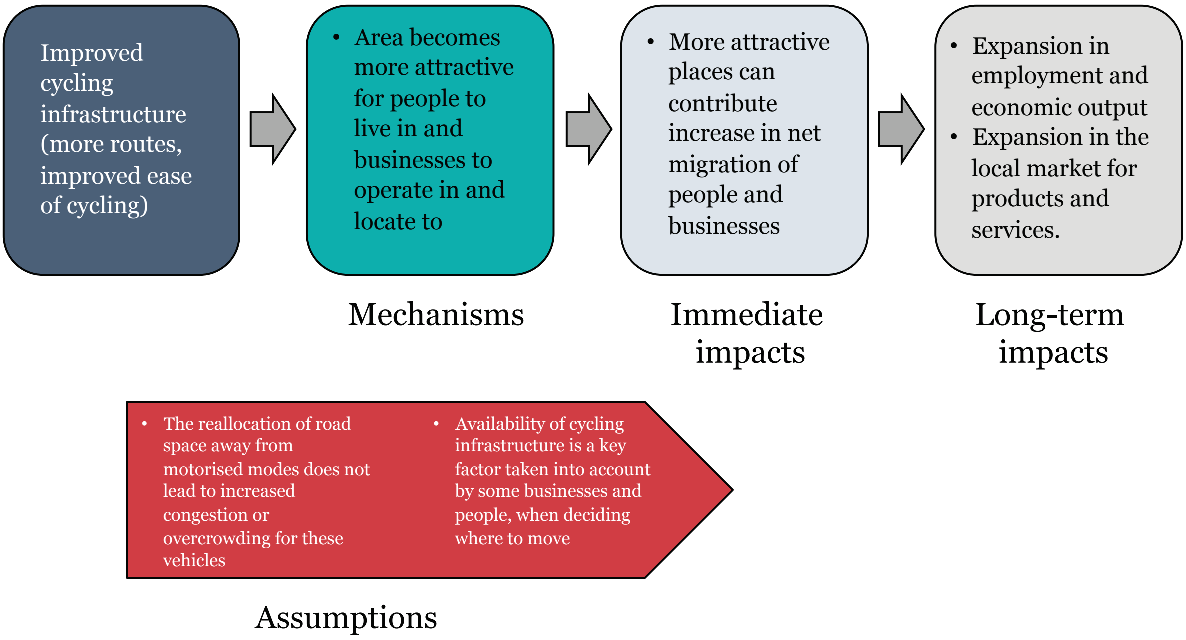
More attractive places can contribute to inward migration of people and businesses – and a reduction in outward migration – thereby contributing to an expansion in both employment and economic output and an expansion in the local market for products and services.

The owners of the various cycling infrastructure programmes considered in our fieldwork do anticipate an improvement in the reputation and attractiveness of their local area, as a result of these investments. There is an expectation that this will help to retain some employers and attract others to the area, excited by the new, improved environment.

There is a sense that bike-friendly cities will encourage or attract certain types of knowledge intensive businesses and start-ups, an idea that is discussed in various case studies and blogs but which has so far not been studied closely.

Figure 2 shows a simple schematic representation of the Logic Model that links the intervention ('improved cycling infrastructure') with the mechanisms that would enable immediate and long-term impacts, as well as the assumptions that lie behind that expected chain of events / results.

Figure 2: Logic Model – Better cities and neighbourhoods




### *3.3.2 Research questions*

An evaluation aimed at understanding and testing this type of impact should be guided by the following research questions:

- Have the improvements in cycling infrastructure increased the attractiveness of the local area as a place to live and do business in?
- Have the improvements in cycling infrastructure attracted new businesses to the local area?
- Have the improvements in cycling infrastructure attracted new people to the local area?

*3.3.3 Metrics and data sources*

There are at least three relevant metrics:

- Changes in property prices or rents, for commercial or residential sectors
- Changes in population size through migration
- Inward investment and new business formation

There are several good sources of relevant secondary data on property prices, population size and new business formation. See Section 4 for a description of those sources.

*3.3.4 Robust evaluation approaches*

There are two approaches that should be considered when measuring the impact of investments in cycling infrastructure on the attractiveness of cities and neighbourhoods.

The two methods can be used with any of the three metrics named in Section 3.3.3, and we explain the approach in a little more detail in the following paragraphs for studying changes in house prices, which is one aspect of the broader set of measures relating to commercial and residential property prices and rents.

- Cross-sectional analysis using the comprehensive data collected by the land registry on house prices, run before and after the intervention. Comparisons between changes in property prices and commercial rents in the vicinity of the cycling scheme and those in the comparison areas would give an indication of the impact on property prices. This sort of approach has often been adopted within transport evaluations albeit for non-cycling interventions (e.g. the Jubilee Line Extension (JLE)[16] and the impact of HS1 in Central London[17])

  It is important to note that a simple cross-sectional analysis on how similar or average property prices vary with distance from cycle facilities would be problematic given the very many other factors that lead to marked unevenness in prices and rents across postcodes within a single city. It is therefore essential to look at before and after data for the area in question and to analyse how any changes compare with price movements in broadly similar comparison areas (see below)

- Difference-in-Difference approach (DiD). The DiD method offers a more robust approach to measure the impact of cycling infrastructure on the attractiveness of cities and neighbourhoods. Good practice examples of this include the Gibbons and Machin study on the impact of the JLE and DLR stations referred to earlier and the Vancouver bike lane study by Shiff et al.[15].With these methods, GIS databases are used to provide crow-fly distances to the nearest cycle path. In the more sophisticated approach as used by Gibbons and Machin the treatment (in their case construction of the JLE and DLR) alters the distance to the nearest infrastructure (in their case, a train station) and this then acts as the explanatory variable in the regression. Shiff et al. in their Vancouver bike lane study use a slightly less sophisticated approach and band residential properties into distance-price bands from the cycle facilities.

[16] Jones, P., T. Eyers, J. Bray, N. Georgeson, T. Powell, J. Paris and R. Lane (2004) The Jubilee Line Extension Impacts Study Main Findings and lessons learnt. European Transport Conference. Available at: http://www.etcproceedings.org/paper/the-jubileeline-extension-impact-study-main-findings-and-lessons-for-future-a (accessed October28th 2012)

[17] Cascetta, E., Pagliara, F., Brancaccio, V. and Preston, J. (2010) Evaluating regeneration impacts of the Channel Tunnel Rail Link. Paper presented at 12th WCTR, July 11-15, Lisbon, Portugal

Again, the methods for robust evaluation could be applied for three metrics named in Section 3.3.3. The most robust evaluation would be achieved using DiD methods and crow-fly distances from the household to the nearest cycling infrastructure as the 'treatment'.

### *3.3.5 Time considerations*

In order to obtain a robust impact estimate there is a need to commence data collection and or ascertain secondary data availability some time before the intervention.

House prices and commercial rents can start adjusting in anticipation of major transport infrastructure being constructed. The baseline for the data for these metrics therefore needs to be around the time that planning consent is granted for the new facilities. The population metrics are likely to be less sensitive to this kind of prior information, and so can be collected at any time before construction begins. Due to the disruption associated with construction, the construction period should be avoided for the surveying and collection of data for these metrics.

Due to the time taken for changes in transport infrastructure to feed through into the economic sphere, and settle down, we would recommend the 'after' evaluation is undertaken 2-3 years after the cycling infrastructure programme has opened.

In terms of timing and frequency of data collection, data should be collected on an annual basis during the same month in either spring or autumn. Otherwise, data could be collected 12 months after the project completion to obtain a short-term impact and then 36 months after project completion to obtain a view of the medium-term impact.

### *3.3.6 Use in different settings*

In principle each of the metrics can be evaluated in any setting: town, city region, London Borough or a rural environment.

In practice however, data limitations will influence the degree to which robust socio-economic impact evaluation is practicable in different settings: single infrastructure programmes implemented over extensive spatial areas (e.g. green corridors) and particularly in areas of lower population density will struggle with the combined effects of diffuse impacts and small numbers of data observations (e.g. numbers and frequency of house sales in the immediate vicinity of the infrastructure investment).

### *3.3.7 Conclusion: feasibility of measuring impacts*

We find that the feasibility of measuring this category of impact is relatively high given the existence of secondary data and the availability of approaches that allow getting closer to the issue of attribution.

## 3.4 Decongestion and improved connectivity: labour market impacts

### *3.4.1 Overview*

In the context of monitoring and evaluating transport infrastructure it is customary to look at the effect of investment in road infrastructure on improving access to city centres: improved accessibility of motorised transport to city centres is seen as a proxy for improved access to labour markets.

Improved cycling infrastructure ought to encourage people out of their cars and on to their bikes, thereby decreasing traffic volumes and improving the overall flow of traffic. In this case, a decrease of motorised transport travel time is attributable to the cycling intervention and can be expressed in monetary terms. The decrease in travel time also includes the time taken to find parking space in the centre of towns/cities. When the flow of car traffic to centres of towns/cities decreases, those that do travel by car will find it relatively easier to find a parking space (unless car parking space decreases or becomes more costly). However, in the event that the space taken up by the new cycling infrastructure impinges negatively on the road infrastructure capacity, one could observe an increase in the level of congestion and an increase in average journey times overall, for cars and public transport. In already busy towns and cities, good master-planning is rather challenging and it is all too easy to create bottlenecks and disconnects that negatively impact all modes of travel.

The degree to which a decrease in the volume of cars leads to an increase in cycling is dependent on the area type, the average number of car passengers, the distance of the journeys travelled, the time of day, alternative means of (public) transport and more. Modal switch is generally greater in the centres of towns and cities where the average distance travelled is lower. Often in centres of towns and cities there is a greater concentration of cycling infrastructure; cycle lanes meet and allow for greater connectivity to various parts of the cities as well as to alternative means of public transport. Removing barriers to cycling and walking can also bring significant extensions of 'travel horizons' to people who either choose not to own cars or cannot afford to.[18]

Ultimately, planners need to be realistic about what can be achieved here. Unlike the cycling scenario in the Netherlands where cycling levels are ten times higher than here in the UK and growing strongly, it should be noted that any demonstrated impact in the UK is likely to be substantially lower: doubling UK cycling levels from 2% to 4% is likely to only remove about 3% of car journeys. This level of mode switching from car to cycling may be too small to bring about noticeable changes in congestion in most areas outside our major cities.

Reduced congestion is not the only benefit of improved connectivity, however. Good cycling infrastructure can make it easier for people to reach a larger number of workplaces without a car as well as widening access to employment opportunities for people on low incomes, who may not be able to afford or justify the higher costs of commuting over slightly longer distances, even by public transport. There is some US research that suggests improved access can be especially important for the less well off, helping people to increase the catchment area within which they can reasonably and economically commute to work.[19]

For employers, having access to a larger pool of prospective workers ought to increase the likelihood that they can fill vacancies more easily and thereby avoid capacity problems and also keep a downward pressure on wages. For the local population, improvements in connectivity should help to improve equality of opportunity among areas within the city or region and across socio-economic groups. Any positive impact on overall employment levels would need to be looked at over the longer term, on the assumption that a more open and dynamic labour market should help to sustain the competitiveness of businesses locally, possibly even attracting inward investment from other areas.

Improving the network of cycle lanes throughout a city should improve the connectivity of each neighbourhood with all other neighbourhoods. This may be especially important for more peripheral and less well-off neighbourhoods increasing the opportunity for citizens in those neighbourhoods to participate in more of the activities that occur throughout the city. Improved connectivity can expand the effective number of schools, workplaces, retail and other services

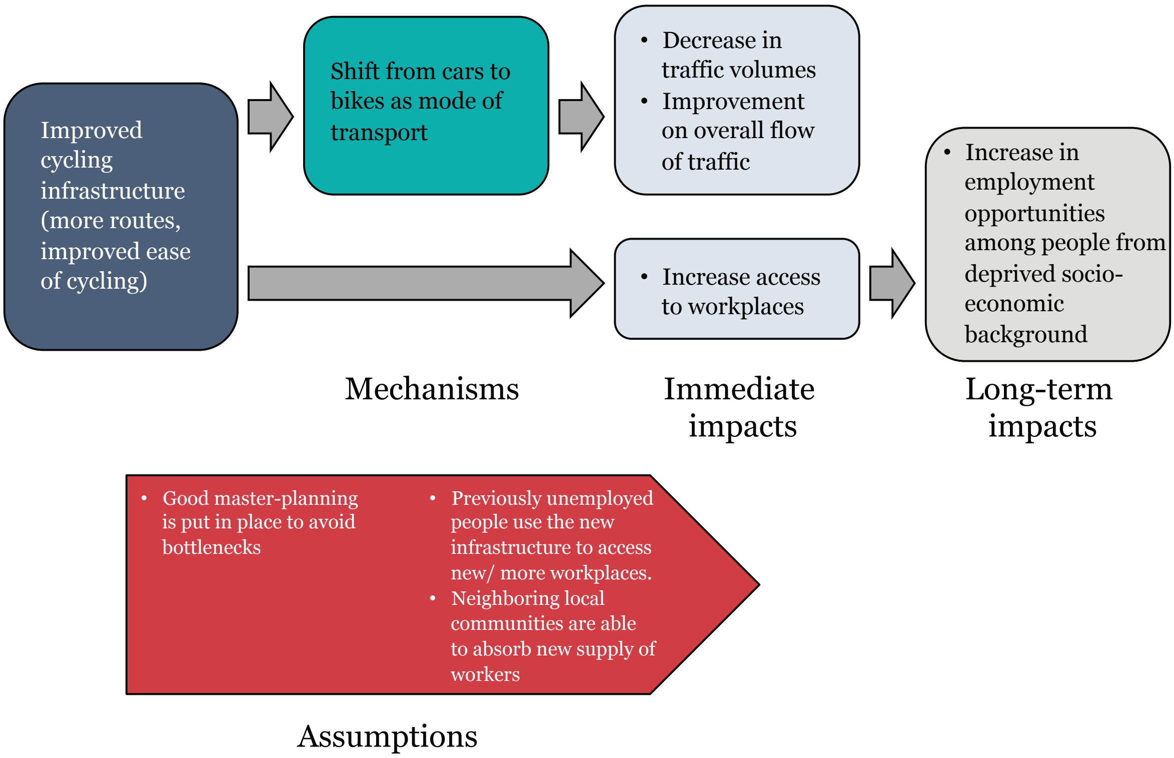
[18] Car ownership may become less clearly correlated with car use: in major cities, it is increasingly common for people to view cars as a tool that one hires rather than owns, whether that is a 20-minute taxi ride or a seasonal day trip. So, while car share schemes or new software aps are improving the efficiency and cost-effectiveness of the use of motorised vehicles, they are not necessarily reducing the numbers of journeys made by car.

[19] US immigrants and bicycling: two-wheeled in Autopia, Michael Smart, Transport Policy Vol. 17 / 3, May 2010, pp 153-159

that can be accessed. In addition, by improving the connectivity of peripheral neighbourhoods to train stations, cycling infrastructure investments can improve access to job opportunities in other locations beyond one's place of residence. Moreover, the benefit of improvements in the flow of traffic is of key interest to those citizens with lower mobility.

Figure 3 shows a simple schematic representation of the Logic Model that links the intervention ('improved cycling infrastructure') with the mechanisms that would enable immediate and long-term impact, as well as the assumptions that lie behind that expected chain of events / results. It assumes that improved infrastructure will cause some level of modal shift from cars and buses to cycling, and that this will reduce car usage and improve overall traffic flows within city regions. This in turn is expected to reduce journey times and improve effective commutable differences, improving connectedness across neighbourhoods and supporting more dynamic labour markets and enhanced social inclusion. There are various confounding factors, including the possibility that new infrastructure may introduce additional bottlenecks or possibly cause people to switch from public transport to cycling and that this may even reduce network efficiency (e.g. reducing bus utilisation levels is unlikely to reduce the number of buses on the roads, while switching to cycling from buses will inevitably require more road space rather than less. Moreover, the presumption of a positive link between improved infrastructure, city-wide connectivity and more efficient labour markets does rely to some extent on the nature of the pre-existing labour market within the city-region.

Figure 3: Logic Model – Decongestion and improved connectivity



### 3.4.2 Research questions

An evaluation aimed at understanding and testing this type of impact should consider the following research questions:

- Have the improvements in existing cycling infrastructure led to a decrease in journey times among commuters?
- Have the improvements in existing cycling infrastructure encouraged a mode shit from motor vehicle to cycling?
- Have the improvements in existing cycling infrastructure reduced vehicular traffic / congestion?
- Have the improvements in existing cycling infrastructure made it easier for employees to reach more workplaces?
- Has this lead to improvements in vacancy rates or/and a reduction in unemployment among certain socio-economic groups?

### 3.4.3 Metrics and data sources

We envisage one main indicator that can (indirectly) capture the economic effect of improved accessibility for individual commuters and a second metric to (indirectly) capture the benefit to local labour markets

- Change in average journey times for commuters, attributable to improved accessibility and a modal switch to cycling
- Change in unemployment levels for selected occupational groups (e.g. lower skill occupations), attributable to improved accessibility to a larger labour market

Data on the decrease in travel time of motorised transport, attributable to a modal switch can be collected using automatic traffic counters (ATCs), while information on unemployment could be obtained from the ONS. See Section 4 for further discussion on data sources.

However, these conventional data sources do not offer enough granularity and additional primary data would have to be collected.

### 3.4.4 Robust evaluation approaches

Robust evaluation would seek to identify the causal relationship between a modal switch from car or bus transport to bicycle transport and the associated improvement in the overall flow of traffic and average journey times.[20]

#### *Monetising the costs of reduced congestion*

Using DiD it will be possible to identify the effect of improved connectivity of cycle lanes to centres of towns/cities on the decrease in travel time of motorised transport. A DiD methodology will allow evaluators to control for the decrease in travel time that is associated with generic changes in travel behaviour. The methodology matches data from a comparison group with data from a treatment group. The comparison group consists of those travelling by car to town/or city

[20] Further exploration of this relation may additionally consider the number of commuters travelling via train *and* cycleways

centres along a route where there have not been any improvements to the cycling infrastructure. The treatment group consists of a matched group of people travelling by car using a route where there have been major improvements to the cycling infrastructure. The methodology determines the percentage change in the travel time of the treatment group that is attributable to the cycling intervention. Using this information as well as the number of transport users it is possible to estimate the benefit of the cycling scheme. For example, a 10% increase in cycling may decrease the unit car travel time by 15%[21]. The benefit of the intervention is dependent on the average travel time and the number of individuals travelling by car before and after the intervention. The cost/benefit of time saved can be estimated using bandwidths (e.g. can be assumed £5 per hour or even £50 per hour).

One caveat for the method is that it requires assuming that, within the period of evaluation, there are no further improvements made to the road network that influence the flow of traffic. If this assumption is violated the methodology will not yield robust results.

The DiD analysis would need to be complemented with a survey designed to capture the degree of modal switch in the area of interest.

***Monetising cost of unemployment***

A robust evaluation will need to carry out primary research, possibly working with local employment agencies / research groups to track the metrics named in Section 3.4.3– before, during, after – for a given location, and for a selection of similar areas that have not benefitted from infrastructure investments.

Those data can then feed into the kind of DiD methodology described elsewhere in this report in order to determine net impacts on unfilled vacancies and local unemployment levels. These can be monetised using the average estimates of the costs of unemployment prepared by labour market economists.[22]

Labour market economists have carried out studies to monetise the costs of unemployment, in terms of the costs to the exchequer for

- Tax income foregone (on wages)
- The cost to provide unemployment and other benefits
- The cost to provide family credits

The annual cost estimates fall in a range of £5K to £10K, depending upon the age of the person and his or her skill levels. Clearly, the costs to the Exchequer will be very much higher for the unemployed that were previously employed in occupations with higher salaries. Longer-term unemployment is however heavily concentrated on younger people and lower skilled occupations, where the costs to the Exchequer (in income tax) are less because of the predominance of low-paid work. These labour market estimates do not include any element for the additional social costs associated with supporting young people affected by long periods of worklessness, and we would expect the total cost to local communities would be greater than the immediate cost of paying unemployment benefits and foregone taxes.

[21] Fietsberaad (2010). Gevoeligheidsanalyse effecten fietsbeleid. Fietsberaadpublicatie 18.

[22] Such as the Commission on Youth Unemployment's 2012 report, Youth unemployment: the crisis we cannot afford).

