Estimating the benefits of active travel investment

for Active Travel England
John Nellthorp, Institute for Transport Studies, University of Leeds
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Summary

The central question addressed by this think piece is: how can economic appraisal be done better for active travel interventions that do not fit neatly into existing frameworks? The commissioning of this work by Active Travel England follows a successful workshop held at the Department for Transport (DfT) on 25 May 2022, where representatives from academia, civil service, transport authorities and other interested bodies met to discuss 'transport appraisal guidance and active travel'. The report also speaks to the points raised by the National Audit Office (2023) in relation to measuring and monitoring value for money from active travel interventions.

The main steps were:

- a rapid desk-based review of existing tools;
- identification of opportunities to address gaps in the current methodology, to update and/or strengthen the methods and the evidence base that already exists, and opportunities to enhance the tools available to practitioners;
- prioritisation of opportunities based on an initial assessment of work needed and timescales involved in implementation (short/medium/long term).

This was primarily a desk-based study, however the author also consulted with practitioners who are involved in both implementing and improving the current tools, as well as with the DfT and Active Travel England (ATE) who share the responsibility for this area of policy delivery. Academic groups across the UK (and beyond) have a wealth of relevant expertise, and the report identifies where research can help to provide necessary new evidence and inform the development of improved tools.

Findings on the state of the art

The 'state of the art' in active mode appraisal in England is already quite advanced in global terms. DfT provides appraisal guidance for active mode schemes in England and an Active Mode Appraisal Toolkit (AMAT) which partly automates and structures the appraisal. Some regional authorities have similar tools, which in some respects go beyond AMAT - e.g. Transport for London (TfL)'s ABC tool contains more detailed evidence on journey quality improvements, and Transport for Greater Manchester (TfGM)'s PEAT tool brings together the latest evidence including from AMAT and ABC. Globally, the World Health Organisation's HEAT Tool is an important comparator, whose scope is narrower than AMAT.

These appraisal methods and tools have some notable gaps, many of which are widely known - this report attempts to bring them together:

a. in the health benefits, the mortality benefits (life expectancy) are included but the **morbidity benefits (quality of life)** are not;
b. the **wider economic impacts** of active travel investment are limited, in appraisal, to the effects of reduced workplace absence - there is evidence that the effects go beyond this, but not yet a robust body of evidence that can be used in appraisal;
c. **travel time savings** for walking and cycling are now recognised by DfT as valid benefits, but work is needed so that they can be measured readily in AMAT;

d. **safety benefits** could be strengthened by bringing methods from PEAT into AMAT;
e. **place quality and urban realm** are valuable, but their coverage in transport appraisals is limited - further research is needed to complete the valuation of place-based benefits and potentially to join up local transport appraisal with appraisal of public health, housing and communities;
f. area-wide strategies are important to the success of active travel policy, and the appraisal methods could do more to enable and encourage the **assessment of schemes as part of a strategy**, rather than in isolation;
g. there is an opportunity to measure the health benefits from **active travel as an access mode to public transport** - focusing greater attention on the health implications of modal shift;
h. **embodied carbon in vehicles and infrastructure** needs to be regularly included in appraisals;
i. **journey quality improvements** are a key part of the existing methods and tools, but there is an opportunity to update the evidence and complete the set of journey quality benefits that are valued - for example, the benefits of active mode priority are not fully captured;
j. the **distributional impacts** of active mode investment could be focused and brought more to the fore, including by focusing on which impacts on household budgets are cashable (money) benefits, and relating this to local area incomes and potentially the use of 'Green Book' distributional weights; and
k. there are technical issues to be addressed around: **destination shift** (towards more local destinations); **NHS cost savings**; and the **definition of the benefit:cost ratio** (BCR).

Finally, the report highlights opportunities to reduce the burden of appraisal. More flexible and easier-to-use demand forecasting tools are identified as a key requirement, building on the tools already available such as PCT, Datashine and the CWIS Investment Models/DfT Uplift Tool. This is particularly important for scheme promoters with less access to specialist modelling and forecasting resources. Better demand forecasting could be informed by – and complemented by – greater use of monitoring and evaluation for completed schemes.

Prioritisation of work to improve active mode appraisal

The report has identified a set of actions which could be taken in to order to tackle the above gaps and potentially move the dial on value for money for some active travel interventions:

- Some of these are **short term** actions, including:
    - where the solutions mainly involve updating guidance and making modest changes to existing methods to include evidence which already exists. The main items in this category are: active mode time savings; and certain journey quality benefits that are covered by the existing evidence (e.g. on walking and cycling priority measures);
    - in the short term DfT and ATE could also begin the process of reviewing the other gaps identified, and considering what work is needed to move forward in a useful way.

- In the **medium term**, many of the opportunities identified in this report could confidently be addressed by targeted activity, including - for example by commissioning:
    - empirical research on specific questions to address identified evidence gaps where this is feasible (e.g. on aspects of journey quality);
    - best-practice updates to guidance where practice exists and can be transferred (e.g. on strategy and scheme appraisal);
    - development of methods to address identified issues such as destination shift, NHS cost savings, active travel as an access mode to public transport, embodied carbon, and cashable benefits & distribution - these are topics where evidence exists but requires some synthesis and then incorporation into appraisal methods.

  Progress with these could be made within a 1 year horizon, once specifications are drawn up.
- Some of the topics identified in the report may require some more time, given the depth of the issues, and the likelihood that a phased approach would be needed, e.g. a scoping phase; new evidence gathering - for example including new evaluation studies; and then synthesis to produce updates to applied methods and tools. These **medium-long term** topics could also produce some short-term 'easy wins', e.g. an initial systematic review on morbidity benefits may reveal that there is enough evidence to begin incorporating them (as some authorities in the UK and overseas already have). It would take longer to produce a definitive research study (or programme) covering all forms of 'quality of life' benefits and relating those to all relevant active mode interventions. The other topics where a medium-long term research study is most likely to be justified are: place quality and urban realm; economic benefits of active mode investment; demand forecasting and behavioural response; wider aspects of journey quality; and life-cycle carbon impact analysis.

Which types of active mode intervention may benefit?

The interventions which stand to benefit most from these changes are the ones where the current gaps have the most impact - potentially these are:

- new links for walking, wheeling and cycling;
- priority measures for active modes across the network;
- urban realm schemes and roadspace reallocation;
- area wide strategies
- town centre and junction schemes;
- station improvements, transport hubs, modal integration;
- levelling-up contexts;
- schemes promoted by smaller authorities and non-government promoters.

1. Objectives

The central question addressed by this think piece is: how can economic appraisal be done better for active travel interventions that do not fit neatly into existing frameworks? The commissioning of this work by Active Travel England follows a successful workshop held at the Department for Transport (DfT) on 25 May 2022, where representatives from academia, civil service, transport authorities and other interested bodies met to discuss 'transport appraisal guidance and active travel'. This report reflects a determination to move the field forward, while aiming to be specific about what the issues are and focusing on what can be done to resolve them. The report also speaks to the points raised by the National Audit Office (2023) in relation to measuring and monitoring value for money – strengthening the appraisal framework and making it more applicable to a wider range of active travel interventions will be of assistance in formulating a benefits monitoring approach (requested by NAO) and in evaluating the value for money achieved.