### *3.4.5 Time considerations*

This approach and methodology is relevant to estimate the short-run effect (1-2 years) of the improvement in cycling infrastructure. Over longer periods of time we anticipate that it will be more difficult to identify a setting with limited additional changes in the wider transport infrastructure, and hence additional impacts on transport behaviour and labour markets.

### *3.4.6 Use in different settings*

The effect of cycling infrastructure on congestion levels and journey times is easier to capture in settings where there is potential for a substantial modal switch. Modal switch is most likely in areas where cars are used to travel shorter distances and congestion levels are quite high, such as in our larger cities. At the same time, the method may only detect an effect where the cycling investment is made in areas where there are a substantial number of potential new cyclists. It is less likely to yield meaningful results in urban peripheries or semi-rural areas with lower population densities.

The impact of improved cycling infrastructure and connectivity on labour markets may be more significant, in that the extension of travel horizons can have a major impact on the size of the addressable labour market for very many employers. The evaluation question would be equally applicable in urban and semi-rural areas, albeit the challenge and cost of running the analysis would be higher in areas with lower numbers of employers and populations and possibly more prominent confounding factors. On this last point, there are examples of single infrastructural investments designed expressly to improve access between previously poorly connected residential areas (of predominantly lower-income households with higher levels of unemployment) and employment clusters (business parks), with a view to improving access to work opportunities for the less well off.

### *3.4.7 Conclusion: feasibility of measuring impacts*

There are existing data sources with relevant information on journey time and unemployment, however, they do not allow for the level of granularity that is needed to disentangle the effect of improved cycling infrastructure on those metrics.

A robust evaluation will require collecting primary data over time and additional estimations can me made using secondary information on, for instance, the cost of unemployment. Hence, the level of feasibility for this category of impact is medium to low.

## 3.5 Social inclusion: access to key local services

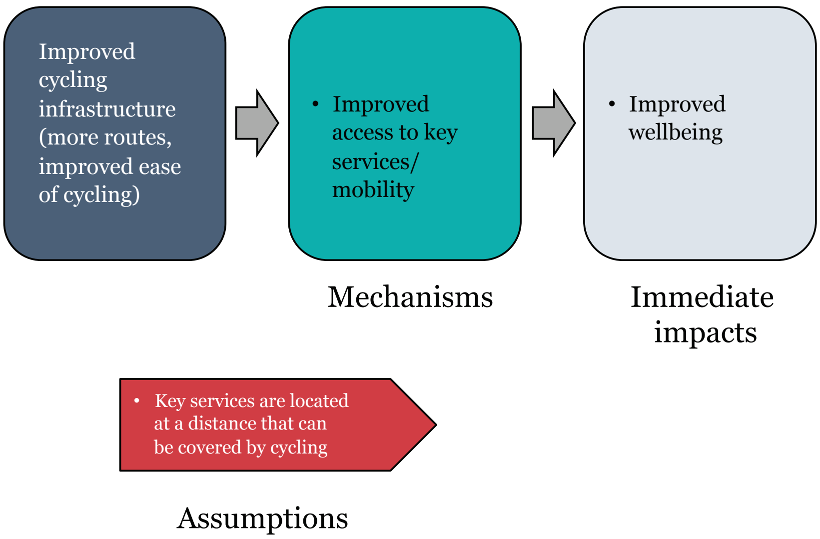
### *3.5.1 Overview*

There is a general sense that access to key local services, many of which are public services (e.g. education, social care, health care), is important in countering social exclusion and poverty. As a result, those services tend to be universal in nature and mostly provided free at the point of use, reflecting a belief that cost is the principal barrier to their use. The ESRC funded Poverty and Social Exclusion (PSE:UK) survey makes clear that while many local services are in theory "universal," both the quality and availability of services can be worse in poorer areas as well as varying between rural (worse) and urban areas (better). Moreover, families in poverty may face additional barriers accessing some services, such as lack of information about services and the affordability of travel-related costs.

Cycling is affordable transport, and a better and more extensive network of cycle paths across a city region should improve access to services for all, and it may be especially significant for the socially disadvantaged living in areas on the periphery of cities and where there may be fewer local amenities or essential services. The cost of buying and owning a bicycle may still be prohibitive for some, and there has been a steady growth in the numbers of charities that have set up local workshops to recycle unwanted bikes so that they can be sold at reasonable prices and re-used and also to provide cyclists with access to the kinds of advice and tools needed to properly maintain one's own bike. Storage remains an issue for many lower income households with bikes tending to need to be kept outside, where they are at increased risk of theft / vandalism and accelerated deterioration from permanent exposure to the British weather. Some of the improved cycling infrastructure schemes include covered shelters in the residential areas linked with the central business districts.

Figure 4 shows a simple schematic representation of the Logic Model that links the intervention ('improved cycling infrastructure') with the mechanisms that would enable immediate and long-term impact, as well as the assumptions that lie behind that expected chain of events / results.

Figure 4: Logic Model – Social inclusion: access to key services




### *3.5.2 Research questions*

An evaluation aimed at understanding and testing this type of impact should consider the following research questions:

- Have the improvements in existing cycling infrastructure led to an increase in cycling among citizens from deprived areas or lower socio-economic groups?
- Have the improvements in cycling infrastructure led to an increase in access to key local services among citizens from deprived areas or lower socio-economic groups?

### *3.5.3 Metrics and data sources*

The DfT publishes annual accessibility statistics, which cover seven essential local services, from employment to primary education to food stores. These statistics are also available at reasonably detailed levels, geographically, allowing trends to be observed and comparisons made all the way down to local authority level (NUTS 3). The principal metric is the 'average minimum travel time' in minutes and by mode of transport.

Unfortunately the data are not sufficiently detailed to allow their use in studying changes over time within a local authority area or among different socio-economic groups.

Notwithstanding this limitation in the published data, the metric used would still be relevant at a more fine-grained level and is a reasonable metric for evaluators to use to examine the distributional impacts of investments in cycling infrastructure. The DfT accessibility data are modelled based on GIS information and actual data on average speeds and public transport schedules. This means that information on accessibility can be cross-references with, for instance, census data with information on distribution of socio-economic groups per geographical area.

*3.5.4 Robust evaluation approaches*

In order to measure the impact of cycling infrastructure on access to services, evaluators would need to consider the extent to which the Understanding Society Household Panel Survey sample adequately covers the area where the infrastructure investment will take place (geographically) and includes the right sorts of information to inform the accessibility metrics (e.g. its questions about access to education and health services). In most cases, we would expect the sample size to be too small and the questions to be too narrow. The PSE:UK survey is also unlikely to be helpful, as it is carried out only intermittently (2012, 1999, 1990, etc.) and with a small sample size and does not include this kind of time-based assessment of access. In some cases, local authorities may have relevant survey data available, but again this will tend to be intermittent and ad hoc.

We found no published studies that have researched this specific question about the potential positive impact of improved cycling infrastructure on access to key services or social inclusion more generally. As such, we are not able to describe past research or comment on the most suitable of the approaches used.

We believe substantial primary research would be necessary in the great majority of cases, and would need to be a large-scale household survey carried out across the city, or rural location, and with some degree of over-sampling in the treatment and comparison areas. As before, there would need to be a baseline exercise and at least one and preferably two post hoc reviews to understand changes over time and sustained effects. There would also need to be substantial effort devoted to gathering data from the populations on a wide range of other demographic and behavioural factors. Lastly, there would need to be work done to characterise / quantify the changes in access made possible by the new infrastructure.

*3.5.5 Use in different settings*

The evaluation of impacts on social inclusion is likely to be most worthwhile where there are multiple infrastructural investments planned, with the intention of substantially improving access and facilities throughout the whole city area, rather than simply improving the cycle links between one part of the city and another.

*3.5.6 Conclusion: feasibility of measuring impacts*

Given the lack of appropriate secondary data we conclude that the feasibility of measuring this impact category is low.

## 3.6 The cycling economy

### *3.6.1 Overview*

The cycling industry is in itself quite a large area of economic activity, with an estimated 3.7 million new bikes sold (£1.62 billion) in 2010[23] and with 2,500 cycle shops across the UK.[24]

Increasing numbers of cyclists can be expected to lead to an increase in the numbers of bikes and accessories sold and an associated boost for local bike shops that will be asked to repair and maintain that expansion in the stock of bicycles in regular use. Increasing levels of cycling may increase sales of replacement clothing and accessories, giving a further boost to the local cycle shops and the wider cycling economy: increased use will mean increased wear and tear, and should benefit both physical and online retailers as well as component manufacturers and UK-based importers.

The total benefit to the UK cycling economy of this expansion in demand will be reduced somewhat by virtue of the fact that the very great majority of new bikes and components are imported, and as such a substantial fraction of the boost in income and employment will be realised in other countries, like China and Taiwan.[25] The modal switch from public or private transport to cycling may also reduce the level of demand for local garages carrying out repair and maintenance of cars and buses, and that kind of displacement would need to be considered in any comprehensive evaluation.

There will be an economic benefit from any cycling infrastructure programme, whereby investments create jobs among designers, engineers and contractors, which according to US research has a stronger local component (added value) than would be the case for larger, more high-tech investments in road or rail infrastructure.

There is also a growing niche within the larger leisure and tourism sector, focusing on cycling (bike parks, cycle hire, guided tours, cycle training, etc.), which was, for example, estimated to be worth more than £358M to the Scottish economy (in 2011). As with manufacturing, leisure and tourism is rather unevenly distributed, reflecting underlying factors, such as ready access to national parks or the existence of bike sharing schemes.

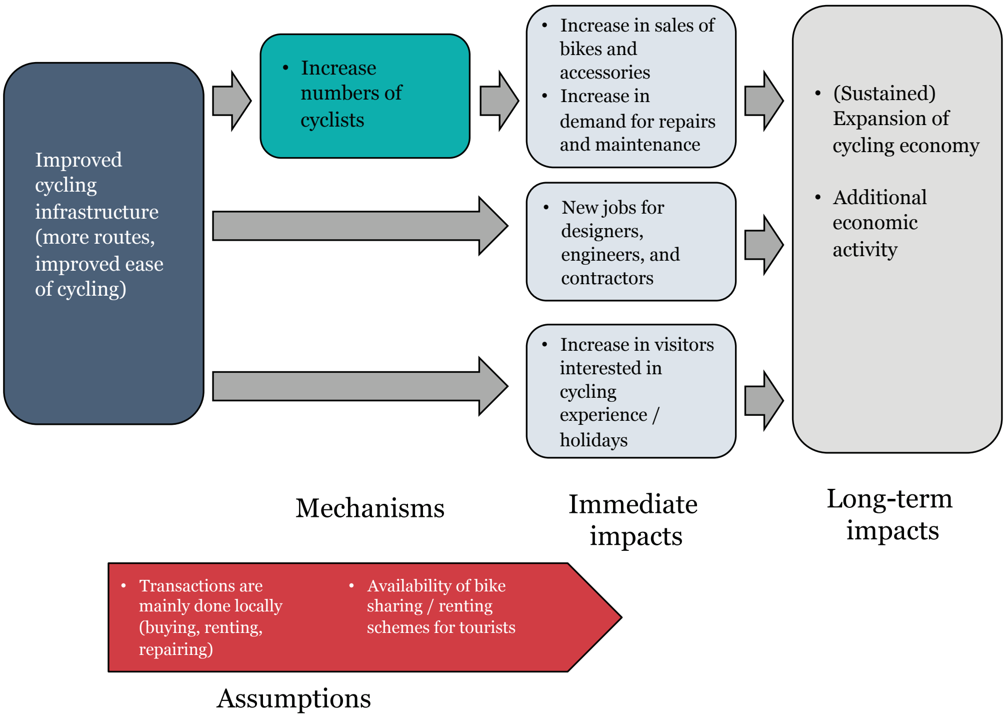
Figure 5 shows a simple schematic representation of the Logic Model that links the intervention ('improved cycling infrastructure') with the mechanisms that would enable immediate and long-term impact, as well as the assumptions that lie behind that expected chain of events / results.

[23] Grous, A. (2011). The British Cycling Economy. London

[24] Association of Cycle Traders. (2012). About the Cycling Experts. Retrieved from http://www.thecyclingexperts.co.uk/the-cycling-industry/opening-a-bike-shop/

[25] Grous (2011) estimates UK manufacturers were responsible for around £50M (c. 3%) of the £1.62 billion sales in 2010 and employed around 900 people nationally

Figure 5: Logic Model – The cycling economy




### *3.6.2 Research questions*

An evaluation aimed at understanding and testing this type of impact should consider the following research questions:

- Have the improvements in cycling infrastructure led to an increase in the number of cyclists?
- Have the improvements led to an increase in the sales of bikes and accessories locally or nationally?
- Have the improvements led to an increase in demand for repair and maintenance and an increase in jobs within bike shops locally?
- Have the improvements led to an increase in the numbers of visitors looking to have a 'cycling' holiday / experience locally?

### *3.6.3 Metrics*

The cycling economy is easily defined, however, it is a relatively small segment of the national economy and as such there are only very limited data reported on a regular basis by the ONS or other official sources.

The UK bicycle and parts manufacturing sector is captured in the related ONS business inquiry, but the sample size is very small.

For instance, the figures show annual sales of around 8,000 units and £2.6M in 2014 (SIC 30923010: manufacture of frames and forks for bicycles); and around £24M for parts (SIC 30923070: manufacture of bicycle parts and accessories). However, the manufacturers data does not fit with the estimates obtained from trade associations. Companies House data shows annual sales of £28M in 2014 for Brompton Bicycles alone.

Small sample sizes appear to be affecting the robustness of the official data on retail as well, and cycling-based leisure and tourism is not separately reported at all.

*3.6.4 Robust evaluation approaches*

Given the patchiness and uncertainty around the quality of national statistics for the cycling economy, any evaluation of the impact of local cycling infrastructure will need to carry out primary research, to estimate the levels of sales and employment in the area relating to each of the three market segments. The great majority of cycling infrastructure is likely to be designed and built by contractors that work in very many different markets, and where cycling is just one part of their business activity. For this market analysis, the evaluations would do better to start with the list of businesses contracted to supply the goods and services required to design and implement the infrastructure.

Given the problems with data and the unevenness of activity geographically, the evaluation framework should perhaps focus on the local impacts of new infrastructure investments, in terms of for example an increase in employment in the shops selling and repairing the expanded stock of bicycles in use.

From this perspective, transport authorities are going to have to mix and match these limited official statistics with the occasional studies carried out by trade associations and other representative bodies. The granularity of these various secondary data will almost certainly mean they will only ever provide a contextual reference for substantial primary research locally (e.g. comparing national and local trends).

Given the increasing policy interest in cycling, this may be an area where the DfT may wish to meet with the ONS to discuss its treatment of the sector and the size and representativeness of its sampling strategies. Equally, commissioning a small number of major studies nationally would provide a reference for local authorities, both in terms of stylised facts that they may use in the assumptions or the methodology and study design for their local investigations.

*3.6.5 Conclusion: feasibility of measuring impacts*

Given the patchiness and uncertainty around the quality of national statistics and the challenges of collecting data from first basis we conclude that the feasibility of measuring this category of impact is low.

## 3.7 Health impacts: improved physical activity

Cycling has the potential to improve health at both the individual and societal level. However, because health is itself affected by a number of often inter-related factors, robustly isolating and quantifying the cycling-specific effects, particularly at a local level, may be methodologically difficult.

At a societal level the greatest gains are likely to be realised through increasing the proportion of the population involved in regular physical activity. The Health Survey for England 2008 examined physical activity and fitness and based on people's own assessments, found that more than 60% of the population falls short of the Chief Medical Officer's (CMO) recommendations (active at moderate levels for at least 30 minutes a day on at least five days in a week[26]). Objective data using accelerometers suggests the Health Survey's self-assessment process is positively biased and that the true figure is closer to 95% of the population fall short of the CMO's recommendations on regular physical activity.[27]

Physical activity is associated with a reduction of all-cause mortality of 30%, as well as a reduction in the risk of all long-term conditions (LTCs), except respiratory conditions, of between 20-40% as well as contributing to maintaining an energy balance, functional health and metabolic balance.[28,29]

Many of the other cycling-related gains, discussed in the preceding sections of this report, including for example increased disposable income, improved access to social networks, services, leisure, employment etc., have positive implications for health. The effect of any increase in disposable income is likely to be greater at the lower end of the income distribution and may correspondingly have greater impact on such as child poverty.[30]

At a societal level, a modal shift towards cycling away from motorised transport, may also improve physical health indirectly – for cyclists and non-cyclists – through a reduction in air pollution (particulate matter, nitrous oxide (NOx), etc.), reduced noise, road deaths and injuries, congestion and social isolation (Hart and Parkhurst, 2011).[31] Increased cycling has also been linked to greater feelings of safety and security through increased passive surveillance (e.g. more people around). For example, the state of Queensland, Australia has actively taken up the idea that an increase in cycling, as part of a larger environmental design scheme, can help lessen or prevent the incidence of crime.[32]

The figure below summarises some of the different ways by which cycling infrastructure may have a positive influence on health and wellbeing.

[26] The definition of 'moderate' levels depends on the individual's physical condition. A moderate intensity physical activity requires an amount of effort and noticeably accelerates the heart rate, e.g. brisk walking, housework and domestic chores. On an absolute scale, moderate intensity is defined as physical activity that is between 3 and 6 Metabolic Equivalent of Task (METs), or simply Metabolic Equivalents, where is 1 is equivalent to a person's metabolic rate when at rest.

[27] The Health Survey for England is an annual survey (sample c. 11,000 adults and children) designed to measure health and health-related behaviours in adults and children living in private households in England. The survey is carried out by the National Centre for Social Research (NatCen) and University College London Medical School (UCL). Each survey covers a number of core question modules as well as one-off themes. The 2008 Survey focused on physical activity and fitness. Adults and children were asked to recall their physical activity over recent weeks (self-reports), and a sub-sample wore an accelerometer for a week after the interview to provide an objective measure of their physical activity.

[28] Start Active, Stay Active, A report on physical activity for health from the four home countries' Chief Medical Officers. Department of Health, 2011.

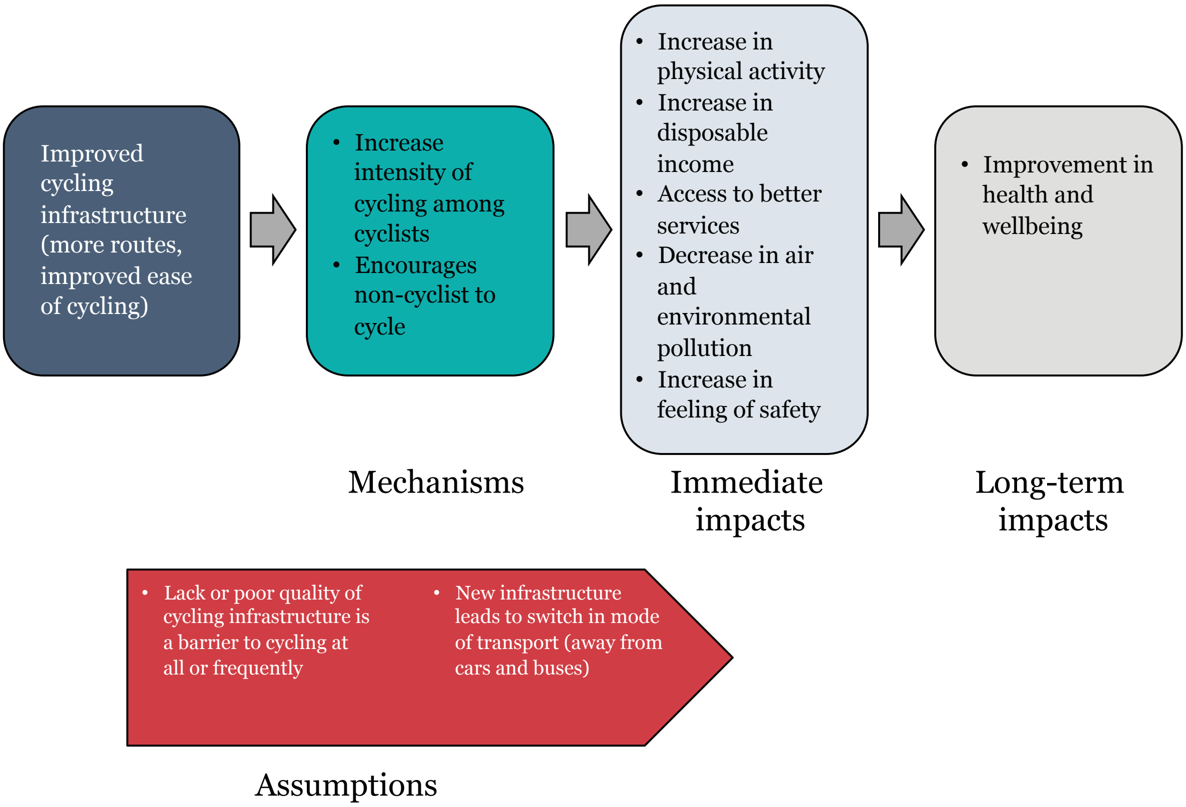
[29] These include: all-cause mortality, Diabetes / metabolic health, Cardiovascular conditions, Breast and colon cancer, Mental illness (depression) and Musculoskeletal health.

[30] See the summary report by Sustrans on the relationship between transport and poverty: Locked Out, transport poverty in England. http://www.sustrans.org.uk/sites/default/files/images/files/migrated-pdfs/Transport%20Poverty%20England%20FINAL%20web.pdf

[31] Hart and Parkhurst (2011) Driven to excess: Impacts of motor vehicles on the quality of life of residents of three streets in Bristol UK. World Transport Policy & Practice, 17 (2). pp. 12-30.

[32] Queensland Government (2007). Crime Prevention through Environmental Design, Guidelines for Queensland.

Figure 6: Logic Model - Health impacts: improved physical activity




### *3.7.1 Research questions*

An evaluation aimed at understanding and testing this type of impact should consider the following research questions:

- Have the improvements in cycling infrastructure led to an increase in the number and proportion of people cycling?
- Have the improvements in cycling infrastructure led to an increase in the frequency of cycling?
- Have the improvements led to an increase in overall physical activity in the catchment area?
- Is there any particular group (e.g. children, women) that has benefited the most in terms of increased physical activity and health outcomes?

### *3.7.2 Metrics*

We can envisage two sets of metrics that capture the impact of improvements in cycling infrastructure on physical activity.

Firstly, the link between physical activity and health is well established and any evaluation should recognise this. An immediate evaluation should therefore be:

- The sustained increase in the number / proportion of people cycling regularly, as a result of the scheme

- The number / proportion of people exceeding the CMO's advice for a minimum 150 minutes a week spent being moderately physically active

As stated already, maintaining reasonable levels of physical activity across a population has been shown to impact positively on the health and well-being of that population, with benefits evident across a number of health indicators including LTCs and precursors like obesity.[33] Showing this at a local level may be more difficult as a) LTCs take time to become manifest and b) the development of LTCs is affected by factors other than physical activity – diet, smoking, alcohol, etc.

As such, it is proposed that diabetes is taken as a proxy for the effect of any scheme on all LTCs. Diabetes is chosen as effects should arise reasonably quickly following the commissioning of the cycling infrastructure, through reduced insulin dependence among Type 1 sufferers and reduced visits and use of medication amongst Type II sufferers. Focusing on diabetes also appeals because of the scale and cost of the condition: it is estimated to cost the NHS approximately £1.5m an hour, 10% of the NHS budget for the UK, which was close to £14 billion a year in 2012.[34] The same study estimated that the annual cost for diabetes drugs, including insulin, was around £1 billion or 8% of the total costs, with the biggest costs relating to hospital admissions for diabetes related complications (£9bn, 65% of total). Diabetes.co.uk maintains statistics and links to recent research on the prevalence and cost of diabetes in the UK, which provide a window on the NHS cost drivers and also showcase studies that have estimated the likely incremental savings to the NHS over time of changed behaviour (eating, physical activity). This may be done at 2 levels: 1) monitoring of the incidence and prevalence of diabetes in relation to comparison(s) groups, and 2) following a cohort of people with diabetes to assess the effect of the scheme on a) their levels of physical activity and b) insulin dependence. There will be confounding factors here, with numerous other major public health programmes targeting diabetes and encouraging people to eat more healthily, lose weight and exercise regularly, and a cohort study would be a good means by which to control for these other drivers.

Specifically, one might look to determine the:

- Change in the prevalence of type 2 diabetes among the population in the catchment area where a major new cycling scheme(s) has been implemented
- Cost savings associated with a reduction in the prevalence of type 2 diabetes among the population in the catchment area, for the applicable hospital trust (e.g. drugs, inpatient, social services, etc.)

### *3.7.3 Robust evaluation approaches*

Every infrastructure evaluation will need to robustly establish the net effect on the numbers and mix of people cycling, and at a level of detail to understand who is cycling (age, gender, employment status, socio-economic status, etc.), why (commuting, utility, leisure, etc.) and how frequently. Understanding the detail of these net effects will be especially important for the estimation of attributable impacts in the health sphere, where the prevalence of certain conditions is highly unevenly distributed among populations.

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33 Inverse associations between cycling to work, public transport, and overweight and obesity: findings from a population based study in Australia. Wen LM, Rissel C., Prev Med. 2008 Jan, 46 (1):29-32. Epub 2007 Aug 23. Walking and cycling can reduce the risk of obesity – and increasing problem in the UK – by 4-6% according to various US studies. The cost of treating obesity in the UK was estimated to be around £4.2 billion a year (in 2010).

34 www.diabetes.co.uk/cost-of-diabetes.html. See also Kanavos, van den Aardweg and Schurer: (2012) Diabetes expenditure, burden of disease and management in 5 EU countries, LSE

Depending on the level of robustness required, health effects could be assumed immediately by assuming that an increase in cycling leads to an increase in physical activity and improvements in health and wellbeing. There is some evidence to support that assumption (Anderson et al., 2000).

### *Primary data collection*

Primary data would need to be collected before and after the cycling investment to measure the change in the number of people cycling and the change in the level of physical activity.

Primary data can be collected via Automatic Traffic Counters (ATCs) (including pneumatic tube counters, piezoelectric counters and inductive loops), Manual Classified Counts (MCC) and Cordon and Screenline Counts. Manual counting and survey will be required in order to determine any social effects (e.g. gender, age, socio-economic group) and critically to identify the extent to which people have been encouraged to cycle and any displacement effects (e.g. people that were already active with exercise other than cycling) as well as attempting to gauge the extent to which cycling had increased physical activity levels overall. Tackling the issue would ideally involve a large, sample survey of the local population in order to determine levels of physical activity before the commissioning of the new infrastructure, and again after perhaps 6 months and two years following the opening of the new cycle lanes.

The survey could use the same questions as the 2008 Health Survey for England, and analysis could include assessment of the effect of a cycling scheme in meeting CMO physical activity guidelines. Given, the 2008 Health Survey also found that self-assessment produced a very substantial overestimate of the proportion of people exceeding the CMO guidelines, it would be helpful to run smaller parallel exercises to gather more objective data using the kind of health monitoring software increasingly available on people's mobile phones. These applications can provide good data on various aspects of physical activity, and would provide a basis for calibrating the self-reported statistics.

### *Accounting for substitution effect*

Establishing the link between an increase in cycling and increases in physical activity will need to account for any substitution effect; an increase in cycling for example, may simply displace another physical activity. However, following the literature, a modal shift from motorised transport towards cycling is likely to increase overall levels of physical activity as people get out of their cars and onto their bikes, rather than swapping the gym for cycling. Moreover, a) Andersen et al. (2000)[35] found a reduction in all-cause mortality in commuter cyclists and b) objective measurements indicate that population levels of physical activity are extremely low.

### *Identifying effects across different groups*

Depending on how data is captured, further analysis of metrics related to physical activity could indicate the impact of any scheme on different population subgroups, for example: children and young people, adults, older adults and inactive people. Women may be of particular interest as, borrowing from the vocabulary of the biological scientist, they may be regarded as an 'indicator species' of good cycling infrastructure, inasmuch as women's propensity to cycle is understood to

[35] Anderson et al. (2000). All-cause mortality associated with physical activity during leisure time, work sports and cycling to work. ARCH INTERN MED, 160.

be very much more sensitive to infrastructure quality than is the case for example with (younger) men who tend to be rather more risk-tolerant and indifferent to infrastructure quality.[36]

***Measuring effects on diabetes***

In the case of the diabetes indicators, panel data (or before and after data) would need to be collected for the 'treatment' area in which there was an investment in cycling infrastructure planned. Data would also be needed from a matched area or areas without any equivalent provision of cycling infrastructure. Data in both the treatment and comparison areas would need to be obtained for several points in time going forward, primarily exploiting secondary data available through the Quality Outcomes Framework (QOF) database and Hospital Episode (HES) data sets. Ideally, these data sets could be linked with data sets from other household surveys that would provide additional information on other important variables, from household income to employment status to bicycle ownership and mode of travel. If researchers were not able to access and link these data sets at the level of individuals – whether for reasons to do with access rights or technical questions around interoperability – the evaluation would need to run large scale surveys in order to collect primary data on key variables not included within the healthcare data sets.

This means that both (i) activity levels and (ii) diabetes prevalence, in the intervention and comparison(s) areas will need to be compared both pre and post intervention. Understanding (long-term) the health impact of an increase in physical activity will require *at least* 3 data points, preferably taken at the same time of year to avoid 'seasonal effects' (e.g. winter 'flu').

The advantage of this type of quasi-experimental design is that the effect of the intervention can be analysed relative to a comparison group. For example, cycling prevalence might rise nationally for a number of other reasons (e.g. rising cost of motoring, financial assistance and tax reliefs on cycling-related expenditure). And, in this case cycling is likely to increase for both the intervention area and within the comparison(s) groups. However, if the rationale for investment in cycling infrastructure is sound, there should still be a difference in increase in the intervention area compared with that for the comparison group areas. A weakness of the DiD analysis is that it would be challenging to account for changes in the sample e.g. people moving in and out of the area.

Alternatively, as a lower cost option, the data on the measured increase in cycling and cycling activity ('an increase in cyclists as a result of the scheme' and 'time spent physically active') can be translated into an estimate of health gains using the Health Economic Assessment Tool (HEAT).[37] HEAT is based on cohort studies run in Copenhagen that included participants that were followed for an average of 14.5 years. Alternatively, the Health Impact of Physical Activity (HIPI) could be used to estimate the burden of illness and disease by unitary and Local Authority.[38]

For studies specifically interested in the relationship between changes in cycling (physical activity) and the cost of healthcare provision, a cohort study is recommended e.g. following a cohort of citizens resident in an area close to a major cycling infrastructure investment and comparing the healthcare costs over time for this group with those of a matched sample of

36 Baker (2009). How to Get More Bicyclists on the Road, Scientific American. http://www.scientificamerican.com/article/getting-more-bicyclists-on-the-road/

37 WHO (2014). Health economic assessment tools (HEAT) for walking and for cycling, Methods and user guide, 2014 update http://www.heatwalkingcycling.org/ http://heatwalkingcycling.org/index.php?pg=cycling&act=more1

38 http://www.apho.org.uk/addons/_122359/atlas.html

residents living in an area without an equivalent cycling intervention. Healthcare costs could be taken for any condition unless it was felt useful to exclude any that may skew results e.g. high cost conditions unrelated to physical activity. Cohorts can be followed for as long as a) resources allow and b) cohort attrition remains such that results remain robust.

A DiD methodology is likely to provide the most pragmatic compromise between robustness and feasibility.

*3.7.4 Time considerations*

DiD analysis requires before and after data to estimate effects. Generally more data points increase robustness as the experimental design is seeking to identify changes in trends. Data on cycling should be compared at similar times of year, while also taking note if the conditions are considerably different even within similar time periods (for example, if there are markedly different weather conditions, like heavy rain or wind, on one day as compared with the others). Another concern with evaluations that are carried out shortly after the completion of an investment is that there exists the possibility that individuals are encouraged to change their behaviour for a short period of time before reverting back to their historical levels of activity. Positive impacts on the health of the population will require behavioural changes to be sustained over the longer term. A review at 6-months for example may not pick up any fallback in numbers or levels of cycling, resulting in an overestimation of the impact of the interventions. For practical purposes (a minimum of) 2-3 years of routine data on diabetes is recommendable.

LTC data may be assessed through QOF and by comparison with comparison areas. Timescales, prevalence and sensitivity to physical activity would need to be considered to assess how long data should be collected for. Use of QOF LTC data would need to take account of any changes in recording / incentives for case-finding etc.

*3.7.5 Use in different settings*

Evaluations of the impact of cycling interventions on health may not be overly sensitive to different settings, provided the intervention and comparison sites remain relatively stable during the study period, and the basic investment is of sufficient scale to have a material effect on behaviour. As with other impact types, it is likely to be easier to detect effects where there have been larger investments made within areas of greater population density. Note should be taken of potential changes in either site's population as, for example, a sudden exodus or influx of younger people within one area and not both, prompted by for example, changes in the local labour market (e.g. opening of a new university, closure of a large manufacturer), would skew results.

*3.7.6 Conclusion: feasibility of measuring impacts*

Given the need for collecting substantial amounts of primary data at several points in time and for several years after the commissioning of the infrastructure, we conclude that the feasibility of measuring this category of impact is medium to low.

## 3.8 Air quality

### *3.8.1 Overview*

A study from 2010 estimated that the UK experiences around 29,000 premature deaths[39] annually that result from long-tem exposure to air pollution. Transport is the largest single contributor to this pollution, estimated to cause around 7,500 premature deaths each year.[40]

Air Quality emerged as a particular challenge for the UK government following a ruling in 2012 by the European Court that the country was in breach of its obligations under the EU's Air Quality Directive.

UK Local Authorities are required to develop and maintain Air Quality action plans (Environment Act 1995), and those plans are placing increasing weight on cycling measures – including infrastructure investment – to bring about a modal switch and help achieve the desired improvements in Air Quality.

Cycling measures are an increasingly common element in the air quality and mobility plans of numerous cities around the world. New and improved cycling infrastructure (such as separated cycling lanes, improved intersections, provision of facilities at various hubs and integration of cycling with urban public transport networks) is generally believed to be the group of cycling measures most likely to help deliver a shift in the mode of transport, away from cars and buses.

A modal switch from motorised transport to cycling (or walking) can have a positive effect on greenhouse gas (GHG) emissions (desirable from the point of view of climate change). It will also impact on the local environment, reducing noise and air pollution. Noise pollution may be associated with elevated stress levels and there is a widely reported negative relationship between air pollution and health. Vehicles emit high levels of nitrogen dioxide, which can irritate the lungs and increase the symptoms of people that suffer from respiratory disease; NOx also forms ozone (smog), which can cause similar problems. Particulates in vehicle emissions can be carried deep into the lungs where they can cause inflammation and a worsening of heart and lung diseases.

In this section, we present the options to measure improvements in the environment and the decrease in air pollution attributable to investment in cycling infrastructure. Such approach directly or indirectly considers a decrease in motorised traffic and overall improvements in the flow of traffic in urban areas. For example, a study on the environmental effects of cycling in the Netherlands,[41] shows that a 10% increase in cycling, decreases $CO_2$ emissions of cars by 7% in urban areas. The study also shows that because of the improved flow of traffic, $CO_2$ emissions of heavy vehicles (trucks) decreased by 4%.[42] While the study cited above established a positive relationship between an increase in cycling and improvements in the environment, it is unclear whether other cycling evaluations will similarly yield positive evidence.

[39] COMEAP (2010). The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom. The Committee on the Medical Effects of Air Pollutants

[40] Yim and Barrett (2012). Public Health Impacts of Combustion Emissions in the United Kingdom, Environ. Sci. Technol., 2012, 46 (8), pp 4291–4296.

[41] Fietsberaad (2010). Gevoeligheidsanalyse effecten fietsbeleid. Fietsberaadpublicatie 18.

[42] The same study by Fietsberaad (2010) also argues that the effect of an increase in cycling on noise pollution is less pronounced. A 10% increase in cycling is expected to decrease noise pollution by 2%. It is argued that as a result, the focus should be on minimising noise pollution caused by motorised traffic via noise solutions including improvements in the isolation of housing.

### *3.8.2 Research questions*

The logic is easy enough to elaborate: more and better cycling infrastructure produces a sustained switch in transport modes, reducing congestion and improving the flow of motorised traffic, thereby lowering polluting emissions. The improvement in air quality locally produces a reduction in pollution-induced respiratory incidents and should in the longer term yield a reduction in premature deaths.

Measuring and attributing those health effects to cycling investments will be difficult, in part because of the fact that cycling is likely to be just one part of a very much broader mix of factors at work and in part because the important longer term health effects may not be realised fully for at least 5-10 years after the cycling programmes were implemented.

Evaluators can reasonably easily estimate the levels of mode switching in areas around cycling infrastructure investments, and link that back to infrastructure investments by comparing trends with those in other areas where there has been no substantial investment in cycling. Air pollution levels can also be easily measured at various points throughout a city, and changes in air quality linked back to cycling investments using the mode shift data as a proxy. The main metric under consideration measures the reduction in air pollution. Although there are many types of air pollution, the obvious candidates include changes in nitrogen dioxide (NO2) and particulates such as PM10 and PM2.5. This is mainly because their levels are frequently above safety thresholds in major towns and cities and have a proven negative effect on respiratory disease.[43]

The effect of air pollution could be measured indirectly through the analysis of the prevalence and treatment of asthma, which is a chronic condition that can be both brought on and exacerbated by ambient air pollution. Equally, improving air quality will tend to reduce the numbers of people suffering from asthma and the number of episodes. Focusing on asthma is helpful inasmuch as it is widespread and well documented and responds in reasonably short order to changes in ambient conditions, so one doesn't have to wait 5-10 years to look for changes in the prevalence of COPD or premature deaths. It is however a condition that has many causes and triggers and the data are likely to be rather noisy.

The quantification of the impacts of air quality on human health can be made using either premature death data or the disability adjusted life years (DALY) metric, as recommended in Rao et al., (2013).[44] The DALY metric extends the concept of potential years of life lost due to premature death to include years of healthy life lost by virtue of being in states of poor health or disability (Murray et al., 2002).[45]

In all cases, there would need to be specific work done to measure (before and after) changes in commuting behaviour and traffic congestion as well as air quality more generally (with suitable controls implemented to deal with external factors, such as changes in the average age of the vehicle stock). There is a further dynamic that would need to be considered, whereby the initial reduction in traffic may 'refill' (rebound) to some extent with suppressed demand as people that had previously been dissuaded from driving by levels of congestion and long journey times are

[43] Particulate matter (PM) consists of microscopic solid and liquid particles suspended in the air coming from both natural and human activities (such as burning fossil fuels for electricity, industry and transport). The lower the size of PM, the more dangerous the pollutant is because such smaller particles can easily be inhaled, which can lead to asthma, lung cancer, cardiovascular and respiratory diseases, birth defects and premature death.

[44] Rao, S., Pachauri, S., Dentener, F., Kinney, P., Klimont, Z., Riahi, K., Schöpp, W., 2013. Better air for better health: forging synergies I policies for energy access, climate change and air pollution. Global Environmental Change 23, 1122-1130.

[45] Murray, C.J.L., Salomon, J.A., Mathers, C.D., López, A.D., 2002. Summary measures of population health: concepts, ethics, measurement and applications. World Health Organisation (WHO). Geneva, Switzerland.

encouraged back into their cars. This kind of feedback loop is likely to be strongest in those places suffering the greatest levels of congestion and where the benefit of improved air quality would be highest.

*3.8.3 Robust evaluation approaches*

In order to study the relationship between investments in cycling infrastructure and changing air pollution and health impacts to address two issues:

- The extent to which an increase in cycling implies a decrease in motorised transport, and
- The extent to which a decrease in motorised transport implies an increase in cycling.

For example, data on $CO_2$ emissions can be used to study the causal link between a decrease in motorised traffic and a decrease in $CO_2$. In this case, it is assumed that a decrease in motorised traffic implies an increase in cycling. A decrease in motorised traffic may produce both a decrease in the volume of traffic and an improvement in the flow of traffic, including a reduction in congestion (and lower emissions) around key network pinch points.

Both data on cycling activity and car traffic can be collected using automatic traffic counters (ATCs).