Active Travel England's objectives for this short report were:

- Assessment of the strengths and weaknesses of existing tools and frameworks, including diagnosing the source of weaknesses (e.g. gaps in the underlying evidence vs methods);
- Identification of the types of intervention, policies and outcomes (e.g. local economic growth and jobs creation) that are poorly served by existing approaches;
- Outline solutions to overcome limitations in existing approaches;
- Exploration of ways to incorporate wider impacts of active travel investment, including their potential to boost local economic growth;
- Discussion of ways to reduce the bureaucratic burden associated with scheme appraisal;
- Identification of approaches that are well suited to emerging types of intervention such as road space reallocation and programmes of work including a range of interventions, the combined impact of which may be greater than the sum of their individual parts.

2. Method

The approach agreed was to undertake the work as a desk-based study in three steps (below), reaching out to key contributors for their comment and views on aspects of the work. In particular, there is expertise embedded in transport authorities around the UK, including TfL and TfGM who were consulted on aspects of the work. DfT's Local & Regional Transport Analysis team and Active Travel England also contributed their thoughts on the topic and commented on a draft. The author wishes to acknowledge the time given and openness to discuss the key issues[1]. It is hoped that the content reflects a wider set of views about the direction of travel for active mode appraisal, however the author takes full responsibility for the findings and the views expressed in this report.

The main steps were:

- rapid desk-based review of existing tools;

[1] An Acknowledgement is included before Appendix A, on p43.

- identification of opportunities to address gaps in the current methodology, to update and/or strengthen the methods and the evidence base that already exists, and opportunities to enhance the tools available to practitioners;
- prioritisation of opportunities based on an initial assessment of work needed and timescales involved in implementation (short/medium/long term).

3. Existing Tools and Frameworks

The first key point to make is that the 'state of the art' in active mode appraisal is already quite advanced. DfT provides appraisal guidance for active mode schemes in England[2] and an Active Mode Appraisal Toolkit (AMAT)[3] which partly automates and structures the appraisal through an Excel spreadsheet. Internationally, the World Health Organisation (WHO) offers the Health Economic Appraisal Tool (HEAT)[4]. Box 1 below gives a brief overview of the field.

Box 1

Active Mode Appraisal - context

Active mode investment is subject to the Treasury '5-case Business Case' approach[5], in common with other UK public expenditure.

A strong business case requires a clear Strategic Case, focusing on the case for change and the demonstrated fit with policy and strategy, and also a convincing Economic Case which addresses various aspects and demonstrates that the proposal would create positive *public value*. In transport, proposals are rated in terms of their value for money - in other words their public value per unit of the 'Broad Transport Budget' spent[6].

DfT generally targets High or Very High value for money in their capital investment decision-making, and this corresponds to a benefit:cost ratio (BCR) of 2.0 or greater. In 2019, the latest year for which there is data, 80% of DfT's approved project spending met this target[7].

DfT introduced the draft 'Guidance on appraisal of walking and cycling schemes' TAG Unit[8] in 2007, based on work by a team of academics and civil servants that was innovative at the time. This led to a step change in the appraisal of walking and cycling interventions in the UK – and in the benefit:cost ratios (BCRs) that could be achieved for some walking and cycle schemes. To an extent, the DfT guidance parallels the World Health Organisation's 'HEAT' guidance, also first published in 2007 (Cavill et al, 2007) – there are differences in scope, but also important similarities of approach, and similar issues.

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[2] DfT (2022a) *TAG Unit A5.1 Active Mode Appraisal*

[3] DfT (2022a) TAG Unit A5.1 and DfT (2022b) Active Mode Appraisal Toolkit (AMAT); and Cavill et al (2007)

[4] Kahlmeier et al. (2017) https://www.who.int/publications/i/item/health-economic-assessment-tool-(heat)-for-walking-and-for-cycling

[5] HM Treasury (2022) Green Book

[6] DfT (2017) Value for Money Framework

[7] DfT (2020a) Transparency Data: Value for Money Indicator 2019 https://www.gov.uk/government/publications/percentage-of-dft-s-appraised-project-spending-that-is-assessed-as-good-or-very-good-value-for-money/value-for-money-indicator-2019

[8] DfT (2007) TAG Unit 3.14.1

Gradually improved over the last 16 years, the DfT methodology - part of the DfT's Transport Analysis Guidance (TAG)[9] - now includes a spreadsheet tool AMAT (Active Mode Appraisal Toolkit) which automates *some* of the steps in the appraisal. Other authorities have parallel tools, which in some respects go beyond AMAT - e.g. TfL's ABC tool contains more detailed evidence on journey quality improvements, and TfGM's PEAT tool brings together the latest evidence including from AMAT and ABC, and extends these to include some additional impacts[10].

All of these tools can calculate the following (given certain user inputs):

- health benefits of the proposal - typically a large % of the total benefits;
- journey quality benefits to users, e.g. from segregated cycle routes;
- other benefits including decongestion, road safety, decarbonisation, air quality, noise reduction and reduced infrastructure costs.

Recently, DfT added an uplift tool capable of estimating the increased take-up of cycling and walking due to common types of improvements, in different areas - the CWIS Investment Models[11].

The scope of these methods and tools, in terms of the types of benefits included, is shown in Table 1. The first two rows relate to health impacts from increased physical activity. Although the measured health benefits of active modes are large in practice (see Figure 1 below), there is a well-known gap in relation to morbidity benefits, which reflect improvements in the *quality* of life, whereas the mortality benefits, essentially the impact on life expectancy, are included.

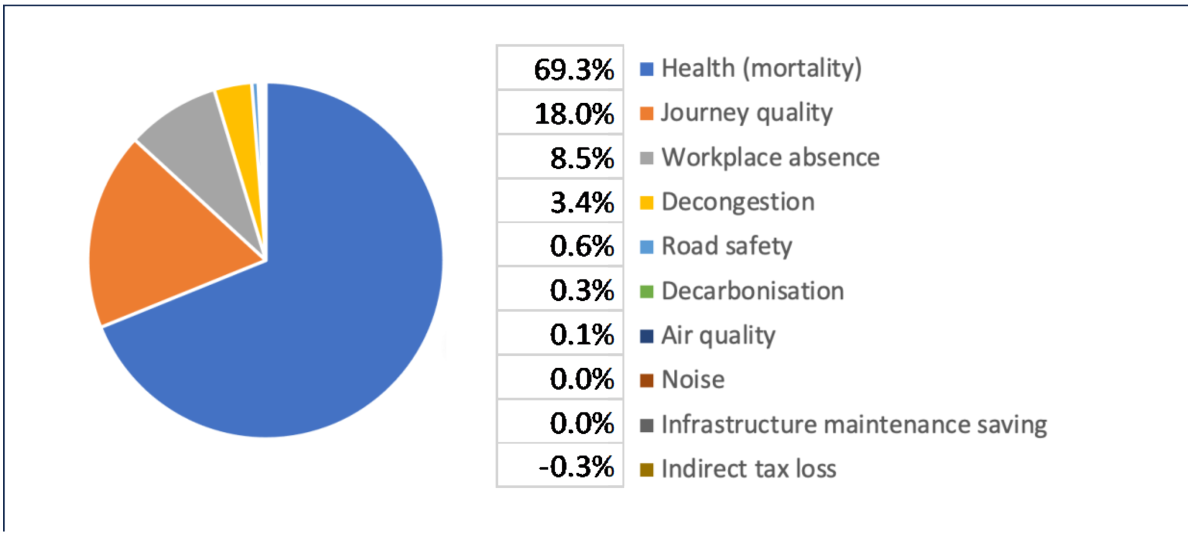
Table 1: Scope of available methods and tools