Assessing the impact of investment in cycling infrastructure on a reduction in air pollution measured by e.g. nitrogen dioxide ($NO_2$) and particulates ($PM_{10}$) requires data on the change in cycling activity. In this case, it is possible to assume that an increase in cycling implies a decrease in motorized transport. However, in areas with a high flux of commuters and residents it will be important to control for changes in population and, more precisely, the change in modal switch.

***Linking changes in motorised transport with air pollution***

This link could be established by using data from the transport impacts to estimate reductions in vehicle KMs and to then use a model to predict changes in carbon emissions and/or air pollution. The level of sophistication of the modelling can be varied from the simplest marginal external cost analysis (as in WebTAG) to more sophisticated analyses that take account of the locations where the vehicle KMs are removed from the network, with associated emissions and dispersion modelling. A recent study carried out by Ricardo-AEA for the European Cycling Federation (Cycling and Urban Air Quality: a study of European Experiences, ECF, 2014) has run this kind of analysis for selected European cities, including London, using current data on modal mix and air pollution at multiple zones across each city, and then modelling future impacts on emissions and health using three scenarios: business as usual (based on extrapolation of recent trends in the cities in question), cycling investment scenario and a limited car free scenario. The modelling produces marked differences across scenarios for both pollution levels and for health impacts; the comparisons across zones within cities is helpful in understanding the relative importance of cycling investments and the comparisons across cities is instructive in terms of the differential effects of other basic factors like traffic flows and congestion.

As noted above, there are strong feedback loops that may greatly reduce the reliability of this kind of modelling for the most densely populated areas, where cycling induced improvements in the efficiency of transport infrastructure are likely to produce an expansion in overall usage (facilitating latent demand). This kind of rebound is likely to confound anticipated improvements in AQ, at least to some degree. Further empirical studies will be necessary to better understand this 'elasticity' in different settings, in order for the 'modelling approach' to prove a credible 'fallback' position in major conurbations.

***Time considerations for robust evaluation***

Robust evaluation will need to use data collected on a regular basis (at different points in time) in the year before the intervention and for several years after the intervention. A before-and-after analysis will not be sufficient to establish any causal relation between investment in cycling and air pollution. On the basis of panel data - using data on pollution and cycling activity at different locations and at different points in time - it would be possible to establish the effect of an intervention on air pollution and to establish whether the effects are sustainable over time. Here one may consider more sophisticated models to take into account the effect of different types of cycling infrastructure on increased cycling/decrease in motorised transport.

The most robust approach would follow a broadly similar approach to that described above for diabetes, making use of baseline and two or more ex post evaluations in both treatment and comparison areas.

***Accounting for confounding factors and externalities***

As noted above, determining the link between changes in the levels of cycling (modal switch) and improvements in air quality is not straightforward, due to the fact that cycling infrastructure investments are invariably just one small part of a package of measures implemented by towns and cities to improve air pollution. As such it is essential to control for these various other factors that are likely to affect air quality. For example, changes in air quality will be sensitive to changes in the stock of vehicles on the road,[46] improvements in the road network that remove bottlenecks and improve traffic flow. There are also issues with pollution being blown in from elsewhere and for which there may be a seasonal effect from either changes in wind patterns or industrial activity. This latter phenomenon is perhaps less significant, given the deindustrialisation of British cities over the past 40 years, but nonetheless it still makes sense to take measurements at numerous different points in time to help combat such volatility.

*3.8.4 Use in different settings*

It is likely that many individual cycling schemes will be too small to cause the level of modal switching and decongestion necessary to produce measurable improvements in air quality across a city, and evaluators may need to focus on larger portfolios of cycling measures or major infrastructure projects that have focused explicitly on pollution blackspots. The impact evaluation in relation to local air pollution is most relevant to urban areas where the population is concentrated and where congestion is especially problematic. All things being equal, it would be less important to research impacts on air quality and respiratory disease for the planned HS2 cycleways as these rural areas will tend to have less of a problem with high particulates or NOx emissions. Given the relatively short trips that dominate travel in most urban areas, there is also greater scope for a modal switch from motorised traffic to cycling in these areas.

[46] The stock of vehicles is not fixed and we have seen quite significant changes in the mix of private and commercial vehicles, average age of vehicles and the influx of low carbon vehicles, from all electric cars to hydrogen buses. These changes are being driven by international regulation in the main, but it is possible they may be given added impetus by local laws (e.g. London's congestion charge and low emission zone policies), which are designed to bring about changes in emissions levels more quickly than would be the case relying on vehicle renewals or the evolution in consumer behaviour.

### *3.8.5 Conclusion: feasibility of measuring impacts*

Given the limited effect most cycling infrastructure will have on modal switching and the potential for 'rebound' in those densely populated areas, we conclude that this would be a challenging area for impact evaluation and the cost and feasibility of measuring this category of impact is medium to low.

## 3.9 Absenteeism

### *3.9.1 Overview*

There is evidence that people who cycle to work take fewer days sick than those who do not, with work by Sustrans for example arguing that workers who cycle take on average 2 days a year less sick leave (average 2.5 days a year) as compared with the average for all workers in the UK (4.5 days a year). There is also evidence from a Dutch study that found white collar workers with a mean age of 43 and that were regular cyclists (3 km/day at least 3 days a week) took 1.3 fewer sick days each year than non-cyclists (defined as people cycling less than once a week) with evidence that the more often and further people cycled the less they reported sick (Hendrickson et al., 2010).[47]

Other studies suggest that there are diminishing health returns (impacts on adverse health outcomes) to further marginal increases in physical activity, beyond moderate levels of intensity and frequency and that the policy focus should be on getting more people engaging in moderate physical exercise regularly.[48]

The UK Labour Force Survey is the principal source of official data on absenteeism, with quarterly and annual booster surveys gathering data from more than 40,000 households on the nature and extent of recent unscheduled absences, with links back to various health-related conditions. The latest available report states that around 130 million days were lost in 2013, with around 30 million days lost due to minor illnesses like coughs and colds.[49] Sickness absence rates are also reported at a regional level for the UK, but only in very aggregate terms. The data do however show quite marked sectoral and regional differences.

There is also evidence that cycling improves psychological wellbeing, with a 2014 study having found a positive relationship between active commuting (cycling or walking) and self-reported psychological wellbeing.[50] The study used data from the British Household Panel Survey (BHPS) to look at the link between commuting and wellbeing for around 18,000 adults aged 18 to 65 (the BHPS was renamed in 2014, Understanding Society: the UK Household Longitudinal Study).

A 2015 report by RAND Europe on health, wellbeing and productivity in the workplace found a measurable difference in productivity levels between staff with higher and lower levels of physical activity, based on a regression analysis of data collected during the 2014 Britain's Healthiest Company (BHC) competition.[51] Among other things, the authors concluded that:

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47 Hendrickson et al. (2000). The association between commuter cycling and sickness absence. Preventive medicine, 51 pp. 132-135. The authors use cross-sectional data using company absenteeism records and a web-based questionnaire to collect data on cycling behaviour, perceived barriers and motivational factors of commuter cycling.

48 Humphreys, B.R., McLeod, L., Ruseski, J.E., 2014. Physical activity and health outcomes: evidence from Canada. Health Economics volume 23 issue 1 pp 33–54, January 2014.

49 http://www.ons.gov.uk/ons/rel/lmac/sickness-absence-in-the-labour-market/2014/sty-sickness-absence.html

50 Does active commuting improve psychological wellbeing? Longitudinal evidence from eighteen waves of the British Household Panel Survey, Adam Martin, Yevgeniy Goryakin, Marc Suhrcke, Preventive Medicine 69 (2014) 296–303

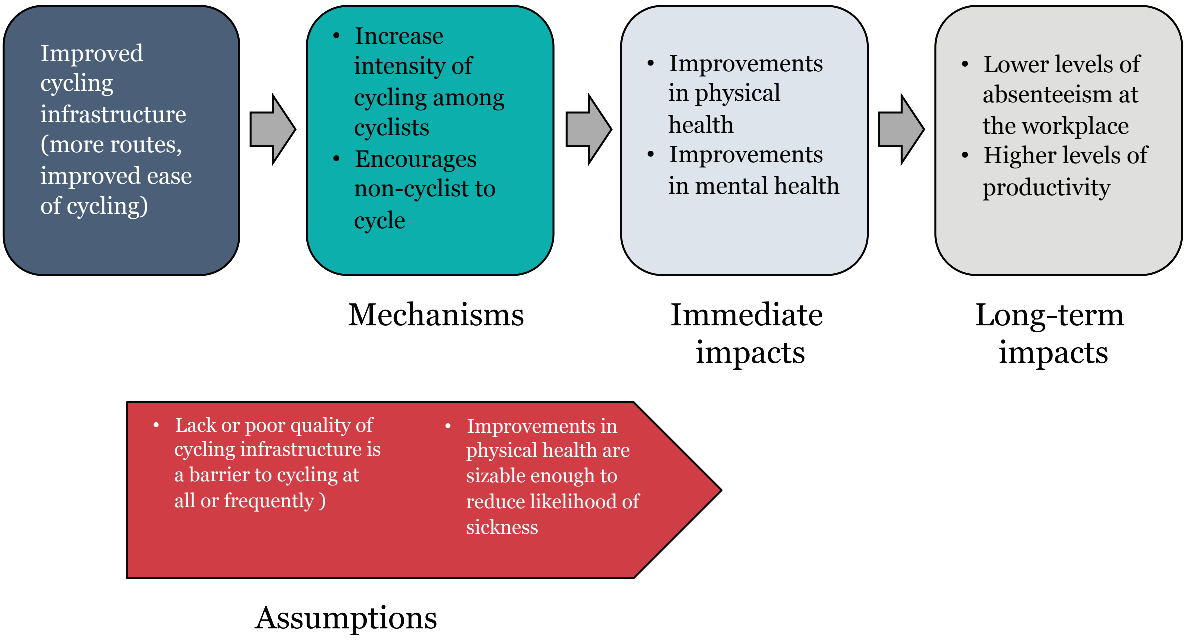
51 Health, wellbeing and productivity in the workplace: A Britain's Healthiest Company summary report, RAND Europe, 2015, Marco Hafner, Christian van Stolk, Catherine Saunders, Joachim Krapels and Ben Baruch

*"When looking at physical inactivity, in line with the wider literature (see Schultz and Edington, 2007[52]), we find a positive association between lack of physical activity and workplace productivity loss, both in terms of absenteeism and presenteeism. An employee not performing the recommended 150 minutes of exercise per week reports on average a 1.91 percentage point higher work impairment due to absenteeism and presenteeism compared to an employee who performs the recommended amount of physical activity."*

Intuitively, increasing cycling will improve the health of employees and therefore reduce the number of days lost due to sickness, which is a substantial cost to employers, and also potentially improve productivity as a result of people's better sense of wellbeing.

Figure 7 shows a simple schematic representation of the Logic Model that links the intervention ('improved cycling infrastructure') with the mechanisms that would enable immediate and long-term impact, as well as the assumptions that lie behind that expected chain of events / results.

Figure 7: Logic Model – Absenteeism




*3.9.2 Research questions*

An evaluation aimed at understanding and testing this type of impact should be guided by the following research questions:

- Have the improvements in cycling infrastructure led to improvements in psychological wellbeing among the population in the catchment area?
- Have the improvements in existing cycling infrastructure led to lower levels of absenteeism among workers
- Have lower levels of absenteeism led to higher levels of productivity?

[52] Employee health and presenteeism: a systematic review, Schultz AB, Edington DW, Journal of Occupational Rehabilitation 2007 September, 17(3):547-79.

### 3.9.3 Metrics

We considered two main metrics to assess the effect of new cycling infrastructure on the health and wellbeing of employees, focusing on the economic impacts of these health gains within the workforce

- Absenteeism – the number of days lost due to sickness absence among staff
- Psychological wellbeing among employees

In the case of the absenteeism and increased workforce retention, it would also be possible to collect data from employers and supplementary employee surveys (See Section 4 for further description on the relevant data sources).

### 3.9.4 Robust evaluation approaches

The most robust evaluation may be a cluster randomisation trial whereby a number of businesses are randomly allocated interventions to increase commuter cycling. A cluster randomisation study e.g. randomisation by site rather than individual would assess the difference in e.g. cycling levels before and after implementation in intervention sites (companies) compared to non-intervention sites. The results could be further explored using additional controls, likewise assessed as a before/after. This would then give the results as a before/after trial.

Although methodologically feasible, a cluster RCT may be pragmatically implausible due to the need to assign sufficient numbers of sites as intervention and comparisons. For this reason, we suspect that the DiD approach with matched companies is the next best robust alternative.

In case it is only possible to collect data from one company, a before and after study is proposed. As in the case of DiD and the before and after trial, the advantage of a before and after analysis is that it would allow evaluators to control for socio and demographic factors such as age, gender, ethnicity, socio-economic class, children, location etc.

### 3.9.5 Time considerations

As pointed out already, The DiD methodology requires before and after data for both the treatment and comparison areas, and preferably some means by which to statistically control for external factors that may also produce convergence or divergence between the treatment and comparison groups. Generally, more data points increases robustness as the experimental design is seeking to identify changes in trends. It is likely that organisations will have ongoing records relating to workforce size, absentee rates etc. DiD methodology should account for seasonal effects though consideration may be needed of geographical variation. At least data for three points in time is required for the analysis but more data points over time is better. It is suggested that data is collected over at least a year to assess seasonal trends. Changes in absenteeism due to a cycling intervention may take longer to show an effect and may vary according to business type.

### 3.9.6 Use in different settings

The evaluation of the impact of cycle schemes on employee wellbeing is perhaps most easily analysed using data from companies that are relatively large. This means that such evaluation is most relevant in somewhat larger towns and cities where one or more bigger companies are located.

### *3.9.7 Conclusion: feasibility of measuring impacts*

Given the need for substantial primary research with large numbers of local employees and employers, we conclude that this would be a challenging area for impact evaluation and the cost and feasibility of measuring this category of impact is medium to low.

# 4. Key data sources

This section provides a description of the different data sources available to test the effect of cycling infrastructure on the different impact categories discussed in the prior section.

## 4.1 Population statistics

There are at least two relevant sources of information on population

i) **UK national census** - The best available data on population change is that offered by the UK national census. The census data has a 100% sample rate of residential properties and provides a demographic and property classification, allowing social and distributive impacts to be identified. The main weakness with respect to the census is that it occurs only every 10 years (March 2011 was the most recent) and infrastructural investments may not fall conveniently.

   For example, if the cycling infrastructure is commissioned around the time of, or close to a census, then the baseline data would arguably need to be taken from the preceding census, which may be up to 10 years old. With data of that age there may be too many confounding effects to be able to successfully identify the impact of the cycling facility on population. Conversely, data might only be a few months old and would not be picking up medium term impacts.

ii) **ONS estimates -** The ONS provides small area population estimates for each year. These data would be useful for identifying background changes in population, but as they are modelled (i.e. are estimates developed in part using the preceding census data) would be inappropriate for use in an evaluation in any other role. Therefore if the opening of the cycling facility lies awkwardly with respect to the census dates, there may be no alternative to assessing the impact on population other than through commissioning an independent household survey. Such a survey would need to be undertaken before and after the scheme opens. In addition to surveying the characteristics of households (size, composition, income, etc.) it would also be helpful to establish when the household moved to the residence and to the area more generally. Sorting effects, where people self-select areas with certain characteristics that match their preferences or needs (and those of others like them), are expected as part of the general impacts of transport infrastructure. Therefore it is useful to understand if the changes in population demographics occur as a result of sorting effects or because households themselves change in characteristics (e.g. have a higher income).

## 4.2 New businesses

There are official data on new business registrations (births and deaths) and a related employment and income survey, which can be analysed by region and industry (and at more disaggregated levels with the appropriate permissions from the ONS).

However, these data do not include data on existing businesses moving from one area to another, or inward investment. Equally, the UKTI FDI data do not capture movements between cities and regions. Moreover, neither of these sources provides any view of motivations for registration or mobility. It looks as though any evaluation wanting to understand the extent to which an investment had attracted new inward investors or prompted uplift in business formation, would need to tackle the issue from first principles, running quite involved primary research.

## 4.3 Vacancy and employer surveys

i) **ONS vacancy survey** is a monthly survey directed to a sample of 6,000 businesses, which provides an accurate and comprehensive measure of the number of vacancies across the economy and by industry but the sample is not big enough to be useable at a local level.

ii) **The annual UKCES employer survey** (93,000 interviews in 2014 survey) is much larger, but focuses more on breaking down vacancies by skills requirements and occupational groups rather than geography. It does however include information on hard-to-fill vacancies (unfilled for more than 3 months). The statistics show that this phenomenon affects higher skilled occupations disproportionately, but not exclusively so. The cost to employers can be quite high, with unfilled vacancies requiring re-advertising and possibly causing capacity bottlenecks that can lower output and create delays that may also reduce cashflow and even lead to lost orders. Skills shortages can be especially costly where they relate to key staff.

iii) **ONS quarterly reports** – This reports include information on unemployment by age, gender, region and by occupation (but not region and occupation together), based on data from the Labour Force Survey. However, while these statistics are accurate and comprehensive, as published, they are also too aggregate for the needs of programme evaluators, albeit it is a useful source of time-series and reference data. The ONS vacancy and unemployment surveys also include definitions of the relevant metrics.

## 4.4 Tourism and visitors

VisitEngland runs an annual GB Travel Survey, using a sample of around 15,000 visitors to gauge the number, duration and purpose of domestic visits. The GB survey reports annual and 3-year averages (to help with sample bias) for home country, region and sub-regional levels (cities and LEPs).

The ONS publishes annual statistics on *international* tourism, based on its international passenger survey, however, it only publishes data at national, home country and regional levels; it is not possible to drill down to city level.

## 4.5 House prices and commercial rents

There are at least two sources of information on house prices

iv) **Land Registry** - The most comprehensive data on property prices is that held by the Land Registry. It provides online access to detailed information on the 'price paid' for individual properties throughout the UK, going back to 1995,[53] showing the price for every transaction across the 20-year period. The standard 'price paid' searches relate to street name / number, postcodes, etc.

There are also standard searches for a city or region, which will show numbers of transactions, average prices paid and trends in those prices by month or year (so one can look at the difference between prices in one street as compared with the whole city).

The data however do not provide any other information other than the transaction price and the address. Thus there is no disaggregation by property size and attributes.

v) **Estate agents and mortgage providers** – Alternative databases on property prices such as those held by estate agents and mortgage providers have also been used to study the impact

[53] This level of coverage is not completely universal: the archive goes back just 10 years, to 2005, in some areas.

of transport investments on property prices. For example Gibbons and Machin[54] used data from the Nationwide to value accessibility to stations on the Jubilee Line Extension (JLE) and the Docklands Light Railway (DLR). In Scotland, the regional estate agent partnerships between solicitors hold a record of a substantial proportion of residential property transactions. Data is also available via commercial property Internet sites, such as www.rightmove.com, with the advantage of being publicly available without charge. The benefit of estate agent and mortgage provider data is that it contains both information on the price paid and also property attributes (e.g. number of bedrooms) to improve matching.

Data on commercial rents is harder to obtain at the right geographical scale, and would almost certainly require evaluators to carry out additional primary research.

There are various surveys of commercial rents, e.g. from the Royal Institute of Chartered Surveyors (RICS),[55] but these are sample surveys and don't have the granularity to help determine the impact of a cycling scheme in one part of a city or local authority. The RICS survey can however provide the reference for wider market developments. Estate agents and local surveyor companies may also hold information on commercial rents. However, to test impacts on commercial rents it is very likely that any evaluation would need to run its own 'before' and 'after' surveys in a series of similar areas, with and without major cycling infrastructure investments. Such evaluation specific surveys could of course potentially augment surveys conducted by RICS and also held by estate agents or surveyors.