Benefit types included	*Methods/tools*			
	DfT TAG+AMAT	TfL BCDM+ABC	TfGM PEAT	WHO HEAT
Health (mortality)	W,C	W,C	W,C	W,C
Health (morbidity)	-	-	-	-
Journey quality	W,C	W,C	W,C	-
Journey time	W,C	W,C	W,C	-
Road safety	W,C	W,C	W,C*	W,C
Decongestion	W,C	W,C	W,C	-
Air quality	W,C	W,C	W,C	W,C
Noise reduction	W,C	W,C	W,C	-
Decarbonisation	W,C	W,C	W,C	W,C
Wider economic benefits	Workplace absence only	Workplace absence only	Workplace absence only	-

Key: applicable to walking schemes (W) and cycling schemes (C); *see footnote 10.

[9] DfT (2023a) Transport Analysis Guidance https://www.gov.uk/guidance/transport-analysis-guidance-tag
[10] e.g. TfGM's PEAT tool includes changes in accidents to active travel users and scheme-specific safety impacts, whereas AMAT currently only includes general changes in accidents due to mode shift from car.
[11] Sloman et al (2019a) Cycling and Walking Investment Strategy: Active Travel Investment Models https://www.gov.uk/government/publications/cycling-and-walking-investment-strategy-active-travel-investment-models

Figure 1: Typical shares of the total benefits, for an active mode corridor scheme



Notes: (i) based on the Clifton Road Active Mode Corridor scheme in Wigan, DfT (2022a); (ii) the negative item 'indirect tax loss' is an impact on the public accounts outside of the transport budget, and under the current process is treated as a negative benefit rather than a cost.

Health (morbidity) benefits

The issue with morbidity benefits is that research needed to define and quantify the relevant impact pathways has not been completed. There is a range of evidence sufficient to demonstrate that benefits exist, but not yet an accepted, systematic method for quantifying them in response to active travel interventions. The World Health Organisation identifies the relevant impacts as follows (Kahlmeier et al, 2017):

- reductions in coronary heart disease, stroke and diabetes;
- reductions in some types of cancer;
- improvements in musculoskeletal health and energy balance;
- improvements in aspects of mental health including anxiety and depression; and
- improved functional health in older people.

Research in Australia by Belen Zapata-Diomedi and others[12] indicates that incorporation of morbidity benefits is feasible, using a health measure which incorporates quality of life as well as length of life (Health Adjusted Life Years - HALYs). Methodological options in the UK would probably be based on either DALYs (Disability Adjusted Life Years) or QALYs (Quality Adjusted Life Years). The former are made up of Years of Life Lost (YLL), which are already counted, plus Years Lived with Disability (YLD) which are not (this is discussed in more detail in Nellthorp et al, 2020). The potential magnitude of the missing benefits is obviously a key question: the author is aware of a range of opinions on this in public health, suggesting that the magnitude may be as large as the mortality benefits or much smaller than that. Research to clarify and quantify this is therefore important, and this is a research task for public health specialists - as was the initial body of work on mortality benefits (e.g. Tainio et al, 2017; Kelly et al, 2014; Woodcock et al, 2011). See Table 14 for suggestions on the scope of this research.

[12] Zapata-Diomedi et al (2018)

Time savings for walk and cycle trips

Returning to Table 1, early versions of the DfT active mode appraisal method included journey quality improvements, such as the provision of segregated cycle lanes, but did not specifically incorporate time savings for active modes. This could be important wherever a scheme provides greater priority on the street for active modes, or provides new links taking shorter routes - for example, pedestrian and cycle bridges across railway lines, roads, rivers and canals (Figure 2). The latest DfT guidance from 2022 has clarified the position as follows:

> "While many active mode schemes may aim to increase demand for walking and cycling through improved quality of facilities, they may also result in time savings to pedestrians and cyclists through provision of quicker or shorter routes. In such circumstances the time saving benefits should be estimated using the 'rule of a half' method described in TAG Unit A1.3 – User and Provider Impacts and the values in TAG Data Book"[13].

Figure 2: Active mode bridges in Manchester, Stratford and Cambridge

Sources: ©Peter Richardson/robertharding/Alamy; own work; Alex Livet; Finlay Cox - details see p43.

This change opens up the possibility of automating the calculation of time savings for walk and cycle trips, although the AMAT tool does not yet include this type of benefit.

Mode shift benefits

For road safety through to decarbonisation in Table 1, much of the analysis comes from the 'marginal external costs' (MEC) method[14], which measures the benefits of removing motorised traffic from roads. The amount of traffic removed is calculated with the aid of 'diversion factors' for active modes[15]. In this respect the DfT method is advanced, and is able to take advantage of stream of research over 25 years commissioned by DfT TASM Division and incorporated into the TAG Data Book[16].

Wider economic benefits

Wider economic impacts are measured in a relatively narrow way in active travel appraisal, although as shown in Figure 1 this does not imply that the benefits estimated are necessarily small. Also, they are not specifically described as wider economic impacts, instead being considered part of the 'physical activity' impacts in TAG[17] and the 'health impacts' in AMAT.

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[13] DfT (2022a), *TAG Unit A5.1 Active Mode Appraisal*

[14] DfT (2023b), *TAG Unit A5.4 Marginal External Costs*

[15] Clark and Parkin (2022), *Cycling Diversion Factors Rapid Evidence Assessment Summary Report to Department for Transport*

[16] DfT (2023c), TAG Data Book v1.22, Nov 2023

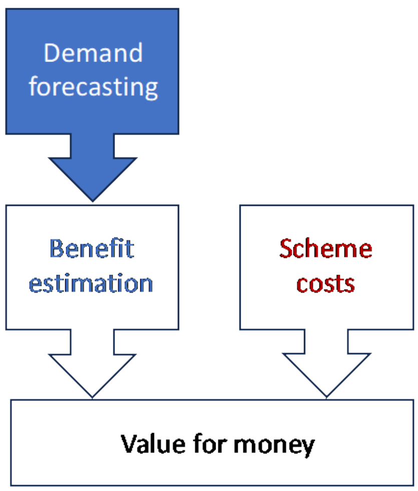
[17] DfT (2022c), *TAG Unit A4.1 Social Impact Appraisal*, Section 3

A calculation is made for reduced absenteeism/workplace absence based on evidence synthesised by DfT, at a rate of 25% less workplace absence for each employed person who starts to travel by active modes for 30 minutes per day (or pro-rata if less than 30 mins) with the scheme in place. Valuation of the benefit is based on average gross salary costs, uprated over time in line with real GDP per capita. AMAT characterises this as resulting in "resulting in increased economic activity"[18]. The extent to which the benefits accrue to employers or to employees will depend on whether wages adjust to reflect the greater productivity per worker. In either case there seems to be a rationale for treating this as an economic impact in appraisal.

There is potentially more that can be done in relation to wider economic impacts, and we hold over the discussion on this to Section 4(iv).

The active mode appraisal process
Finally, looking at the process of active mode appraisal, Figure 3 summarises the main parts of the method. There is a more detailed 'model map' in Section 2 of the AMAT User Guide.

Figure 3: Appraisal process for active modes (schematic) - Economic Case



The first step - demand forecasting - is a challenge for local authorities, scheme promoters and others involved. AMAT requires as an input the 'without scheme' and 'with scheme' trip rates per day as inputs. The 'without scheme' trip rates may be based on count data, which may require fieldwork but is not conceptually or computationally difficult. Online tools are available too, to estimate baseline trips (see below). AMAT then applies a default 0.75% per annum growth rate assumption to both walking and cycling trips.

The 'with scheme' trip forecast is more challenging. TAG recommends three possible approaches to the 'with scheme' forecasting task: comparative study (looking at other active mode schemes that have been opened and evaluated), discrete mode choice modelling, or

[18] DfT (2022b), *AMAT User Guide*, p21.

sketch planning methods[19]. TAG acknowledges the difficulties with each of these - the first is reliant on being able to identify a similar enough scheme in a similar context, while the latter two require some transport planning knowledge and skills, to the extent that many scheme promoters would need to commission a study to estimate take-up for input to AMAT.

A number of tools are available to help with this task, including the Propensity to Cycle Tool[20] (https://www.pct.bike/) co-sponsored by DfT, the Welsh Government, ESRC and EPSRC. The PCT scenarios for *potential* levels of cycling (though not walking) across the national network may be useful in identifying what an ideal scheme might achieve, however the PCT is explicitly not designed to forecast the change in trips due to specific interventions (schemes) in specific locations. It does not, therefore, take account of the inherent limitation of individual schemes that they may not join up across an area to provide the complete network that potential users would need in order to change their travel mode choice and trip patterns. Despite this, DfT, recommends using PCT as a source of baseline cycle trip data if counts are not available[21]. An equivalent for baseline walking trip data is the Datashine tool (https://www.pct.bike/) created by Oliver O'Brien at UCL, which is also based on 2011 census travel to work data.

More recently, DfT has commissioned and recommended the use of the CWIS Investment Models developed by Sloman et al. at Transport for Quality of Life[22], and has produced an uplift tool based upon them (DfT, 2020). This moves the demand forecasting topic forward in several ways. First, the CWIS investment models are evidence-based, being based on an evidence assessment covering 200 sources across 30 types of intervention. They are not limited to infrastructure measures, and do include packages of different measures. Key information in the models includes: cost; additional trip stages generated; and build-up and decay rates, which are relevant where the intervention takes time to reach its sustained 'uplift' effect on active mode demand (e.g. due to time lags on behaviour change in response to infrastructure improvements - see Section 4(iii)) and where the impact decays over time (e.g. relevant to travel training and other 'revenue' initiatives). These models cover cycling and walking, and include a separate 'walk to school model'.

The DfT uplift tool is based on the CWIS investment models, and recommends that scheme promoters estimate the number of additional walk and cycle trips per day based on the following formula:

$$\frac{\text{Scheme cost}}{\begin{array}{c}\text{Cost per additional trip stage per annum}^{\dagger}\\ \textit{(for the particular scheme type)}\end{array}} \times \frac{\begin{array}{c}\text{Intrinsic Cycling/Walking}\\ \text{Potential metric}^{\dagger}\end{array} \times \begin{array}{c}\text{\% of trip stages}\\ \text{on a weekday}\end{array}}{\begin{array}{c}\text{Weekdays per annum}\\ = 261\end{array}} \qquad (1)$$

† from CWIS investment models

[19] DfT (2022a), TAG Unit A5.1, Section 2
[20] Lovelace et al (2017)
[21] DfT (2020b), *Value of money guidance for Tranche 2 of the Emergency Active Travel Fund*, p2.
[22] Sloman et al. (2019a)

A key feature of this approach is that not only is it based on a dataset of previous interventions, but it applies an adjustment (the ICP/IWP metric) based on area type: e.g. "areas were assessed to have a higher intrinsic cycling potential that were flatter, have higher population densities, higher proportions of people of working age and lower rates of deprivation (other things equal)". The ICP/IWP metrics are shown in Table 2, and the costs per additional trip stage in Table 3. This raises a set of interesting questions around whether policy scenarios should be cast widely enough to aim to *increase* population densities, as well as *reduce* deprivation, with feedback to cycling/walking potential. If so, these elements of ICP/IWP should be variable, not fixed, over the course of a 60 year appraisal. However, they do represent the present situation and should provide a useful guide to the immediate impact of active travel measures. We will return to the density issue in Section 4(iv).

Table 2: Intrinsic Cycling/Walking Potential metrics in the DfT Uplift Tool

ICP/IWP category	**Range for ICP/IWP category**	**Average Intrinsic Cycling Potential**	**Average Intrinsic Walking for Travel Potential**
Low	<0.8	0.5	0.7
Medium	0.8-1.2	0.9	0.8
High	>1.2	1.9	1.5

Source: DfT (2020b)

Table 3: Average cost per additional cycling/walking stage per year for capital schemes

Intervention name	**Mode benefiting from intervention**	**Average cost per additional cycling and walking stage generated per year (£, 2020 prices)**
Cycle parking at stations	Cycling	14
On-street cycle hire (of conventional bikes)	Cycling	24
Area-wide cycling network	Cycling	48
Secure cycle parking (with additional facilities)	Cycling	54
Flagship cycling links	Cycling	78
Town centre walking infrastructure interventions	Walking	4
Neighbourhood traffic calming interventions	Walking	4
Flagship walking links	Walking	19

Source: DfT (2020b), based on CWIS Investment Models (Sloman et al, 2019a), costs inflated from 2010 to 2020 prices.

From a practitioner's perspective, points to emphasise include:

- the need for flexibility, to be able to apply the demand forecasting tool to any type of intervention, and any combination of intervention types they may be considering;

- availability, for example the advantage of a web tool, freely available, such as AMAT, the PCT, or CWIS investment models;
- ease of use, to be able to apply the tool without commissioning a consultant, particularly valuable for small schemes;
- getting the balance right between innovation/progress and analytical assurance/confidence - DfT has the role of maintaining robustness in the appraisal system, and that applies to any further advances in tools for active mode demand forecasting;
- also transparency is a concern - in order to ensure that demand forecasts presented by scheme promoters can be checked/audited, it is important that the demand forecasting methodology is more than a black box, and that there is some potential for checking of model performance.