## 4.6 Health and wellbeing

Data on health and wellbeing can be obtained from the following two sources:

- Data from GPs in the UK has been collected annually since 2004, as part of the Quality and Outcomes Framework (QOF).[56] Participation is almost universal. These GP data track the clinical prevalence of various 'relevant' long-term conditions including, for example: diabetes and cardiovascular conditions. This allows detailed comparisons over time across various socio-economic groups and locations, including national and regional averages and neighbours
- Hospital Episodes Statistics (HES) is a data warehouse containing records of all patients admitted to NHS hospitals in England, which is reported annually in a series of publications covering different perspectives (e.g. providers, procedures, specialists, etc.). The HES data warehouse includes detailed time-series data on diseases and conditions of relevance here, and as such, with the appropriate permissions, will support quite comprehensive analysis and statistical controls

While these are both high-quality data sources, caution should still be exercised when interpreting trends because a high/low prevalence of a given disease may be a sign of either a healthy population or poor recording/diagnosis. Moreover, there is some level of underreporting of the prevalence of diabetes. Obtaining either QOF or HES data at the level of spatial disaggregation required for the evaluation of cycling programmes will require special permissions and probably an ethical review to assure the parties involved that data protection

[54] Gibbons, Stephen and Stephen Machin (2005) Valuing rail access using transport innovations. *Journal of Urban Economics* **57**(1):148–169

[55] Commercial rents: http://www.rics.org/uk/knowledge/market-analysis/rics-uk-commercial-market-survey/ and house prices http://www.rics.org/uk/knowledge/market-analysis/rics-residential-market-survey/

[56] http://www.qof.hscic.gov.uk/search/index.asp

and privacy issues will be observed fully. We have no definitive view on how likely it is that access would be granted, however, it will be very much more likely if the request is made by academic research groups that have an established relationship with the health services and a proven track record in working with such sensitive data. Both QOF and HES can be broken down by postcode. The data also allows analysis by other variables including age, and gender thus allowing adding a social dimension to the analysis.

Other relevant data sources include:

- **The Labour Force Survey and Understanding Society** surveys include variables of related to absenteeism and well-being. Both surveys have population sizes large enough to be potentially of value to evaluating the impact of cycling infrastructure schemes, at least in the bigger cities and conurbations.

  If evaluators are not granted ready access to the micro data (given sample size issues and restricted access) the practicable solution may be to run supplementary household surveys targeted at sample populations around the particular infrastructure and similar comparison areas (without infrastructure). The national LFS and Understanding Society surveys do provide proven questions and analytical frameworks that can be replicated, as well as offering more aggregate time-series data for wider contextual analysis.

- **The Chartered Institute of Personnel Development (CIPD)** does commission occasional surveys of both employees and employers, to understand employee well-being and absenteeism nationally and across sectors. The samples are very much smaller than those used in either the LFS (2,000 versus 40,000) or Understanding Society and critically do not provide a basis for linking mode of commuting with absence or wellbeing. The CIPD reports may provide a useful additional source of contextual data and monetisation.[57]

## 4.7 Others

Data on the decrease in travel time of motorised transport, attributable to a modal switch can be collected using automatic traffic counters (ATCs). ACTs are magnetic induction loops in the road surface that collect traffic counts all day, every day. DfT has over 200 of these on Great Britain's roads.

[57] Employee Outlook: Focus on Employee Well-Being, October 2013, YouGov for CIPD

# 5. Recommendations for an evaluation methodology

## 5.1 Overall methodology

This section draws together the discussions from the preceding sections and sets out our recommendations for a generic Cycling Impact Evaluation Framework with which to determine the nature and extent of the different social and economic impacts attributable to a given cycling infrastructure scheme.

We recommend an overall methodological approach that combines theory-based evaluation (TBE), focusing attention on the critical objectives, with before and after measurements for the treatment area and one or more comparison zones for each of those key performance dimensions. We have also outlined two levels of robustness in each case, working between level 1 on the Maryland Scale – typically a single matching comparison zone – and Maryland 3 – with multiple comparisons and closer matching of the treatment and comparison groups over time using statistical techniques like propensity score matching.

Given the relative smallness of most cycling infrastructure investments, when judged against the scale of their local economies, there is a need to control for the many external factors that may amplify or attenuate the effects of these investments. There is also likely to be substantial displacement within most cities and regions. As such, we have given particular thought to the kinds of comparisons and counterfactual analysis that will allow future evaluators to estimate net impacts and attribute an appropriate share of any measured changes to the schemes in question.

In most cases, evaluators will need to carry out primary research as official statistics tend not to be reported at a level of disaggregation suitable for tracing effects at the sub-regional level or lower. Where postcode level data do exist (e.g. household surveys), evaluators will need special permission to access those detailed and confidential micro-data.

The need for primary research is a major cost driver. There is also limited read across between metrics and data sources, which means that covering multiple social and economic impacts will require multiple data collection exercises, with few opportunities for cost savings through, for example, omnibus surveys. We do foresee several employer surveys and household surveys, but with somewhat distinct topics. We would recommend separate sample surveys (for households and for employers) to minimise complexity and reduce the burden on individual respondents.

There may be opportunities for some cost savings if the individual assessments were set up in order to feed data into the evaluations of two or more cycling infrastructure programmes (instead of running separate exercises for each individual programme). However, this may only make sense for a minority of metrics / performance dimensions that are highly consistent across projects.

## 5.2 Design and cost options

We have provided an estimate of the upper and lower bounds for the likely cost of a study to measure each type of economic or social impact, giving a broad range to reflect the fact that the final cost will be highly contingent on the scope of infrastructure and geography under review. In addition, for each type of impact, we have estimated the likely costs for two levels of robustness or options.

The estimates are based on the likely cost of commissioning studies externally, at market prices. The cash cost will be lower where the budget holder’s own analysts can carry out some part of the required work, however, it is likely that most impact evaluations will need some capacity and methodological expertise to be bought in from external contractors.

In each case, we suggest approaches to the definition of baseline periods, establishing counterfactual assumptions and consider the use of statistical techniques to improve the matching between test and comparison sites. We appreciate that the final evaluation design should be as cost effective as possible, bearing in mind the need for robust methods. Given the most robust approaches may not always be feasible or affordable; we have outlined a study design for both Maryland level 1 and Maryland Level 3. In our view, levels 4 and 5 are not feasible study designs for an impact evaluation of a cycling infrastructure programme.

We have summarised our current thinking as regards the design options and likely costs for each of the main economic and social impacts anticipated, and for reasons of legibility these are presented in a series of tables in the appendices rather than here in the main body of the report. Our recommended approach to measuring each of the main types of economic impacts is set out in Appendix A.

**In general, we believe any robust evaluation methodology will need to be built around a substantial programme of primary research.** While there are numerous official data sources of direct relevance to the questions at hand, very few of these data are collected at a level of disaggregation sufficient to support an impact evaluation of a specific infrastructure investment. The one or two that have the spatial granularity may not be sufficiently frequent (e.g. the UK Census, which is carried out every 10 years). There are numerous ad hoc studies (e.g. Sustrans studies on the cycling economy) and other periodical surveys (e.g. CIPD employee wellbeing surveys), but again, from what we have seen, these tend to be very much smaller in scope, focusing on understanding national or possibly regional trends. Local authorities do carry out relevant studies, however, not consistently and not always with the scale or detail required to determine the effects of relatively small infrastructural investments like cycling networks.

Both our Level 1 and Level 3 study designs comprise before and after primary data collection exercises with comparison groups, and as such should be more robust than many of the studies reported here. Infrastructure investments can produce substantial displacement across geographical areas and as such it is important to include suitable comparisons and counterfactual analyses to deal with issues of attribution and leakage (see Section 2.2). A commitment to higher levels of robustness does of course affect the cost, and may prove to be infeasible in some areas for some impact types.

**In all cases, the impact** evaluation **would need to begin with a preparatory phase** in which a working relationship needs to be established with the local authorities and agencies responsible for the investment and wider area; there will need to be local support for the exercise, even if it is funded and commissioned nationally. There will also be a need to review data availability / limitations in each case, impact type by impact type, in order to determine finally the required blend of primary and secondary data and the extent to which it is feasible and affordable to work at Level 1 or Level 3.

**In all cases, the impact evaluation will need to include comprehensive data collection on levels of cycling** (which relates to the scale of outcomes foreseen) **and ideally some view on the quantum and quality of new infrastructure** (objective measures of features and capacities, but also possibly perception studies to understand users and prospective users' views of safety, directness, comfort, etc.).

We envisage the Maryland Level 3 study designs including a baseline and two ex post evaluations (e.g. -12 months, +12 months, +24 months), where the level 1 study design would comprise a baseline and single ex post review (e.g. -12 months, +12 months). The additional evaluation is an important means by which to deal with any temporal issues, whereby for example behaviour may change substantially immediately following the opening of a new cycle superhighway before subsiding to a lower level of activity that will be sustained. Equally, for several impact types, we would expect the full impact to build over several years (e.g. inward investment) as a result of positive feedback loops and there is an intrinsic need to follow that development over a longer period of time.

Equally importantly, we have suggested the Level 3 study designs would be more ambitious in their geographical scope and would specify multiple comparison groups, where our Level 1 studies propose a single treatment and comparison area. Research suggests that cycling infrastructure can produce meaningful benefits to a quite diverse range of social groups and across quite large geographies. The fieldwork needs to have sufficient scope in order to capture that broad reach.

Lastly, we have suggested the Level 3 study designs would be more ambitious in their effort to characterise affected populations and areas, encompassing more variables to improve the statistical matching of treatment and comparison groups (e.g. through Propensity Score Matching applied to DiD analyses). This approach is more data hungry and will tend to require very much larger samples in order for the results to be statistically representative, and able to be grossed up with confidence. The Level 3 study designs will reduce the risk of over-estimating the attributable impact as a result of not properly controlling for other external factors that might very easily produce a substantial change in a given indicator in the treatment or comparison areas within the two or three year period between a baseline study and the first evaluation. Possible examples, might include changes in the mix of residential and retail properties, resulting from the construction of new university halls of residence or the opening of a new out-of-town shopping centre or the designation of an area as the city's design district.

Table 5: Overview of methodological feasibility by impact category

| Impact category | Methodological feasibility |
| --- | --- |
| Expanding the local economy | • The types of impacts and possible confounding issues are well understood, with numerous empirical studies that may be referred to<br>• There are no secondary data available with the granularity needed to determine impacts or to establish a scheme's contributions to any measured impacts<br>• Primary research will be necessary, however, the impact evaluation will make use of established research questions and proven data collection processes<br>• The counterfactual strategy will be important, and possibly quite challenging given the highly variable nature and topography of schemes and the ease with which authorities will be able to find comparison areas that provide a good match; there are also likely to be substantial issues with inter-regional transfers and displacement |

| Impact category | Methodological feasibility |
|---|---|
| Better cities and neighbourhoods:<br>• output / employment<br>• rental incomes | • The types of impacts and possible confounding issues are reasonably well understood, with several empirical studies that may be referred to and a substantial wider body of research looking at these same questions in connection with other forms of transport infrastructure<br>• There are several sources of relevant secondary data available with the granularity needed to determine impacts or to establish a scheme's contributions to any measured impacts<br>• Primary research will be necessary, however, the impact evaluation will make use of established research questions and proven data collection processes<br>• The counterfactual strategy will be important, and quite challenging given the highly variable nature and topography of schemes and the ease with which authorities will be able to find comparison areas that provide a good match |
| Decongestion and improved connectivity: labour market impacts | • The impacts of improved cycling infrastructure on employment have not been extensively researched, and this is an area where evaluators will benefit from further empirical studies going forwards to help calibrate their choice of impact measures and associated impact evaluation strategies<br>• There are several sources of relevant secondary data available on local labour markets, however, most don't have the granularity needed to determine impacts or to establish a scheme's contributions to any measured impacts<br>• Primary research will be necessary<br>• The counterfactual strategy will be important, and quite challenging given the highly variable nature and topography of schemes and the ease with which authorities will be able to find comparison areas that provide a good match |
| Social inclusion: access to key services | • The impacts of improved cycling infrastructure on social inclusion have not been extensively researched, and this is an area where evaluators will benefit from further empirical studies going forward<br>• There are several sources of relevant secondary data available on access to key service, however, they don't have the granularity needed to determine impacts across local districts or socio-economic groups<br>• Primary research will be necessary<br>• The counterfactual strategy will be important, and quite challenging given the highly variable nature and topography of schemes and the ease with which authorities will be able to find comparison areas that provide a good match |

| Impact category | Methodological feasibility |
|---|---|
| The cycling economy:<br>• output / employment<br>• designers, engineers and contractors | • The types of impacts and confounding issues are well understood, with various empirical studies that may be referred to as a source of definitions and research strategies<br>• There are a few sources of relevant secondary data available, but not with the granularity needed to determine impacts or to establish a scheme's contributions to any measured impacts<br>• Primary research will be necessary, as many aspects of the cycling economy are not covered by existing surveys and none of the secondary sources work at the required level of detail<br>• The counterfactual strategy will be important, however, it should be more straightforward to find comparison areas that provide a reasonably good match with the treatment area (in terms of the scale of the cycling economy) |
| Health impacts: improved physical activity | • The impact of cycling infrastructure on levels of physical activity has been researched in a small number of cases, and there have also been numerous studies exploring the impact of increased physical activity diabetes<br>• There are several sources of relevant secondary data available, which should allow quite detailed analysis over time of changes in the health of the population and the associated costs to the NHS<br>• Primary research will be necessary<br>• The counterfactual strategy will be important, and quite challenging given the number of other policy initiatives seeking to promote healthier lifestyles and improved health outcomes for all |
| Air quality | • The impact of cycling infrastructure on Air Quality has not been researched in any great detail, although the links between Air Quality and various health problems (e.g. respiratory disease) and premature death has been established<br>• There are several sources of relevant secondary data available at appropriate geographical resolution, covering changing traffic volumes, Air Quality and health data<br>• Primary research will be necessary to understand modal switching and the possible rebound in motorised traffic volumes in some of the most busy / congested locations<br>• The counterfactual strategy will be important, and quite challenging given the number of other policy initiatives seeking to improve air quality |
| Absenteeism | • The impact of cycling on absenteeism has been researched in several large-scale studies, here in the UK and overseas, which suggests there is a clear link between the two. There has been less work done on the link between cycling and psychological wellbeing, although there are one or two useful reference studies<br>• There are several sources of relevant secondary data available at appropriate geographical resolution, covering employment, modes of commuting and absenteeism, and also occasional household surveys that deal with wellbeing<br>• Primary research will be necessary<br>• The counterfactual strategy will be important |

## 5.3 Overall costs – three scenarios

Table 6 presents an overview of three financial scenarios and Figure 8 provides a graphic representation of those scenarios. Given the number of impact types and the potentially substantial costs involved in executing any one of the individual elements, we have devised three evaluation packages, with a lower cost scenario that covers each of the main social and economic impact types and deploys only study designs that we judge to be Maryland Level 1. Conversely, the higher cost scenario covers all impact types and only deploys study designs that we judge to be Maryland Level 3. The mid-priced scenario is a hybrid, and proposes a mixture of level 1 and level 3 study designs. The choice is based on our judgement as regards the likely importance of the impact type in question combined with a view on the likely added value of a more costly study design. On this last point, for several of the impact types (e.g. change in volume of retail trade), where there are few useful 'official' data, and there is necessarily a heavy reliance on primary data, the cost of a Level 3 study design will be very much greater than Level 1.

Our estimates are first approximations, and it is possible the Level 3 work packages while looking rather costly as written, are in fact under-budgeted.

Notwithstanding this caveat, in broad terms, our first approximations suggest that a robust assessment of the attributable impacts of single major investment in a smaller area is likely to cost at least £650,000. Working at a higher level of robustness, we estimate the Department or Local Authority may need to invest around £3.7 million in order to cover all impact types and in each case determine the net impact of its multiplicity of cycling investments in a larger and more complex setting. We believe the lower-cost scenario may be problematic in terms of the robustness of the evidence collected and conclusions that can be reached, and would therefore recommend narrowing the scope of any impact evaluation, to focus on a sub-set of the most important impact types (determined in part by the objectives of the infrastructure investment in question), in order to allow a configuration closer to Scenario two.

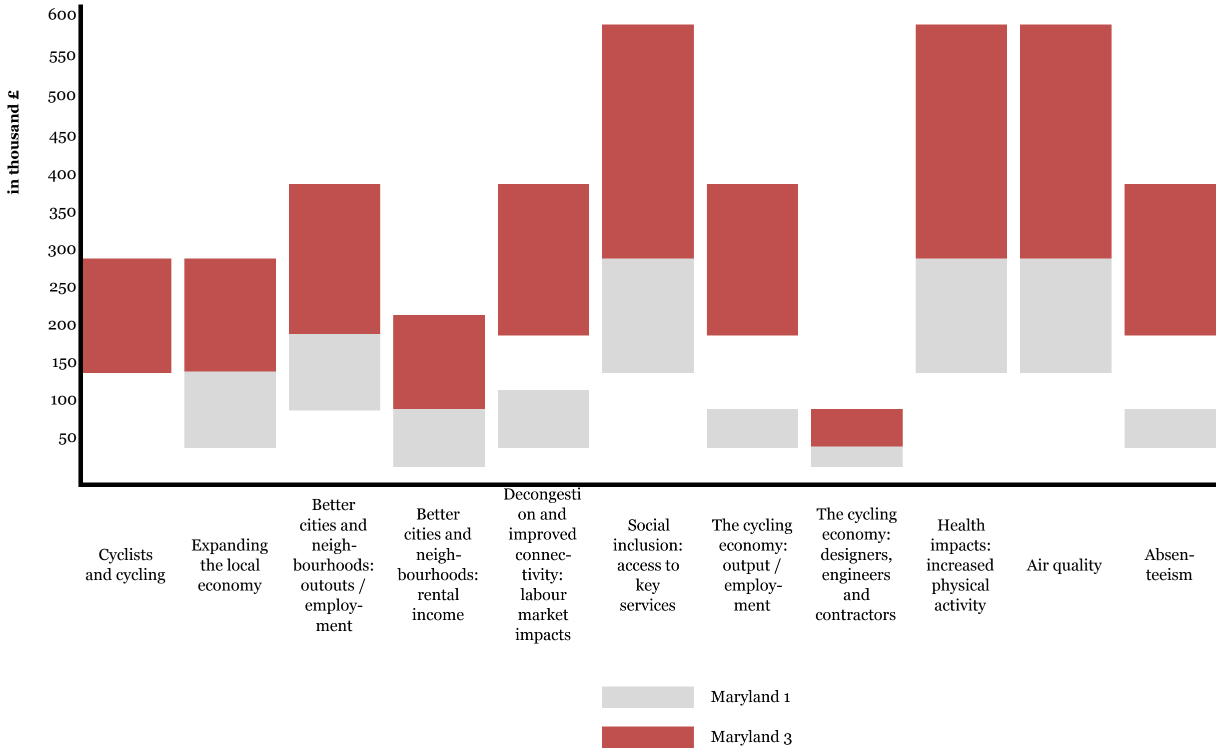
The other issue that arises from this consideration of costs is the relative value for money of the different options. Looking at the differences in the tractability and cost of the different impact evaluations, there may be a value for money argument to consider:

- Several of the economic impacts (e.g. expanding the local economy, better cities and neighbourhoods) offer relatively good chances of measuring net effects at medium cost. If these themes are a key objective of specific cycling infrastructure schemes, then the more robust evaluation approaches can arguably be justified on value for money grounds
- On the other hand, several of the social impacts (e.g. social inclusion, health impacts) would be more expensive to evaluate robustly and the number of confounding factors means the chances of definitively measuring net impacts would be relatively low. Therefore, unless these impact categories are essential to justification of schemes, or there is otherwise a particular demand for robust evidence about them, the more robust evaluation approaches are unlikely to represent good value for money. For these impact types, imputation of scheme-specific impacts based on measured changes in net cycling linked with the findings of other research on these themes would probably be more proportionate.

Table 6: Overview of cost options by type of impact, for three cost scenarios

| Type | Measures | Lower cost scenario | Medium cost scenario | Higher cost scenario |
|---|---|---|---|---|
| Cyclists and cycling | Increase in the number of people cycling regularly | **Option 2 – Maryland 3** £150K to £300K | | |
| Expanding the local economy | Increase in retail sales resulting from locals shopping locally and increased visitor numbers | **Option 1 – Maryland 1** £50K to £150K | **Option 2 – Maryland 3** £150K to £300K | |
| Better cities and neighbourhoods: output/ employment | Increase in output and employment resulting from businesses moving into the area and new start-ups | **Option 1 – Maryland 1** £100K to £200K | **Option 2 – Maryland 3** £200K to £400K | |
| Better cities and neighbourhoods: rental income | Increase in rental income for local landlords | **Option 1 – Maryland 1** **£25K to £75K** | | **Option 2 – Maryland 3** **£100K to £200K** |
| Decongestion and improved connectivity: labour market impacts | Reduction in the number of hard-to-fill vacancies resulting from improved access | **Option 1 – Maryland 1** £50K to £100K | | **Option 2 – Maryland 3** £200K to £400K |
| Social inclusion: access to key services | Reduction in differences in access to essential services across socio-economic groups | **Option 1 – Maryland 1** £150K to £300K | **Option 2 – Maryland 3** £300K to £600K | |
| The cycling economy: output / employment | Increase in economic output and jobs attributable to an expansion in bike sales and maintenance | **Option 1 – Maryland 1** £50K to £100K | | **Option 2 – Maryland 3** £200K to £400K |
| The cycling economy: designers, engineers and contractors | Increase in output and employment relating to the design and construction of the new infrastructure | **Option 1** £30K to £50K | | **Option 2** £50K to £100K |
| Health impacts: increased physical activity | Decrease in the proportion of residents with diabetes | **Option 1 – Maryland 1** £150K to £300K | **Option 2 – Maryland 3** £300K to £600K | |
| Air quality | Decrease in incidence of respiratory disease associated with poor air quality | **Option 1 – Maryland 1** £150K to £300K | **Option 2 – Maryland 3** £300K to £600K | |
| Absenteeism | Increase in economic output attributable to reduced levels of absenteeism and improved wellbeing | **Option 1 – Maryland 1** £50K to £100K | **Option 2 – Maryland 3** £200K to £400K | |
| | **Total** | £955K to £1,975K | £1,755K to £3,525K | £2,150K to £4,300K |

Figure 8: Overview of cost options per type of impact and level of robustness (in thousand £)



# Appendix A Evaluation design and cost options for different types of economic and social impacts

| **Type** | **Measures** | **Design and cost options** |
|---|---|---|
| Expanding the local economy | Increase in retail sales resulting from locals shopping locally and increased visitor numbers | **Option 1 – Maryland 1**<br>*Baseline*<br>Carry out a sample survey to estimate retail sales across the city-region or geographical area in scope, including the areas around and adjacent to the planned new cycling infrastructure (treatment) and one other comparable zone with a similar profile (selection based on = development mix, demographics, etc.) but without the cycling infrastructure. The survey would need to be complemented by 'footfall counters' and interviews with businesses and consumers. It could also consider spend out of town and spend in town by visitors (using VisitEngland's GB Tourism Survey). The baseline should be carried out no more than 12 months before construction work starts, and preferably 3-6 months<br><br>*Impact evaluation*<br>Carry out a second equivalent survey and programme of interviews 6-12 months after the opening of the new infrastructure<br>Use Difference in Difference analysis to compare the differences in trade and footfall for the treatment and comparison areas between one another and over time, in order to estimate the impact of the infrastructure<br><br>*Likely cost*<br>£50K to £150K<br><br>**Option 2 – Maryland 3**<br>*Baseline*<br>As before, but with a wider geographical scope to incorporate selected out of town-shopping centres or other possible areas where planners expect the infrastructure investment may produce some change in business<br><br>*Impact evaluation*<br>As before, but with the a wider geographical scope and using multiple comparison areas<br>And run a second ex post review 12-18 months after opening of the new infrastructure in order to gauge sustained impact<br>Analyse ONS data from the national monthly Retail Sales Inquiry, to adjust for any evident trend in wider retail activity within the region or possibly even particular categories of retail outlet<br>Run a DID regression analysis based on treatment and multiple comparison zones and using PSM to control for (exogenous) changes over time in those zones (e.g. proportion of retail, industrial, residential and other amenities within each area; occupational mix; demographic profile of residents, etc.)<br><br>*Likely cost*<br>£150K to £300K |

| Type | Measures | Design and cost options |
|---|---|---|
| Better cities and neighbourhoods: outcomes / employment | Increase in output and employment resulting from businesses moving into the area and new startups | **Option 1 – Maryland 1**<br>*Baseline*<br>Analyse newly registered businesses (from Companies House registrations) and businesses new to the city (using local estate agent data on commercial sales and lets), before running a sample survey (CATI) focusing on the areas in the immediate vicinity of the new cycling infrastructure and in a similar control area also within the city but without access to similar infrastructure. The survey would explore locational motivations as well as information about employment and annual sales. The baseline should be carried out no more than 12 months before construction work starts, and preferably 3-6 months, focusing on businesses that have been set up or moved into the area in the previous 12 months<br><br>*Impact evaluation*<br>Carry out an equivalent ex post analysis and survey 12 months after the opening of the new infrastructure for treatment area and one matching control area<br>Compare the differences in the number of startups / inward investments for the treatment and comparison areas, in order to estimate additional impact; Use DiD techniques to estimate any differences in employment and sales<br>Analyse trends in ONS regional and economic growth statistics (GVA / capita for the relevant NUTS 3 local authority area), IDBR data on regional business formation and UKTI data on FDI to provide a view of wider activity within the region<br><br>*Likely cost*<br>£100K to £200K<br><br>**Option 2 – Maryland 3**<br>*Baseline*<br>As before, but with a wider geographical scope and multiple comparison areas<br><br>*Impact evaluation*<br>As before, but with the a wider geographical scope and multiple comparison areas<br>And run a second ex post review 24-36 months after opening of the new infrastructure in order to gauge sustained impact<br>Analyse differences across treatment and multiple comparison zones<br>Adjust for any relevant trends evident in regional and local statistics on output, business formation and investment<br>Run a DID regression analysis based on treatment and multiple comparison zones and using PSM to control for (exogenous) changes over time in those zones (e.g. business mix within each area; demographic profile of residents, etc.)<br><br>*Likely cost*<br>£200K to £400K |

| Type | Measures | Design and cost options |
|---|---|---|
| Better cities and neighbourhoods: rental income | Increase in rental income for local landlords | **Option 1 – Maryland 1**<br>*Baseline*<br>Compile statistics on average residential and commercial rents for a number of property types from local authorities and local estate agents, for the areas around the planned infrastructure (treatment) and for one similar zone or area with no equivalent cycling infrastructure (control). Index against regional statistics on rents published by the government. The baseline should be carried out no more than 12 months before construction work starts, and preferably 3-6 months, as residential rents can change quite quickly month on month<br><br>*Impact evaluation*<br>Carry out an equivalent ex post analysis and survey 6-12 months after the opening of the new infrastructure for the treatment area, one matching control area and the city overall<br>Compare the differences in the rents for the treatment and comparison areas, in order to estimate any change in rents attributable to the infrastructure; Use DiD techniques to estimate any differences between areas and over time<br>Analyse trends in regional statistics to provide a view of wider rental activity within the region<br><br>*Likely cost*<br>£25K to £75K<br><br>**Option 2 – Maryland 3**<br>*Baseline*<br>As before, but with a wider geographical scope and multiple comparison areas<br><br>*Impact evaluation*<br>As before, but with the a wider geographical scope and multiple comparison areas<br>And run a second ex post review 24-36 months after opening of the new infrastructure in order to gauge sustained impact<br>Analyse differences across treatment and multiple comparison zones<br>Adjust for any relevant trends evident in regional statistics<br>Run a DID regression analysis based on treatment and multiple comparison zones and using PSM to control for (exogenous) changes over time in those zones (e.g. property mix within each area; demographic profile of residents, etc.)<br><br>*Likely cost*<br>£100K to £200K |

| Type | Measures | Design and cost options |
|---|---|---|
| Decongestion and improved connectivity: labour market impacts | Reduction in the number of hard-to-fill vacancies resulting from improved access | **Option 1 – Maryland 1**<br>*Baseline*<br>Work with employment agencies / advertisers to compile statistics on the numbers of vacancies across the city and at ward level if possible. Run a sample survey directed to employers across the city-region to profile the required skill levels of those current vacancies and the proportion that have proved hard-to-fill. The baseline should be prepared no more than 12 months before construction work starts, and preferably 3-6 months, as residential rents can change quite quickly month on month<br><br>*Impact evaluation*<br>Carry out an equivalent ex post analysis and employer survey 6-12 months after the opening of the new infrastructure, ensuring the research is conducted at a similar time of year to the baseline survey to avoid any seasonal differences<br>Compare the differences in the numbers of vacancies and hard-to-fill vacancies, by ward, skill level and broad sector (if samples a large enough), in order to estimate any change over time; Use DiD techniques to estimate any differences between areas and over time. Analyse trends in ONS national and regional statistics (and UKCES skills data from employers) to provide a view of vacancies more generally<br><br>*Likely cost*<br>£50K to £100K<br><br>**Option 2 – Maryland 3**<br>*Baseline*<br>As before, but with a wider geographical scope to include employers in areas that are expected to become more 'commutable' as a result of the new infrastructure investment. Run a household survey – based on the ONS Labour Force Survey – to profile employment and unemployment levels and to understand job search and commuting (Cross-checked with data from Department for Work and Pensioners on the numbers of people locally claiming job seekers' allowance).<br><br>*Impact evaluation*<br>As before, desk research and employer survey 6-12 months after the opening of the new infrastructure<br>And run a second ex post review 24-36 months after opening of the new infrastructure in order to gauge sustained impact (desk, employer and household survey)<br>Analyse differences across wards around treatment and multiple comparison zones, as well as throughout the city and the 'newly commutable' areas<br>Adjust for any relevant (external) trends evident in national and regional statistics<br>Run a DID regression analysis based on treatment and multiple comparison zones and using PSM to control for (exogenous) changes over time in those zones (e.g. business mix within each area; occupational types and skill levels; demographic profile of residents, etc.)<br><br>*Likely cost*<br>£200K to £400K |

| Type | Measures | Design and cost options |
|---|---|---|
| Social inclusion: access to key services | Reduction in the differences in access to essential services across socio-economic groups | **Option 1 – Maryland 1**<br>*Baseline*<br>Primary research to establish levels of access to key services for different socio-economic groups in areas across the city or region, involving a large-scale household survey to gather DfT-style information on access and the populations in question (well characterised, by age, gender, employment status, socio-economic group, etc.). Survey should cover the areas around a planned infrastructure investment and in one other similar zone (control area) where there are no plans to build new cycling infrastructure. GIS and transport modelling will be needed to quantify access to key services. Run the analysis no more than 12 months before the construction work begins and preferably just before<br><br>*Impact evaluation*<br>Carry out the post implementation review 12 - 24 months after the new infrastructure is opened<br>Use DfT statistics on access as a cross-reference.<br>Use DiD techniques to compare differences between treatment and control over time<br><br>*Likely cost*<br>£100K to £200K<br><br>**Option 2 – Maryland 3**<br>*Baseline*<br>As before, but with at least two comparison areas and a city-wide assessment (and larger samples to support more detailed matching). Use panel data (named individuals) rather than stratified random samples<br><br>*Impact evaluation*<br>As before, but with reviews at 12, 24 and 36 months<br>Use DiD techniques to compare differences between treatment and comparison areas over time, supported by PSM<br><br>*Likely cost*<br>£300K to £600K |

| Type | Measures | Design and cost options |
|---|---|---|
| The cycling economy: output / employment | Increase in economic output and jobs attributable to an expansion in bike sales and maintenance | **Option 1 – Maryland 1**<br>*Baseline*<br>Identify and survey a sample of cycle retailers / workshops across the city-region to arrive at an estimate of income and employment relating to the sale of bikes and accessories and the repair and servicing of equipment (non-specialists like Halfords, specialists like Evans, e-tailers, wholesalers and manufacturers). Include a larger sample of bike shops in the area closest to the planned infrastructure (treatment) and for one similar zone or area with no equivalent cycling infrastructure (control). The baseline should be carried out no more than 12 months before construction work starts<br><br>*Impact evaluation*<br>Carry out an equivalent survey 6-12 months after the opening of the new infrastructure for the treatment area, one matching control area and the city overall<br>Compare the sales and employment for the treatment and comparison areas, in order to quantify any change in activity levels as compared with the baseline; Use DiD techniques to estimate any differences between areas and over time that are attributable to the cycling infrastructure<br><br>*Likely cost*<br>£50K to £100K<br><br>**Option 2 – Maryland 3**<br>*Baseline*<br>Industry survey as before, but with multiple comparison areas. Plus a household survey – with several questions from National Travel Survey – to quantify citizen's access to bikes and the nature, extent and source of any purchases of cycles or accessories<br><br>*Impact evaluation*<br>Carry out an equivalent industry survey 6-12 months after opening<br>And run a second ex post review 24-36 months after opening of the new infrastructure in order to gauge sustained impact<br>Run a second household survey to gauge use / consumption of cycles and cycling services by residents<br>Analyse differences across treatment and multiple comparison zones<br>Run a DID regression analysis based on treatment and multiple comparison zones and using PSM to control for (exogenous) changes over time in those zones<br><br>*Likely cost*<br>£200K to £400K |

| Type | Measures | Design and cost options |
|---|---|---|
| The cycling economy: designers, engineers and contractors' | Increase in output and employment relating to the design and construction of the new infrastructure | **Option 1**<br>*Baseline*<br>No baseline<br><br>*Impact evaluation*<br>Carry out financial analysis within 3-6 months of completion of infrastructure<br>Collect and analyse cost data from the relevant local authority / commissioning bodies to establish the broad sectoral mix of the purchases, which could then be used to estimate the indirect and induced impacts of these purchases within the wider UK economy, based on established input-output multipliers (to arrive at an estimate for GVA and employment, with the local / national split being dictated by the standard tables). Use standard transport infrastructure coefficients to adjust for likely deadweight and leakage effects.<br><br>*Likely cost*<br>£30K to £50K<br><br>**Option 2**<br>*Baseline*<br>Targeted interviews with a sample of local designers and construction firms to estimate the level of income they would expect in a typical year that relates to cycling infrastructure specifically (design, build, repair, maintain). 12 months before planning / design work begins<br><br>*Impact evaluation*<br>Carry out financial analysis within 3-6 months of completion of infrastructure<br>A more robust analysis would gather detailed cost data from the relevant local authority / commissioning body to establish the sectoral and geographical mix of each of those suppliers, within the local, wider and international marketplace. One might also consider looking at prices / work packages for the good but unsuccessful bids, in order to arrive at a more rounded view of prices, the mix of work and suppliers. To ensure a more accurate estimate of indirect and induced effects, on GVA and employment, one would use the detailed supplier data as the basis for analysis of the ONS IO tables.<br>Targeted interviews with local industry to seek views on the likelihood that the increase in cycling infrastructure may have a lasting effect on the level of cycling-related business they anticipate going forward. 12 months after opening of new infrastructure<br><br>*Likely cost*<br>£50K to £100K |

| | | |
|---|---|---|
| Health impacts: increased physical activity | Decrease in the proportion of residents with diabetes | **Option 1 – Maryland 1**<br>*Baseline*<br>Use QOF / HES data to establish prevalence of Type 2 Diabetes within the population (well characterised, by age, gender, employment status, socio-economic group, etc.) in the areas around a planned infrastructure investment and in one other similar zone (control area) where there are no plans to build new cycling infrastructure. Run the analysis no more than 12 months before the construction work begins and preferably just before<br><br>*Impact evaluation*<br>Carry out the post implementation review 12 -24 months after the new infrastructure is opened<br>Use national / regional statistics on prevalence and associated costs, to provide a basis for computing costs / health burden.<br>Use DiD techniques to compare differences between treatment and control over time<br><br>*Likely cost*<br>£100K to £200K<br><br>**Option 2 – Maryland 3**<br>*Baseline*<br>As before, but with at least two comparison areas and a city-wide assessment (and larger samples to support more detailed matching)<br>Use panel data (named individuals) rather than stratified random samples<br>Link QOF and HES data with patient / citizen-level data from other household surveys (e.g. National Travel Survey)<br><br>*Impact evaluation*<br>As before, but with reviews at 12, 24 and 36 months<br>Use DiD techniques to compare differences between treatment and comparison areas over time, supported by PSM<br><br>*Likely cost*<br>£300K to £600K |

| | | |
|---|---|---|
| Air quality | Decrease in incidence of respiratory disease associated with poor air quality | **Option 1 – Maryland 1**<br>*Baseline*<br>Use QOF / HES data to establish prevalence of asthma within the population (well characterised, by age, gender, employment status, socio-economic group, etc.) in the areas around a planned infrastructure investment and in one other similar zone (control area) where there are no plans to build new cycling infrastructure. Run the analysis no more than 12 months before the construction work begins and preferably just before<br><br>*Impact evaluation*<br>Carry out the post implementation review 12 - 24 months after the new infrastructure is opened<br>Use national / regional statistics on prevalence and associated costs, to provide a basis for computing costs / health burden.<br>Use DiD techniques to compare differences between treatment and control over time<br><br>*Likely cost*<br>£100K to £200K<br><br>**Option 2 – Maryland 3**<br>*Baseline*<br>As before, but with at least two comparison areas and a city-wide assessment (and larger samples to support more detailed matching)<br>Use panel data (named individuals) rather than stratified random samples<br>Link QOF and HES data with patient / citizen-level data from other household surveys (e.g. National Travel Survey)<br><br>*Impact evaluation*<br>As before, but with reviews at 12, 24 and 36 months<br>Use DiD techniques to compare differences between treatment and comparison areas over time, supported by PSM<br><br>*Likely cost*<br>£300K to £600K |

| | | |
|---|---|---|
| Absenteeism | Increase in economic output attributable to reduced levels of absenteeism and improved wellbeing | **Option 1 – Maryland 1**<br>*Baseline*<br>Sample survey of employers and employees to establish mode of commuting, levels of absenteeism and staff turnover, focusing on the areas in the immediate vicinity of the new cycling infrastructure and in a similar control area also within the city but without the same levels of provision of cycling infrastructure. The baseline should be carried out no more than 12 months before construction work starts, and preferably 3-6 months<br><br>*Impact evaluation*<br>Carry out an equivalent ex post analysis and survey 12 months after the opening of the new infrastructure for treatment area and one matching control area<br>Compare the differences in the absenteeism / churn for the treatment and comparison areas, in order to estimate impact; Use DiD techniques to estimate any differences over time between areas and for both metrics<br>Compare / index against relevant data from LFS regionally and nationally, on absenteeism and average time in post<br><br>*Likely cost*<br>£50K to £100K<br><br>**Option 2 – Maryland 3**<br>*Baseline*<br>As before, but with a wider geographical scope and multiple comparison areas<br>Complement employer survey with household survey, using LFS questions<br><br>*Impact evaluation*<br>Carry out an equivalent ex post analysis and survey 12 months after the opening of the new infrastructure<br>Run a second ex post review 24-36 months after opening of the new infrastructure in order to gauge sustained impact<br>Analyse differences across treatment and multiple comparison zones<br>Adjust for any relevant trends evident in national and regional statistics (e.g. impact of economic crisis on absenteeism and turnover)<br>Run a DID regression analysis based on treatment and multiple comparison zones and using PSM to control for (exogenous) changes over time in those zones (e.g. sectoral mix, size mix, occupational profiles, local labour markets, etc.)<br><br>*Likely cost*<br>£200K to £400K |

# Appendix B Overview of cycling plans and cycling activity

Table 7: Overview of candidate areas and programme types

| Cycling programme | HS2 corridor cycleway and the Buckinghamshire priority link | Leeds and the CityConnect Programme / Leeds-Bradford Cycle Super Highway | Sheffield and the South Yorkshire cycle action plan | Brighton & Hove's cycling strategy | Kingston-upon-Thames mini-Holland |
|---|---|---|---|---|---|
| **Time frame** | Proposal stage | Ongoing since 2010. Construction started in Jan 2015 | 2011-2015 (ongoing) | 2005-2008 | 2015-2016 (ongoing) |
| **Area type** | Rural | City region (urban and rural) | City region (urban) | Small city (suburban) | Outer London borough (suburban) |
| **Population (Census 2011)** | 505,300 (Buckinghamshire); 174,100 (Aylesbury Vale) | 751,500 | 552,700 | 273,400 | 160,100 |
| **Scale of the infrastructure investment** | HS2 investment options range from £100m-£450m and above | £29.2m | Investment options range from minimum £5,648K - £8,716K (4-year plan) | Total budget of £3m. £500,000 per year from DfT for 3 years (starting 2005) with local authorities match funding of £500,000[58] | £30m, 4-year investment |
| **Principal objective** | Increase cycling in England via the creation of a cycleway of a world class standard that broadly follows the alignment of the high speed 2 (HS2) railway network<br>• Increase cycling in between Brackley and Buckingham, providing a **linear park** and **traffic free route** and an invaluable place to learn | CityConnect will make it easier and **safer** to get around on foot and by bike giving you better **access** to your local area, increasing your travel options and reducing road **congestion** | To achieve a modal shift away from vehicle use in order to release highway capacity, thereby **reducing lost productive time** and **CO2 emissions and improving air quality**;<br>To increase levels of active travel contributing to **healthier lifestyles, quality of life** and tackling social exclusion, obesity and health inequalities | Maximise the role of cycling as a transport mode, in order to **reduce the use of private cars**, improve **health** and reduce social exclusion; Develop a **safe**, convenient, efficient and **attractive** transport infrastructure which encourages and facilitates walking, cycling and the use of public transport and powered two-wheelers, and minimises reliance on, and | Make cycling in the borough more convenient, better connected and safer, making cycle travel appeal to many more people more often; seen as an **enjoyable, safe, practical and accessible** everyday option for more people, including older and disabled people, children and families; reduce **congestion** by encouraging more people to |