We are also aware of proprietary tools offered by consultancies, and would anticipate more such tools coming to the market. This is an opportunity area where the state of the art is shifting fast and practitioners urgently need the emerging tools. A challenge for ATE and DfT is to continue to strike the right balance between the robustness requirement and the other considerations listed above - balance and proportionality are important.

To summarise the main findings so far (Section 3):

- existing tools and frameworks for active mode appraisal exist and are well established in UK and international practice;
- there are known gaps in the scope of these methods, particularly around:
    - the morbidity benefits of physical activity;
    - the wider economic impacts of active travel investment - we will say more about this in Section 4(iv);
    - travel time savings for walking and cycling;
    - safety benefits specific to the scheme (rather than due to mode shift effects from car);
- predicting take-up of active travel schemes is a burden on practitioners, which the CWIS investment models and uplift tool have begun to address. There is scope for further development of such tools, aiming for ease of use and flexible application to scheme design and optimisation, and better integration with the rest of the benefit estimation process.

4. Specific Issues and Potential Solutions

Having started with an overview of the field, we now focus on a set of specific issues emerging from the review. These are issues particularly with the way the benefits are estimated for active mode investments. Each one is discussed in turn in this section, aiming to bring out the underlying problems - whether it be lack of evidence, lack of suitable methods or tools, something else, or a combination of factors. A first take on potential solutions is offered. In the final section of this report (Section 5), the potential solutions are gathered together and an initial prioritisation is attempted.

The issues which are covered in Section 4 are the following:

i) Place quality
ii) Destination shift
iii) Roadspace reallocation
iv) Economic benefits of active modes
v) Strategy and scheme appraisal
vi) Definition of the benefit:cost ratio - NHS cost savings and other impacts
vii) Active travel as an access mode
viii) Embodied carbon in infrastructure and vehicles
ix) Cashable and non-cashable benefits, and distributional benefits
x) Journey quality improvements
xi) Reducing the burden of scheme appraisal

4.(i) Place quality

Transport appraisal has been moving gradually towards a more place-based approach. TAG has a Place-Based Analysis unit[23], and although located in the 'Social and Distributional Impacts' part of TAG, it does point towards place-based impacts under the economic, social and environmental headings[24].

Recent research has started to take a more explicit and direct approach to place quality. In research for Transport for the North[25], researchers at ITS have explored the factors in location attractiveness across the North of England. The research has shown that accessibility to employment via different modes of transport is a key determinant, and the value of this was estimated using econometric modelling techniques and working with property market data - specifically the Land Registry price paid dataset for the whole of the North of England (covering approximately 15 million people). Among the key findings were that walk accessibility to employment is significant and important in its own right, alongside rail accessibility and car accessibility. Each mode has its own distinctive spatial pattern - the influence of walk access is strongest within a relatively short distance of each employment cluster, highlighting the potential for active mode planning to benefit inner-urban areas, brownfield development sites and a wider urban and peri-urban catchment in the case of cycling. The results also point towards the important role of active modes in increasing economic mass and productivity (see Section 4(iv)).

Table 4: Value of accessibility to employment in the North of England

Mode	*% price premium per 100,000 jobs (GJT-discounted)*	*Worst-to-best accessibility in the North:*	
		% price premium	*difference in jobs accessible (worst-to-best)*
Rail	1.6%	+14.3%	917,000
Walk	36.1%	+51.2%	142,000
Car	1.9%	+17.3%	895,000

Source: ITS (2019), p12. To convert these figures to £, they may be multiplied by a round number of £200,000 representing the current average value of a home in the North of England. Note: the large price premium per 100,000 jobs accessible by walking is offset by the much shorter distance reachable by that mode - still, as shown in the table, the range in the data for walking is substantial and the price premium from best to worst is large. GJT refers to 'generalised journey time', a measure of the quality-adjusted time taken to reach a particular job.

By focusing on the value of place, we also learn something about the value of other place quality attributes alongside accessibility to jobs. The table below highlights the value of local facilities, green space and traffic noise reduction (Table 5). The first row shows the value of having easy access to local centre facilities (shops, services, etc) compared with none - and

[23] DfT (2022d) TAG Unit A4.3 Place Based Analysis

[24] e.g. see Table 1 in DfT (2022d) *op cit*

[25] The study was jointly sponsored by Transport for the North, West Yorkshire Combined Authority and EPSRC, with TfN as the lead client. Results have been incorporated into TfN's NELUM model (Northern Economy and Land Use Model).

would be relevant to valuing the provision of local facilities in a new housing development, for example. The second shows the value of the best level of provision of green space and recreational space, versus none. The third row relates to a large noise reduction, which would be the equivalent of, e.g., placing a trunk road in a cut-and-cover tunnel. For comparison, the table shows the value estimated for a new commuter rail station 500m away from home.

Table 5: Evidence of the value of local accessibility and place quality

Place quality attributes	*% premium (housing)*
Local 'centre' facilities - shops and services (versus none available)	+7.6%
Green space and open space – parks & playgrounds (versus none)	+6.8%
Traffic noise reduction in urban areas (73→53 dB)	+8.1%
Example accessibility change	
New suburban rail station (500m from home location)	+5.9%

Source: Nellthorp et al (2019), p14. To convert these figures to £, they may be multiplied by a round number of £200,000 representing the current average value of a home in the North of England.

It is clear from this that place quality attributes are important, and potentially of a comparable order of magnitude to rail station openings, for example, in terms of their value to residents, measured using property market data. What is not addressed in Table 5 is the full range of place quality attributes. In other research recently completed[26], we have also been able to establish through household surveys in two study areas (in the North West and the South East) that:

- residents perceive and value place quality;
- accessibility to local facilities by active modes is a key part of place quality;
- residents are concerned about the conditions for walking and cycling generally, and within this road safety - note that this is not just the cost of accidents, but the impact of the threat of accidents, which deters people from walking and cycling;
- residents desire more & better cycle routes;
- residents identify traffic as a substantial negative influence on place quality, and better provision to walk and cycle across existing main roads is a part of the solution, alongside other measures.

There are also lines of research which seek to demonstrate the value of walkability (Cortright, 2009; Leinberger & Alfonzo, 2012), the value of improved urban realm (see Nellthorp, 2016, for a review), and the value of a reduction in severance (Anciaes et al, 2018; Millard et al, 2018).

This evidence contributes to a view that place quality improvements can be quantified and valued, and indeed local accessibility to different activities and opportunities can be valued as

[26] Arup, AECOM, University of Manchester & ITS (2023)

part of it. However, it sits somewhat uneasily with the standard transport appraisal toolkit (see Section 3 above) with its focus on movement and user benefits, and then other impacts arising from that[27]. In trying to integrate the two, there will be some problems to solve, including which parts of 'value' to take from the user benefit analysis and which parts of to take from a place based analysis. However, the place quality evidence does provide a spur to value a set of attributes which are not currently valued in transport appraisal - e.g. the value of local facilities, the value of green & open space, and the value of those street-level place quality attributes that remain unvalued in TAG (Table 6 gives some examples).