[58] DfT (2009) Analysis and synthesis of evidence on the effects of investment in six Cycling Demonstration Towns (also cite as Sloman L, Cavill N, Cope A, Muller L and Kennedy A (2009) Analysis and synthesis of evidence on the effects of investment in six Cycling Demonstration Towns Report for Department for Transport and Cycling England) 27% increase in cycling and physical activity 2006-2009 (Automatic cycle counts) 8% increase in counts of parked bicycles 2007-2009 [58] Proportion of adult residents doing any cycling in a typical week in the previous year: **+7%** or +1.7%-points (from 24.7% to 26.4% (Surveys in 2006 and 2009[58])

| | | | | | |
|---|---|---|---|---|---|
| | to cycle again as well as popularizing the activity. | | | discourages unnecessary use of private cars; Ensure that policies to increase cycling and meet the needs of cyclists are fully integrated into the council's Structure Plan, Local Plan, Local Transport Plan and Road Safety Plan and into all complementary strategies including transport studies and strategies, and regeneration, social inclusion, environment, education, health and leisure strategies and community initiatives | cycle, freeing up road space for those making journeys for which the car or bus is the only sensible option. And improve relations between cyclists, drivers and pedestrians through innovative design that caters for the needs of all road users |
| **Key elements of the investments** | Major investment in infrastructure: identify new routes and upgrade existing cycle networks | Major investment in infrastructure: CityConnect is a new 23km cycle super highway being created from East Leeds to Bradford Centre | Modal cycling programme with some investment in infrastructure: investment in increasing cycling to school and work via the provision of cycle training and safe routes; integration with public transport (e.g. parking); complementary initiatives (e.g. cycle maintenance, public bike hire) | Multi-faceted cycling policy with major investment in infrastructure: 28 initiatives to support the development of cycle routes ranging from safe routes, cycle audits, cycle route maintenance, cycle maintenance, cycle training, and cycle campaigns | Major investment in infrastructure: Every day infrastructure includes the development of a strategic routs network, hubs around Kingston station plaza and Surbiton station. Landmark projects are the Thames riverside bridge and the Thames riverside broadway. Some investment in bikeability training |
| **Number of residents (16-74) cycling to work in 2011 (ONS, 2011)** | 1,474 (Aylesbury Vale) | 6,237 | 4,267 | 6,635 | 3,278 |
| **Proportion of working residents (16-74) cycling to work in 2011 (ONS, 2011)** | 1.6% (Aylesbury Vale) | 1.8 % | 1.7% | 4.7% | 4.0% |
| **Change in proportion of working residents (16-74) cycling to work, 2001-2011 (ONS, 2011)** | -0.4 (Aylesbury Vale) | 0.5 | 0.7 | 2.1 | 0.9 |

# Appendix C Logic models for cycling infrastructure programmes

The logic models capture the global and specific objectives of the investment in question as well as the associated indicators as set out in the programme documentation. As is customary, the logic models comprise a hierarchy connected propositions – cause and effect – whereby there is an presumption in the logic that a given activity will produce a given output and a given output will produce a given outcome and so on through to the programme's overall objective or goal. The logic is expected to work, subject to various external assumptions also turning out to be true. For example, it is generally assumed that various external factors (e.g. the local labour market or macro-economic changes) will not have a major bearing on the success or otherwise of the cycling programmes. The policy teams responsible for the respective programmes have not verified the logic models.

## C.1 HS2 corridor

Figure 9: Logic model for the HS2 corridor

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| **Global objective** | Increase cycling in England via the creation of a cycleway of a world class standard that broadly follows the alignment of the high speed 2 (HS2) railway network.<br>• Increase cycling in between Brackley and Buckingham, providing a linear park and traffic free route and an invaluable place to learn to cycle again as well as popularizing the activity. | |
| **Specific objective** | Create a mainly traffic free core route that would be attractive to non-confident cyclists and encourage domestic and international tourism | Cycle parking and changing facilities in office buildings of business centres<br>Traffic free cycle access to employment hotspots<br>Cities establishing a cycle friendly reputation |
| **Specific objective** | To serve both leisure and utility cyclists and walkers by providing safe, convenient, attractive and continuous network of links to stations, urban centres, existing and planned employment centres, tourist attractions and new housing developments within the HS2 corridor<br>Place-making and public realm; more attractive, useable open space | Reduction in accident rates for cyclists<br>Increase in tourism travelling via train and/or cycle ways<br>Reduce cost of transportation<br>Improve air quality<br>Reduction in stress of commuting and mental well-being<br>Reduction of burden on NHS in relation to disease attributable to inactivity<br>Increase physical activity |
| **Specific objective** | Provide a national exemplar of a modern and international cycling network and its infrastructure | Traffic free access to new high speed stations<br>Overcome car dependency in a number of settlements along the route<br>Support the agenda of DEFRA, treasury, DCMS, DCLG, DfE on cross-cutting topics |

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| **Programme objective** | Identify new routes and upgrade existing cycle networks to provide confidence to the large number of people interested in cycling but who currently do not do so. This involves the development of local routes that feel tranquil, safe and are as flat as possible<br>• Priority route Brackley and Buckingham: create a cycling route along the former railway. This cycleway is identified as one of the priority links of the HS2 cycleway project. | Five options:<br>1. £100m: create some prioritised new local routes<br>2. £255m: provide new routes into and out of settlements within the HS2<br>3. £300m: create a linear route. For a further £45m these routes could be joined together into a single linear route connecting London, Manchester and Leeds<br>4. £450m: create a linear route connecting London, Manchester and Leeds with satellite links. For a further £150m, settlements close to the linear route could be linked to the main route via a series of spurs<br>5. Creation of a 'higher standard' option<br>The Brackley and Buckingham project entails:<br>• Resurfacing of sections of the route<br>• Creation of new cycle paths in sections of the route<br>• Widening pathways along sections of the route<br>• Construction of a new bridges<br>• Trim overgrown embankment, replace missing sections of embankment<br>• Introduce zebra crossings<br>• Ect. |

Source: Technopolis reading of DfT (2014) Cyleway associated with HS2

## C.2 Leeds and the CityConnect programme

Figure 10: Logic model for Leeds and the CityConnect programme

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| **Global objective** | CityConnect will make it easier and safer to get around on foot and by bike giving you better access to your local area, increasing your travel options and reducing road congestion. | |
| **Specific objective** | To increase walking and cycling so that it becomes part of residents' healthy living plan | |
| **Specific objective** | To make cycling a natural and popular choice for short journeys | Introduce cycle parking on key points along the route |
| **Specific objective** | To make cycling accessible to all low income and vulnerable groups | |
| **Specific objective** | Improve access to employment, skills and education | |
| **Specific objective** | Reduce CO2 and improve to local air quality | |

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| **Specific objective** | Create a safe environment for active modes | Educate other road users (lorry drivers, bus drivers, general public)<br>Reduce speed limits when cyclists are intended to mix with general traffic<br>Allow cyclists to set from a junction at a different time than HGVs<br>Introduce high quality surfacing of the Leeds-Liverpool canal towpath<br>Introduce a segregated cycleway along parts of the route |
| **Programme objective** | CityConnect is a new 23km cycle super highway being created from East Leeds to Bradford Centre. | CityConnect consists of a number of different schemes including[59]:<br>• Bradford – Leeds cycleway – largely segregated<br>• Leeds Liverpool Canal Towpath Upgrade<br>• Improved Leeds City Centre cycle parking and cycle lanes<br>• 20 mph zones for adjacent streets to the CityConnect cycleway<br>• (Best Foot Forward – getting more people walking in their own communities)<br>The full scheme (Cycle Superhighway, Towpath Upgrade and Supporting Measures) will cost £29.2 million.[60] The funding will come from a combination of £18.05 million in DfT funds, £10.89 million in Local Authority contributions, with the remainder coming from third party contributions |

Source: Technopolis reading of http://cyclecityconnect.co.uk/faq.php and http://www.leeds.gov.uk/residents/Pages/city-connect.aspx

## C.3 Sheffield and the South Yorkshire Cycle Action Plan

Figure 11: Logic model for South Yorkshire Cycle Action Plan

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| **Global objective** | To achieve a modal shift away from vehicle use in order to release highway capacity, thereby reducing lost productive time and CO2 emissions and improving air quality;<br>To increase levels of active travel contributing to healthier lifestyles, quality of life and tackling social exclusion, obesity and health inequalities | |
| **Specific objective** | More efficient travel and healthier employees. | More efficient journeys<br>Reduced level of sickness<br>Reduced need for car parking spaces |
| **Specific objective** | Quality of life, tackling social exclusion and health inequalities (incl. personal finance). | Increase the number of children cycling |

[59] CityConnect is a partnership between Leeds City Council, City of Bradford Metropolitan District Council and West Yorkshire Combined Authority (WYCA). £18.1 million of the funding comes from the Department for Transports Cycle City Ambition Grant and the remaining £11 million is matched locally through the Local Transport Plan and other funds. http://www.leeds.gov.uk/residents/Pages/city-connect.aspx

[60] http://cyclecityconnect.co.uk/faq.php

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| **Specific objective** | Increasing physical activity, thereby improving health and reducing risk of disease | Physical activity<br>Heart disease<br>Cyclists are cycling longer journeys<br>Shift to bike from other modes of transport |
| **Specific objective** | Training of cycling skills and volume of cyclists (critical mass) as well as improved infrastructure should improve safe cycling, thereby also removing an important barrier for more people to take up cycling | Number of deaths and serious injuries<br>Increase in bicycles parked at public transport stations and interchanges |
| **Specific objective** | Fewer car miles will reduce CO2 emissions and air quality | Reduction of car journeys to schools<br>Reduction of car journeys to work<br>Volume of traffic<br>CO2 reductions (calculated from 1-3)<br>Reduction in morning peak car traffic |
| **Specific objective** | Improve perception to cycling, develop cycling culture and improve cycling skills. | People received training<br>Perception of cycling/barriers to cycling |
| **Specific objective** | Demonstrate approach to cycling: combining behavioral and infrastructure interventions | Demonstrated benefits of combining Smarter Choices and cycling infrastructure |
| **Programme objective** | Investment in increasing cycling to school and work via the provision of cycle training and safe routes; integration with public transport (e.g. parking); complementary initiatives (e.g. cycle maintenance, public bike hire) | Minimum funding for strand 1-4: £ 5,648,000<br>Ideal funding level for strand 1-4: £ 8,716,000<br>Depending on funding level:<br>• 15/20/30% of schools have Bike IT and CSNA/Safe Routes to School<br>• 1500/2250/3000 employees in Bike Boost (30/45/60 employers)<br>• Cycle training delivered to 1000/1200/1500 employees/year<br>• 8000/12000/16000 individuals receive personalised travel planning<br>• Secure cycle storage at all stations and interchanges |

Source: Technopolis reading of the South Yorkshire Cycling Action Plan, 2011

## C.4 Brighton & Hove's Cycling Strategy

Figure 12: Logic model for Brighton & Hove's Cycling Strategy

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| **Global objective** | Increase cycling in the city: Maximise the role of cycling as a transport mode; Develop a safe, convenient, efficient and attractive transport; Ensure that policies to increase cycling and meet the needs of cyclists are fully integrated into the council's Structure Plan, Local Plan, Local Transport Plan and Road Safety Plan and into all complementary strategies including transport studies and strategies, and regeneration, social inclusion, environment, education, health and leisure strategies and community initiatives | |
| **Specific objective** | Maximising Cycling:<br>Maximise the role of cycling as a transport mode, in order to reduce the use of private cars, improve health and reduce social exclusion | Increasing Cycle Trips (Target 1)<br>Treble the number of cycle trips measured on cordon-based counts over the ten year period (to 2010).<br>Public attitude to cycling: Increase the proportion of people who think that it is easy and safe to cycle (Target 2 – measured via interview survey)<br>Reducing Accidents involving Cyclists (by 2010, compared to the average for 1994-98 - Target 4):<br>• Reduce the number of cyclists killed or seriously injured in road accidents by 40%;<br>• Reduce the number of children cycling who are killed or seriously injured by 50%;<br>• Reduce the slight casualty rate for cyclists by 10% expressed as the number of cyclists slightly injured per 100 million vehicle kilometres.<br>(Additional possible indicators:<br>– Reduce congestion<br>– Reduce pollution<br>– Increase attractiveness of the town<br>– Improve health<br>– Decrease travel time for people with no car) |
| **Specific objective** | Transport Infrastructure:<br>Develop a safe, convenient, efficient and attractive transport infrastructure which encourages and facilitates walking, cycling and the use of public transport and powered two-wheelers, and minimises reliance on, and discourages unnecessary use of private cars. | Completing Key Cycle Routes (Target 3): Complete five key cycle routes by the end of 2005/6, namely:<br>• Lewes Road Corridor (to Brighton city centre) National Cycle Network (NCN)<br>• Regional Route No. 90;<br>• South Coast Cycle Route (i.e. the seafront cycle route) NCN Route 2;<br>• London Road Corridor (to Brighton city centre) NCN Route 20;<br>• Hangleton to Hove town centre NCN Regional Route 82; and<br>• Dyke Road corridor (Just north of bypass to Brighton city centre)<br>Increasing Cycle Parking Facilities (Target 5): Increase the amount of publicly available cycle parking facilities by providing |

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| | | for an additional 300 bicycles over the period from 2002/3 to 2005/6 inclusive; some of these facilities to be Sheffield Cycle Stands and some to be more secure facilities such as cycle lockers.<br>Reducing Cycle Theft (Target 6). Reduce cycle theft as reported to the Police by 25% by 2010/11 compared to the average for 2000/1- 2002/3, taking into account the change in cycling levels.<br>Increasing Cycle Training (Target 7): Increase the proportion of 10–11 year olds each year having council-initiated onroad cycle training at schools to 50% by 2010/11.<br>(Additional indicators:<br>– Decrease in road traffic<br>– Roads are more cycle friendly) |
| **Specific objective** | Related Strategies:<br>Ensure that policies to increase cycling and meet the needs of cyclists are fully integrated into the council's Structure Plan, Local Plan, Local Transport Plan and Road Safety Plan and into all complementary strategies including transport studies and strategies, and regeneration, social inclusion, environment, education, health and leisure strategies and community initiatives | |
| **Programme objective** | Policies for cycle routes: | • Policy 1 Cycle Route Network. A network of high quality cycle routes will be completed within the city providing convenient and safe access to all destinations.<br>• Policy 2 Cycle Route Characteristics. Wherever possible, cycle routes will achieve high standards of coherence, directness, attractiveness, safety and comfort, and reflect the hierarchical approach to design, all as set out below from the IHT publication 'Cycle–friendly Infrastructure: Guidelines for Planning and Design' endorsed by the CTC (i.e. Cyclists' Touring Club) and the DfT.<br>• Policy 3 Priority for Cyclists in Traffic Management Schemes. Wherever possible, measures will be provided in traffic management schemes which give cyclists priority over motorised traffic in terms of accessibility and journey time but in accordance with the application of the hierarchies of road users to be adopted by the council.<br>• Policy 4 Cyclists and Pedestrianised Areas Measures to facilitate cycling will be integrated, where appropriate, with pedestrianised areas.<br>• Policy 5 Cycle Reviews of the Road Network Cycle Reviews of parts of the road network, including their associated parts of the Cycle Route Network, will be undertaken to an appropriate level of detail when considered necessary.<br>• Policy 6 Cycle Audits of New Schemes. Where required by a protocol on Cycle Audits, highway and traffic management schemes, including those forming part of, and arising from land-use developments will be audited. These audits, to be undertaken in accordance with national guidelines, will ensure that such schemes provide improvements to, or at least make no inadvertent negative impact on the coherence, directness, safety, attractiveness and comfort of routes used by cyclists.<br>• Policy 7 Cycle Routes on Development Sites The council will seek to ensure that development does not sever routes used by cyclists or unjustly prejudice accessibility by bicycle. The council will identify opportunities, and, where appropriate, will require developers to provide through routes for cyclists across development sites where these routes will deliver improvements to the wider cycle route network.<br>• Policy 8 Cycle Routes outside Development Sites. Wherever appropriate, the council will seek 'planning obligations' from developers in relation to their proposals in order to improve transport infrastructure to aid cyclists outside the |

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| | | development site.<br>• Policy 9 Protected Cycle Route on Railway Land. The council will protect from development railway land between Dyke Road Drive and New England Road to allow for the provision of a cycle route between Dyke Road Drive and the proposed 'Greenway' on the disused railway bridge over New England Road.<br>• Policy 10 Cycle Routes outside the City Boundary, Associated with Trunk Roadsand in the Countryside The council will work with adjoining local authorities and Sustrans, promoters of the National Cycle Network (NCN), to seek to ensure that cycle routes on either side of, and leading to the joint boundary are mutually compatible. The council will also liaise as necessary with the Highways Agency, who are responsible for trunk roads, about improvements to NCN routes in the A23 and A27 trunk road corridors; and with the Sussex Downs Conservation Board (SDCB) (and its planned successor, the South Downs National Park Authority) on cycle routes in the countryside.<br>• Policy 11 Cycle Route Maintenance and Cleansing and Cycle Parking Maintenance The council will seek to undertake high standard structural and surface maintenance, and cleansing and lighting maintenance of cycle tracks on pavements and paths, and of roads in the Cycle Route Network. Cycle stands will be resecured or replaced as necessary. Other forms of cycle parking such as lockers will also be maintained appropriately.<br>• Policy 12 Cycle Parking associated with Development Proposals. The council will seek the provision of cycle parking facilities associated with proposals for development proposals through the use of Policy TR12 in the council's Local Plan (second deposit draft, dated 2001) and Supplementary Planning Guidance Note 4.<br>• Policy 13 Cycle Parking to serve Existing Developments. The council will provide cycle parking spaces at locations in the city serving shops and leisure and tourist attractions, etc. Some of this parking will be in the form of Sheffield Stands<br>•<br>• installed on the pavement or in protected locations on the carriageway. More secure parking facilities, such as cycle lockers will also be provided primarily to cater for long-stay parking. Cycle parking will also be provided in connection with the policies in this document for School Travel Plans and Company Travel Plans.<br>• Policy 14 Reducing Cycle Theft. The council will consider and take actions to reduce cycle theft, recognising that fear of cycle theft is a major deterrent to cycling for utility journeys.<br>• Policy 15 The council will seek to ensure that cycling is fully integrated with public transport to facilitate cycle use as part of longer journeys.<br>• Policy 16 Casualty Reduction. The council's approach to casualty reduction is given in the Full Local Transport Plan (p 136-153) and the 'Road Safety Plan 1997 – 2000' and its First Review.<br>• Policy 17 Cycle Helmets. The use of cycle helmets will be encouraged.<br>• Policy 18 Cycle Training for Children. The council will seek to provide on-road cycle training at all schools who wish to be participate and will encourage other schools also to become involved<br>• Policy 18 Cycle Training for Children. The council will seek to provide on-road cycle training at all schools who wish to be participate and will encourage other schools also to become involved.<br>• Policy 19 Cycle Training for Adults. The council will encourage, and endeavour to secure on-road cycle training for adults.<br>• Policy 20 Campaigns to improve Road–User Behaviour. The council will support, and possibly initiate publicity campaigns aimed at educating cyclists about responsible behaviour and other road users about considerate driving and the needs of cyclists and other vulnerable road users.<br>• Policy 21 Enforcement of Traffic Law by the Police. The council will liaise with the Police to ensure that the enforcement |