Table 6: Street-level place quality and urban realm attributes

Impacts from traffic:	*Included in TAG benefits*	*Not included in TAG benefits*
- noise exposure		•only at home, not on streets
- air pollution exposure		•only at home, not on streets
- threat of collision		•
- accidents	•	
- severance & delay		•
Impacts from urban design:		
- space		•
- navigability – lines of sight, and signage	•only 'directional signage' and 'information panels' for walking, wheeling	•not included for cycling; lines of sight omitted
- character		•
- greening – including street trees		•
- places to stop	•only 'benches'	
Other urban realm attributes:		
- personal security on streets		•
- cleanliness		•

Note: there is evidence relating to all of the above attributes (some key sources were listed above), however in some cases there is a lack of consistent valuation evidence suitable for benefit measurement. Also note that many of the above apply to people using streets for 'place' functions, not only 'movement' functions.

Finally, there is a strand of research which offers the possibility of integrating place quality and transport user benefits in a theoretically consistent way. Going right back to Williams (1977) and Neuburger (1971), it has been understood that benefit measures can be taken from land use and transport models (LUTI models), and that by doing so the value of accessibility

[27] Professor Peter Jones and colleagues made the key observation that streets have both a movement function and a place function (Jones, Boujenko and Marshall, 2007). Transport appraisal tends to be very focused on the movement function - and tends to neglect the impact on other uses of urban street space, including social, business and recreational uses.

improvements can be calculated directly. This approach has been developed further and implemented in the Netherlands (e.g. Geurs et al, 2010), where it has been used to assess the benefits of different regional transport and land use scenarios including:

- Compact Urban Development scenarios in which housing development is focused within existing urban areas or in new transit-oriented developments;
- Alternative housing policy scenarios in response to climate change impacts;
- Various different transport investment options including road-based and public transport measures, together with alternative pricing options.

For transport appraisal in the UK, this type of approach could be used to develop a valuation framework which includes:

i. transport user benefits that are already included in the 'rule-of-a-half' measure and the current TAG appraisal and TUBA software;
ii. place quality benefits driven by changes in location attractiveness – including changes in the level of facilities and amenity in the area where the person lives (the home location), and changes in the level of facilities and amenity in locations accessible from a person's home location (e.g. town and city centres). Note that place quality improvements near to a person’s home would potentially reduce their demand for motorised transport and increase demand for active travel, while increasing utility (welfare/wellbeing).

Any such change in the benefit measure would represent a shift in methodology for DfT. DLUHC have appraisal guidance which measures the benefits of development using land value uplift as a key metric (DLUHC, 2023), however this does not go into the welfare economics of accessibility, transport and land use change in the way the current DfT methods do, nor does it duplicate the type of approach discussed above.

In order to move forward, it is recommended that ATE & DfT consider:

- how to value improvements to street environments for active mode use (see Section 4(x) below for more on this);
- how to value improved accessibility to local facilities, green & open space, and a range of other place quality attributes (whether through changes in provision or changes in active mode access);
- generally how to capture the value of lower-traffic urban environments - this is mostly not being captured in TAG or AMAT at present, however there is a useful literature (UK and international) on which to draw for methods and initial evidence;
- this probably requires a review stage, then development of a theoretical framework, followed by quantitative research on place quality, alongside careful work to develop changes to the TAG appraisal framework.

4.(ii) Destination shift

As shown in Tables 4&5 above, people value accessibility to local facilities, as well as to local green & open space, and to local employment opportunities. One of the effects of a successful active mode policy could be to encourage a shift in destinations - for shopping, recreation and other trip purposes - towards nearer places, such as neighbourhood centres and local town centres. Shorter journeys potentially use less resources while also increasing the vibrancy of local neighbourhoods[28].

There is a specific issue in the mathematics of transport user benefit analysis, not just in the UK but internationally[29], which needs to be carefully addressed in order to ensure we fully capture the benefits of a shift to nearer destinations with increased active travel. This is at root a technical issue, and a short appendix is included to define it (Appendix A), however the key points are:

- standard transport user benefit analysis relies on a reduction in travel cost per trip (generalised user cost) in the 'nearer' zone to create some benefit for people switching from a 'farther' zone;
- if the main reason for the shift in destinations is actually the increasing attractiveness of the 'near' zone (see Place quality above), then there may be very little or no benefit measured using the standard formula;
- however in reality people switching destinations may be saving travel costs (money and time), and may even be able to change their household car ownership decisions (number and types of vehicles) potentially saving further expenditure. Davis (2014) finds that "the operating and maintenance costs of a bicycle are around 5% of the equivalent cost for a motor vehicle. Walking is, arguably, almost cost neutral".

Addressing this in the short term could involve recognising the limitation imposed by the user benefit formula, and opening-up the possibility of calculating a benefit due to destination shift (the implications for guidance and software would need to be worked through). A more satisfactory long term solution would need to be linked to the development of a joined-up approach to location attractiveness/place quality and transport user benefits.

4.(iii) Roadspace reallocation

The third area for discussion is roadspace reallocation. This is important because many current urban transport policies involve reallocating roadspace, and the way this is analysed has profound impacts on the benefits of schemes.

Examples of roadspace reallocation include: street design and urban realm projects, such as London's Healthy Streets and Safer Junctions; cycleways, particularly where the cycleway replaces a mixed traffic running lane; and pedestrianisation schemes. These projects can all involve a reduction in space allocated to mixed traffic, and an increase in space allocated to pedestrians and cyclists. A prominent example in Central London is the Trafalgar Square remodelling completed in 2003 (see Figure 4), which reallocated the roadspace in front of the National Gallery from mixed traffic to pedestrians - a road which was previously wide enough for up to five lanes of mixed traffic[30] all running eastbound. The cost of this project to the GLA

[28] The idea of 15- or 20-minute neighbourhoods, for example (Moreno et al, 2021), embodies this approach.
[29] see Nellthorp (2017)
[30] In the 1980s, 5 lanes were marked at the eastern end and there were no lane markings at the western end.

and TfL was £25.7million[31]. Traffic through the square was reduced by around 40% overall[32], while pedestrian footfall increased[33]. Many roadspace reallocation schemes across the country are smaller in scale and lower-cost than this, but they share the same principle - that making considered changes to the use of existing street space can help to achieve the overall goals of policy (such as improvements in human health and wellbeing, better economic performance, sustainability and decarbonisation).

Figure 4: Roadspace reallocation in Trafalgar Square, London, 2003

Late 1960s   2003 onwards

Sources: ©PA Images/Alamy; A.P.S.(UK)/Alamy - details see p43.

The issue in appraisal is that roadspace reallocation projects reduce network capacity by some modes - particularly by car - in order to increase it for other modes. It then becomes absolutely essential to capture the benefits of the change *and not to overestimate any disbenefits of the change*.