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| | | of traffic law receives the highest possible priority.<br>• Policy 22 Enforcement by Parking Attendants. The council is responsible for parking enforcement and will encourage cycling by giving priority to action against illegal parking on the Cycle Route Network, particularly on any such routes with cycle lanes which are being frequently blocked by parked cars. If appropriate, changes will be sought to the parking restrictions to facilitate such enforcement.<br>• Policy 23 Travel Strategy for Schools. The Council will prepare, and consult with schools on a Travel Strategy for Schools which will encourage and facilitate cycling and walking (and public transport use where necessary) as a means to improve the safety, fitness and independent mobility of school children, and to reduce congestion and traffic danger around schools. Target 7 given in this strategy for increasing cycle training will be adopted.<br>• Policy 24 Company Travel Plans. The council will establish a Company Travel Plan for its employees, possibly including visitors to its premises. The Plan will seek to encourage and support other employers in starting or developing their plans. Such plans aim to promote environmentally-friendly travel choices including cycling and reduce reliance on the car.<br>• Policy 25 Campaigns to Encourage Cycling. The council will encourage use of its cycle routes and parking facilities through complementary publicity including emphasis on the health, financial and environmental benefits of cycling and the need for reduced use of private cars. The council will also support events raising the profile of cycling.<br>• Policy 26 The council will meet with representatives of local cycling organisations. to review policies relating to cycling and their implementation, and to obtain the representatives' views on cycle infrastructure proposals, other highway proposals affecting cyclists, preliminary versions of draft traffic regulation orders, and any issues or problems relating to existing schemes affecting cyclists.<br>• Policy 27 The council will obtain monitoring information to enable progress to be measured towards the targets given near the beginning of this document.<br>• Policy 28 The council will seek to identify and consider bidding for all possible funding sources for cycling and establish adequate budgets to meet the Targets and deliver on the Policies above. |

Source: Technopolis reading of http://www.brighton-hove.gov.uk/sites/brighton-hove.gov.uk/files/downloads/transport/B_Hcycling_strategy.pdf. http://www.brighton-hove.gov.uk/content/parking-and-travel/travel-transport-and-road-safety/cycling

## C.5 Kingston's 'mini-Holland' project

Figure 13: Logic model for Kingston's project

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| **Global objective** | Make cycling in the borough more convenient, better connected and safer, making cycle travel appeal to many more people more often; seen as an enjoyable, safe, practical and accessible everyday option for more people, including older and disabled people, children and families; reduce congestion by encouraging more people to cycle, freeing up road space for those making journeys for which the car or bus is the only sensible option. And improve relations between cyclists, drivers and pedestrians through innovative design that caters for the needs of all road users | |
| **Specific objective** | Increase the amount of cycling in the borough;<br><br>Encourage more cycling among 'hard to reach' groups;<br><br>Improve the level of satisfaction with cycling infrastructure | Increase in the number of cyclists<br>Double the level of cycling in the borough in the first three years of the programme<br>One in five trips to be made by bike within 10 years of the programme delivery commencing. |
| **Specific objective** | Transform the environment for cycling in the borough;<br><br>Provide a high quality, high capacity cycle network of interconnecting routes that form an identifiable core network<br><br>Facilitate part-cycled commuter journeys | Provision of high quality links towards the Cycle Superhighways to facilitate cycle journeys into central and inner London |
| **Specific objective** | Improve safety for cyclists | Cycling is actually and perceptually safer as a result of the high capacity cycle infrastructure<br>Bikeability Level 1 and 2 training to approximately 1,500 children each year and Bikeability Level 3 training to 200 secondary school children and adults<br>Programme of travel information, training, marketing and promotion |
| **Specific objective** | Reduce congestion and smooth the flow of traffic by making driving easier | Increase in children and young people cycling to and from school, college and university<br>Increase the overall capacity of transport network via an increase in cycling<br>Release of car parking spaces for those who need them<br>Reduction of pressure on public transport leading into our town centres |
| **Specific objective** | Improve the quality of the public realm | Improvement in pavements adjacent to the new cycle lanes and tracks<br><br>Make walking more comfortable due to distance to traffic<br><br>Level pavements making access by wheelchairs and those with sensory impairments easier.<br>Construction of a pedestrian and cyclist bridge over the Thames, provide improved connectivity but also open up the river bank, bringing more people to the waterfront. |

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| **Specific objective** | Support the vitality and viability of our town, district and local centres | Introduction of cycle parking in our town centres<br>Increase in people shopping locally rather than going further afield, helping local businesses to survive and expand, sustaining and increasing the variety of shops and services that people want to use. |
| **Programme objective** | Every day infrastructure includes the development of a strategic routs network, hubs around Kingston station plaza and Surbiton station. Landmark projects are the Thames riverside bridge and the Thames riverside broadway | A £30M, four year investment in new cycle hubs; station plaza; improved cycling routes; and an extended river cyclepath (Boardway)<br>Projects in key areas: a cycle link from New Malden to Raynes Park, a new public plaza outside Kingston train station<br>Wheatfield way 'Greenway' in Kingston town centre, a riverside boardway in Kingston town centre<br>New cycle routes: Portsmouth Road, Kingston Bridge / Kingston town centre connectivity, Kingston Hill / Kingston Vale, Kingston to Surbiton, Cambridge Road / Kingston Road, Ewell Road |

Source: Technopolis reading of Royal Borough of Kingston-upon-Thames (2013) stage II submission to the Mayors Outer London Cycling Fund, Mini Holland Bid.

## C.6 Norwich and Cycle City

Figure 14: Logic model for Norwich and Cycle City

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| **Global objective** | We aim to become an admired example of a progressive and prosperous European cycling city by doubling the level of cycling over the next ten years, and by narrowing the gap in cycling rates between women and men and between children and older people and those of working age.<br>Double the level of cycling within ten years<br>Broaden the demographic appeal of cycling | |
| **Specific objective** | Boost economic growth by enabling residents to reach job opportunities, city centre facilities and linking major development sites to the cycle network<br>Attracting businesses and employees by making the city attractive – architecture, public spaces, trees and cycling infrastructure. | Travel time benefits<br>Absenteeism |
| **Specific objective** | Place-making and public realm; more attractive, useable open space | Journey quality benefit |
| **Specific objective** | Improving the health and well-being of people, supported by building of excellent cycling infrastructure that makes cycling the obvious choice for most utilitarian journeys around the city<br>Tackle health problems in parts of the city with high levels of obesity<br>Reduce the rate of accidents involving cyclists and pedestrians | Physical activity and morbidity<br>Road safety – number of deaths and serious injuries per journey |
| **Specific objective** | Cut carbon emissions from journeys within the city | Air quality – level of emissions of $CO_2$ |
| **Programme objective** | An eight mile cross-city route that directly connects homes to important destinations and can be safely ridden by less experienced riders (such as an unaccompanied twelve year old) because the entire length is either separate from traffic or shares road space with traffic that travels at or below 20mph. | • A 20mph zone across the entire city centre, covering 228 hectares<br>• Targeted speed management in two neighbourhoods<br>• A simplification and clarification of the rules governing cycling in the pedestrianised heart of the city centre<br>• A comprehensive city wide cycling wayfinding system<br>• Street furniture clutter removal on an existing bicycle lane<br>• Augmentation of existing network of automatic cycle counters to monitor the performance of the interventions. |

## C.7 Hillingdon Uxbridge Cycle Scheme

Figure 15: Logic model for Hillingdon, Uxbridge Cycle Scheme (NB: the Hillingdon Mini-Holland bid was not a winning bid.)

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| **Global objective** | "Increasing the number of people making trips by bicycle has benefits for everyone. For the rider it is a relatively affordable mode of transport providing access to jobs, training and healthcare. It is also a good form of exercise helping to reduce the risk of heart disease. If more people cycle, this has benefits for the wider community by freeing up road space and tackling road traffic congestion. Journey times would become more reliable and buses more punctual. Air quality would improve and there would be less noise from vehicle traffic. Finally there would also be more seats available on buses and a reduction in demand for a limited supply of parking spaces". | |
| **Specific objective** | Economic: uptake of affordable mode of transport providing access to jobs, training and healthcare | Decrease the cost of transport for new cyclists<br>Cyclists can access work areas, education and training, doctors and hospitals |
| **Specific objective** | Health: reduce the risk of heart disease | Increase in mobility of (new) cyclists<br>The number of trips by bicycle |
| **Specific objective** | Wider impact:<br>• Free up road space and tackle road traffic congestion<br>• Make journey times more reliable and buses more punctual<br>• Improve air quality<br>• Decrease noise pollution<br>• Decrease demand for parking spaces<br>• Decreases dependency on bus transport | Decrease road traffic<br>Journey times are more reliable<br>Reduction of $CO_2$<br>Reduction of noise pollution along cycleways<br>Decrease demand for parking permits, increase in the availability of parking<br>Increase free space on buses |
| **Programme objective** | "Hillingdon's "Mini-Holland" bid is end to end seamless connectivity for cyclists along seven radial routes linking the Metropolitan town centre of Uxbridge, Brunel University, Hillingdon Hospital and the Grand Union Canal" (pp. 4) | University Line<br>• Shared space, Dutch cycle streets, carriageway realignment, parking £600k<br>• A408 Cowley Road junctions with side roads, reallocate road space £700k<br>• Sub total £1,300k<br>Hillingdon Hospital Line<br>• St Andrews roundabout cycle priority solutions £600k<br>• A4020 Uxbridge Road between Royal Lane and Uxbridge town centre £1,600k<br>• Royal Lane, Kingston Lane, Pield Heath Rd traffic calming measures £900k<br>• Junction treatments to secure space for cyclists £400k |

| Hierarchy of objectives | Description | Indicators |
|---|---|---|
| | | • Sub total £3,500k<br>Uxbridge “Western Approach” Line<br>• Cowley Mill Road (East) shared space £350k<br>• Junction treatments to secure space for cyclists £350k<br>• Sub total £700k<br>Uxbridge Industrial Estate Line<br>• Waterloo Rd/A4007 St John's Rd - Dolphin Bridge/Grand Union Canal £600k<br>• Junction treatments to secure space for cyclists £400k<br>• Sub total £1,000k<br>The Grand Union Canal<br>• Towpath improvements suitable for shared space £2,800k<br>• Sub total £2,800k<br>Hillingdon Circus Line<br>• Route upgrade between Uxbridge High St and Oxford Road £700k<br>• Junction modifications and parking bay conversions £100k<br>• Sub total £800k<br>Vyners Line<br>• B483 Park Rd cycle path between Swakeleys and St Andrews R'bout £1,300k<br>• Junction modifications and adjustments to signalled crossings £300k<br>• Sub-Total £1,600k<br>Cycle parking 500k<br>Boroughwide on-street cycle ways £500k<br>One way street exemptions £500k<br>Cycle tracks for training and leisure £200k<br>Marketing and publicity £200k<br>**TOTAL £13.1m** |

Source: Technopolis reading of http://www.hillingdon.gov.uk/cycling https://www.whatdotheyknow.com/request/186157/response/460997/attach/3/London%20Borough%20of%20Hillingdon%20Mini%20Holland%20bid%205%20July%202013%20Redacted.pdf; https://www.hillingdon.gov.uk/media.jsp?mediaid=28137&filetype=pdf

# Appendix D Notes from consultation with stakeholders

In our discussions with local officials and experts responsible for various cycling infrastructure programme, recommendations on the design of an evaluation scheme included the following elements:

- A tool that can be used alongside other transport-related evaluation methodologies, allowing the comparison and cross-appraisal of different options
  - Monetising the costs and benefits of cycling interventions means that planners can more readily compare cycling proposals with data on the cost and benefits for other transport modes, including cars. For example, the City of Copenhagen developed a method of comparing unit price costs of cycling (including for time costs, prolonged life, health, and accidents) with unit price costs for cars61. Similarly, the kinds of omnibus surveys favoured by local government can be used to capture the perceptions of citizens about recent and planned investments in cycling infrastructure, from a stratified sample of local people, both cyclists and non-cyclists
- A tool that allows for a range of levels of financial commitment and programme sophistication
  - The toolbox should include different study designs / approaches that will work with larger and smaller cycling programmes. The size and cost of any evaluation should be proportionate to the scale and complexity of the subject under review: a £1b infrastructure programme (roughly the size of Boris Johnsons cycle superhighways that have a price tag of £913M[62]) might reasonably be examined rather more closely than a £100K cycling project investment. The larger programmes should support more robust evaluation and may in time yield stylised facts that can be used by lighter touch evaluations of smaller interventions
- A flexible tool that can be used to evaluate the socio-economic impacts of the most prominent types of cycling infrastructure investments
  - Able to cover different levels of complexity ranging from single infrastructure investments through to broader policies that comprise a package of cycling interventions, possibly implemented over an extended period of time
  - Able to cover a range of types of distributive objectives, jointly or separately, including for example, cycling activity levels for different groups within a population (e.g. decomposed by gender or age), and cycling safety but also including local economic, environmental and longer-term health related benefits
  - Able to cover cycling interventions implemented in different area types and settings, including for example, urban, suburban and rural settings
- A tool that is user friendly and produces results that are credible / accessible to non-technical users, and estimates value for money in a way that may be used to communicate with (local) policy makers and stakeholders

[61] COWI (2009). Economic evaluation of cycle project – methodology and unit prices.

[62] https://www.london.gov.uk/media/mayor-press-releases/2015/01/mayor-announces-final-build-plans-for-crossrail-for-the-bike

  - The toolbox should yield robust and credible results. Caution should be taken to interpret monetised benefits and to compare and compile benefits of different types (health, safety, etc.) Monetised benefits may not be additive.
- A tool that has the flexibility to promote or demote certain specific types of objective (benefit) in line with wider (local) commitments, as changes in the political landscape may bring new or different manifestos and priorities

# Appendix E Methodologies

## E.1 Randomised Control Trial (RCT) / Cluster randomization trials

Commonly referred to as a 'gold-standard' methodology in establishing a causal relationship, a randomised control trial (RCT) requires full randomisation of programme participants. In the case of cycling infrastructure, this would mean that the characteristics of the group using the new cycling facilities should be closely matched (the same characteristics) with a group that is not using the cycling infrastructure in order to understand the extent to which the investment has caused citizens to begin cycling or increase their cycling. Given the fact that transport users self-select their mode of transport (e.g. electing to cycle or drive or take the bus), the strict condition of randomisation is usually violated: users and non-users are categorically different. Another limitation in the context of evaluating the impact of investment in cycling is that RCTs yield robust internal results but have limited external validity. Moreover, RCTs are often not feasible for the evaluation of economic and social impact of an intervention when it comprises a package of investments made over time and where the ultimate objective is an improvement in wider economic and social factors, such as the long-term health of citizens, and not simply increased cycling. RCTs cannot be used to capture trends. For these reasons, RCTs are not ideally suited to evaluating the longer-term impact of cycling infrastructure investments.[63] In particular, in the field of health, the Medical Research Council (MRC) has issued guidance on natural experiments and stated that there are situations where an RCT is clearly not possible (citing the example of urban motorway construction). MRC warns that it is important not to create an 'evidence bias' where evidence is only gathered on interventions that are amenable to certain research methodologies.[64]

A cluster randomization trial requires the same strict assumptions as the RCT but uses site e.g. workplace rather than individual as the unit of analysis. This requires a number of sites as part of the treatment group and a number of sites as part of the comparison group.

## E.2 Instrumental variables (IV)

Instrumental variable (IV) estimation methods apply 'instruments' to control for endogeneity between the intervention and the effect of the intervention on the target beneficiaries. The challenge with using instrumental methods to evaluate cycling interventions is identifying a valid instrument, i.e. a control variable that is exogenous, relevant, and excludable.[65]

Duranton and Turner (2012)[66] use an IV approach to study the effect of US interstate highways on the growth of employment in cities between 1983 and 2003. The set of instrumental variables used by the authors reflects a city's historic level of transportation infrastructure and the

[63] See Tavistock (2010) Guidance for transport impact evaluations. Choosing an evaluation approach to achieve better attribution. Report to the Department for Transport. Report dated March 2010, for an example of RCT method to evaluate a walking and cycling to work initiative.

[64] Craig P, Cooper C, Gunnell D, et al. Using Natural Experiments to Evaluate Population Health Interventions: Guidance for Producers
and Users of Evidence. London: Medical Research Council, 2011.

[65] For examples in the transport literature see Redding and Turner (2014) Transportation costs and the spatial organization of economic activity. NBER Working Paper 20235. http://www.nber.org/papers/w20235, Gibbons et el. (2012) New Road Infrastructure: the Effects on Firms. SERC discussion paper 117, September 2012, and Baum-Snow (2007) Did highways cause suburbanization? Quarterly Journal of Economics 122(2):775–805.

[66] Duranton and Turner (2012). Urban Growth and Transportation. Review of Economic Studies,79, 1407–1440.

suitability of the cities' geography for building roads. The authors use data on U.S. metropolitan statistical areas (MSAs) that describe interstate highways, decennial population levels since 1920, the 1947 plan of the interstate highway system, the U.S. railroad network at the end of the 19th century and, maps of routes of major expeditions of exploration of the U.S. from 1518 to 1850. On the basis of this IV approach, the authors conclude that an increase in a city's initial stock of highways causes an increase in employment.

### E.3 Difference-in-differences (DiD)

The DiD methodology compares the effect of the (cycling) intervention before and after the treatment using both a comparison (or control) group and a group receiving treatment. The group receiving no treatment, the comparison group, is used as a counterfactual to control for a change in behaviour that occurs independent of the treatment. For instance, it may be possible to compare the effect of bikeability training before and after the training, by looking at cycle use at two different schools, where bikeability training is only provided at one of the locations within the life of the study.[67] Alternatively, the effect of cycling infrastructure such as a cycle highway on (e.g.) cycling may be estimated by comparing the difference in cycling activity before and after the implementation of the new cycling infrastructure in two communities with different proximity to the cycle highway (i.e. those with good access to the infrastructure and those with less good access). Other factors may also influence the outcome and, unless controlled for, influence the credibility of establishing a causal relationship. A disadvantage of this approach is that individuals may move between the areas of 'treatment' when moving home, schools or work environment.

### E.4 Panel data methods

Panel data methods, such as random and fixed effect methodology, control for endogeneity by repeatedly observing the same subjects, e.g. individuals or communities, over time, allowing researchers to analyse change at the individual level. As in DiD analysis, other factors may influence the outcome and such factors should be controlled for. For example, panel data methods can be used to measure the increase in cycling activity for different economic and social groups over time, along with the implementation of cycling infrastructure (degree of continuity of cycling highways) in a region.

### E.5 Cross-sectional regression

In contrast to panel data methods, cross-sectional analysis studies the effect of (e.g.) a cycling intervention across a cross-section of individuals or communities (a population), at a single point in time, without attempting to track changes over time. Such an approach does not allow evaluators to establish a strict causal effect, however, cross-sectional analysis provides some idea of differences across individuals and communities and it is a rather more feasible and economical approach as compared with a longitudinal and panel data analysis.

### E.6 Before-and-After

Before and after analysis compares e.g. cycling activity, before and after the intervention in an area, without controlling for differences across individuals, towns or cities. As before, such an

[67] For examples from the transport literature see: Gibbons, Stephen and Stephen Machin (2005) Valuing rail access using transport innovations. Journal of Urban Economics 57(1):148–169 and Graham, D.J., R. Brage-Ardao and P.C. Melo (2013) Measuring the Impact of High-Speed Rail on Economic Performance: Evidence for the Madrid-Barcelona corridor. Paper presented at European Transport Conference, Frankfurt, October 2013. http://abstracts.aetransport.org/paper/index/id/136/confid/1

approach does not allow evaluators to establish a strict causal effect but collecting or analysing (aggregate) data for only one area type is more economical.

## E.7 Theory based approach

The theory-based approach articulates and tests the assumed (theorised) connections between an intervention (investment in cycling infrastructure) and a sequence of linked effects: outputs, outcomes and impacts. The theory-based approach does not provide evidence for a causal relation. Because evaluators will typically want to consider achievements at each level, i.e. outputs, outcomes and impacts, the theory based approach can complement more rigorous methodology and generate greater confidence in those results. In contrast to the selection of metrics measuring economic and social impact, the theory-based approach can typically draw upon a wider pool of output and outcome indicators to describe the correlations between different indicators of interest.

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