- Capturing the benefits. The approach described in Section 3 would usually be applied, and - subject to the concerns identified in this report - can be expected to produce a positive benefit estimate.
- Avoiding overestimation of any disbenefits. The challenge here is to correctly forecast the impacts of capacity reduction on motorised traffic. This is not straightforward and current tools are not well adapted to the challenge. As a result, highway authorities may be put off from implementing or even proposing worthwhile active mode measures.

Looking more closely at this issue, if analysis is undertaken then it needs to recognise that *behavioural adaptation* will occur, and the final outcome will be very different from the initial impact that an individual perceives when confronted with a 'road closure' or 'lane reduction' on their regular driving route. Behavioural adaptations that have been found to occur within a year of a change in roadspace allocation include:

i) Change of route

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[31] London Assembly (2001) https://meetings.london.gov.uk/Data/London%20Assembly%20(Mayor's%20Question%20Time)/20011219/Minutes/Appendix%20B%20PDF.pdf

[32] Cotton, S (2002). 'World Squares for All - management of traffic on the approaches to Trafalgar Square'. Paper presented at the European Transport Conference, Homerton College, Cambridge, 9-11 September 2002. London: PTRC.

[33] https://www.ucl.ac.uk/made-at-ucl/stories/space-syntax-makes-structure-city-spaces-work-people

ii) Change of departure time
iii) Change of mode - e.g. switching to public transport or active modes
iv) Change of trip frequency
v) Change of destination
vi) Change of car occupancy (e.g. car sharing on certain trip types)
vii) Change to working from home that day, or other substitution[34]

Further adaptations come into play when longer timescales are considered.

These individual behavioural adaptations combine to reduce the pressure on the road whose capacity has been reduced - the impact is shared out across the network, over time and across modes. If the transport authority provides alternative forms of capacity - e.g. cycleways or better public transport - there may well be an increase in accessibility overall.

The biggest risk is that an analyst uses a form of model which is not capable of representing all these behavioural responses to predict the outcome. A common situation is that models used for detailed design work on the highway network assume a 'fixed trip matrix' - in other words they focus on adaptation (i) above, known professionally as 'reassignment'. This assumes that the amount of car traffic between all origins and destinations remains fixed, and it can only be re-routed, potentially causing increased congestion (and disbenefits related to congestion) on other parts of the network. So the question arises: what does the evidence show about the outcomes of road capacity reduction?

The most important body of evidence on this topic comes from research by the ESRC Transport Studies Unit at UCL in the 1990s and 2000s. Cairns, Hass-Klau and Goodwin (1998) examined a set of 49 case studies of road capacity reduction - they found that the average (mean) traffic reduction in response to a capacity reduction was 41% on the route concerned. Meanwhile, the key finding relates to the overall traffic reduction at area level: the authors found good evidence to indicate that traffic reduced in the area as a whole, and that the mean amount of traffic reduction was approximately 25% (expressed as a % of the traffic on the main route). The median, possibly a more useful measure as the distribution is not symmetrical, was 14% - still a marked reduction in total traffic. This means that the 'fixed trip matrix' does not represent the outcome in many real cases, and that road capacity reduction can have a much more subtle set of effects than simply shifting traffic from one route onto the rest of the network.

Cairns et al (2002) expanded the pool of case studies to 70, including new evidence on recent projects in the UK - in Gloucester, Oxford, Cambridge and South London. Overall, the findings showed a 22% mean reduction in traffic at area level and a 10.6% median reduction[35].

There has not been another major comparative study since 2002, however, there have been several rigorous case studies, which provide evidence on the more detailed pattern of traffic changes. For example, Nello-Deakin (2022) uses a method which benchmarks traffic changes against control areas elsewhere in the city, and finds the following pattern (Table 7). This

[34] e.g. Cairns et al (2002), Tennøy & Hagen (2021)
[35] again expressed as a % of the 'before' traffic on the main route

highlights that the displacement of traffic onto adjacent streets is very small in this case, and that there is no significant effect on streets in the wider local area. Of course, the outcome will vary from case to case - in situations with high car dependency, poor walking and cycling environment and few public transport options, the outcome could include much more displacement of trips[36]. Achieving a good outcome is likely to follow from a sensitively-planned mix of road capacity reduction, active mode measures and other improvements designed to suit the particular case (e.g. see Melia and Calvert, 2021).

Table 7: Traffic impacts of roadspace reallocation measures in Barcelona, relative to control areas

Road type	*Mean traffic change*	*Median traffic change*
Intervention streets • with roadspace reallocation measures	-14.8%	-15.4%
Adjacent streets • with same traffic direction as intervention streets	+0.7%	+3.9%
Buffer streets - other streets within 500m of the intervention	-0.4%	-1.1%
Control areas - elsewhere in the city	Datum	Datum

Source: Nello-Deakin (2022).

TAG Unit A5.1 and AMAT do not currently address this - specifically they do not discuss how to forecast the impacts of road capacity reductions and then how to appraise the results. We need to consider whether this matters and, if so, what could be done to resolve the issue.

First let us be clear about the scope: the current guidance remains suitable for active mode investments that don't affect mixed traffic capacity. So for a new off-road cycle track or a new pedestrian bridge there may be no implications - also for the addition of a cycle lane where there is enough carriageway width to do so without changing the number of mixed traffic lanes[37]. The issue concerns schemes which do reduce mixed traffic capacity. In these cases, the evidence reported above suggests that:

- there is likely to be some 'traffic evaporation';
- the extent of this is variable - depending on the alternatives available to people; and

[36] Melia and Calvert (2021) provide a detailed analysis and discuss the implications of two interesting, recent cases in England, and examine the policy context in Paris where roadspace reallocation on the banks of the Seine has been accompanied by falling traffic levels on parallel routes, encouraged by wider policy measures across the city.

[37] The existing method specifically includes the decongestion benefit of these types of schemes, as some motorised vehicle-km are removed from the network, see Table 1 and Figure 1 above. This is part of the Marginal External Costs method (DfT, 2023b, TAG Unit A5.4) which is incorporated into AMAT.

- in typical cases where there is traffic evaporation, a 'fixed trip matrix'-type model, which assumes that car trips all remain on the car mode and simply shift route, is likely to produce unrealistic results and overstate any disbenefits[38].

If a scheme promoter attempts to measure the impact on motorised traffic using readily available tools, they may estimate large disbenefits due to modelled delays to traffic which are an artefact of the model, not the reality. In the past, even large transport planning authorities in the UK were finding that models would predict roadspace reallocation schemes could cause large disbenefits. For example, we are aware of one case where the disbenefits to the car mode based on the *model* were forecast to be roughly as large as the scheme costs (approx. £20million) and the BCR of the project was forecast to be <0. These large authorities are now able to take a more robust view, and emerging best practice is to look at the detailed traffic impacts of pro-active travel measures in their region using monitoring and evaluation evidence, to provide a basis for forecasting the impact of future schemes. We recommend that ATE and DfT undertake focused work to pull together the available evidence and issue suitable guidance. Among the beneficiaries would be smaller authorities and scheme promoters who lack the resources and access to specialist techniques and data.

4.(iv) Economic benefits of active modes

There has been a range of research on the economic benefits of active modes which has shown that:

- Physical activity through active travel is associated with reduced sickness absence from work. Transport Scotland (2023) provides an up-to-date literature review, and these benefits are already included in TAG and AMAT (Section 3 above);
- More widely, health impacts include reduced mortality and morbidity from physical activity, air quality and noise exposure[39], as well as changes in road casualty numbers and severities. These impacts were discussed as part of the active mode appraisal in Section 3: their total impact on welfare/wellbeing is included itable bn TAG/AMAT. The productivity or GDP elements of them have not yet been isolated specifically - that may be of interest for the assessment of the economic performance impacts of active travel.
- Evidence suggests that active mode users tend to shop more frequently and spend slightly less per visit than car users (Transport Scotland, 2023). As yet the overall impact on household retail spending is unknown.
- Retail activity in a locality has been shown to respond to street improvements prioritising active modes. Metrics differ between studies, partly due to differences in data availability between countries. New York City DOT (2013) shows that retail spending has increased on streets that have undergone active mode improvements versus other control locations, while Carmona et al (2018) find that there is a retail property value premium using rental data in London (where shop-level expenditure

[38] Noting that in cases where the alternatives to car use are very poor, the outcome could be closer to this 'fixed trip matrix' situation (see Melia and Calvert, 2021).

[39] at present only air quality/noise impacts on people at home are included in TAG/AMAT – see 4(x) for air quality/noise impacts on people in the street environment.

data is not readily available). It is unclear at this stage to what extent these changes in retail activity and value are displaced from other locations. One of the advantages of a more place-based approach would be to actively consider who gains from local retail activity, and how that feeds into and supports a more sustainable/productive economy overall.

- Tourism is a sector which potentially benefits from active mode provision, increasing the attractiveness of the UK as a destination for both domestic and international visitors. Transport Scotland (2023) and Rajé & Saffey (2015) find that active mode tourists visit more rural areas and may stay longer than other tourists, although the results of Transport Scotland's review are inconclusive in terms of additionality - the extent to which cycle/walking tourism expenditure is additional or displaced from other activities.

Alongside these impacts which are widely recognised, although not all incorporated in active travel appraisal as yet, there are some systemic links between active mode use, residential and commercial density, and key outcomes including productivity. Some of these have been brought together in recent international literature (e.g. Cao et al, 2022).

Evidence for the UK and internationally (Graham and Gibbons, 2019) shows that a key route to increased economic performance is to increase the effective density of economic centres – in other words to enable a greater concentration of jobs in each economic centre, and to link the centres better to each other, and to the workforce who work in them. The processes at work include better job matching, labour market pooling, specialisation, knowledge interactions, learning and sharing of inputs/outputs between businesses. There is a positive relationship between effective density and productivity in most sectors. Effective density is made up of an absolute density element (jobs per unit of land area), adjusted for the ease of movement measured by generalised cost of travel. A key question then is how to increase effective density?

Table 8 focuses on the relationships between urban density, car use (VMT), walking and public transport use. The numbers are the results of international meta-analyses - sources are given in the second row.

Table 8: Responsiveness of transport indicators to density

Density measure	*Vehicle Miles Travelled (VMT)*		*Walking*		*Transit Use*	
	Ewing & Cervero (2010)	Stevens (2017)	Ewing & Cervero (2010)	Yang et al (2019)	Ewing & Cervero (2010)	Aston et al (2020)
Population/ household density	-0.04	-0.22	0.07	<0.01	0.07	0.10
Job density	0.00	-0.07	0.04	-	0.01	0.08
Commercial floor area ratio	-	-	0.07	-	-	-
Commercial density	-	-	-	-	-	0.15

Source: Tian (2022). Elasticity indicates the % changes in each indicator for a 1% change in density.

These findings indicate that increasing density is associated with increased active travel and public transport use, and reduced car use[40]. The elasticities are small, however, and it is worth considering whether speeding up travel using the current mix of modes would be a more effective policy - however the key finding on this from the literature is that density is more effective than speed in improving accessibility (Levine et al, 2012). Denser urban areas are found to have lower travel speeds but greater origin-destination proximity, and overall the effect is an increase in accessibility – and according to the other relationships described above, greater productivity.

It is hard to imagine these linkages between active travel, density and economic outcomes being modelled solely at the active travel scheme level. Instead, they may be best modelled at the strategy level - e.g. city level or regional level. For example, there are numerous city region economic models in existence around the UK (e.g. Leeds City Region Economic Model) as well as regional strategic transport models (e.g. MoTiON in London). However the link between active travel investment and money incomes (a cashable benefit - see 4(ix)) is important, and consideration could be given to whether there is rule-of-thumb item that could be included at scheme level.

Moreover, since 2020 it has been recognised in the HM Treasury Green Book that localised increases in income can have a net positive impact on wellbeing, by raising the living standards of people in lower-income households where the marginal utility of income is greater. Distributional weights are set out in Annex A3 of the Green Book[41]. The local economic impacts of active travel could have national-level benefits through this channel.

[40] In taking this further, it would be important to critically assess the evidence for causality, not only association.
[41] HM Treasury (2022), Green Book

4.(v) Strategy and scheme appraisal

Following discussions with practitioners, one of the important options capable of moving the dial on benefit:cost ratios for active mode schemes is the level at which appraisal is undertaken.

Specifically, there is a choice, for authorities which have an area-wide strategy, to undertake scheme appraisal in the context of the wider strategy being implemented, i.e. a 'strategy on' appraisal at scheme level, or whether to pursue the default approach which is to appraise investments scheme-by-scheme in isolation. The difference will typically be felt through the forecast levels of walking and cycling, which are related not only to conditions on one link or set of links, but a wider area forecast based on a range of measures.

An example of the 'strategy on' approach, which shows the scale of the impact on the benefit:cost ratio, is TfGM's appraisal of their Bee Network investment package (Table 9a and 9b).

Table 9a: Bee Network active mode demand - policy on versus policy off

Forecasts	*Policy Off*	*Policy On*	*% of Target*
Cycle trips (baseline)	34,265		
New cycle trips	17,378	69,000	c. 5% - 20%
Walk trips (baseline)	230,066		
New walk trips	31,825	40,000	c. 10% - 15%

Source: TfGM (2023) (shared presentation)

Table 9b: Bee Network appraisal and BCR - policy on versus policy off

Forecasts	*PVC*	*PVB*	*BCR*
Policy Off	£280m	£540m	1.93
Policy On	£280m	£1,075m	3.83

Source: TfGM (2023) (shared presentation)

To some extent this is an easy win, in that it involves a change of assumptions which could be written into guidance and practice would follow, as has been done with many TAG changes previously. This may need to remain a sensitivity test, as for some authorities there may be no 'area wide strategy' and corresponding growth forecasts. For authorities who do have an area wide active mode strategy including demand forecasts, there is a case for 'strategy off' to be the sensitivity test - since that would reflect incomplete delivery and an inferior outcome.

There is a related change, which needs further discussion about who would implement it - which is whether to undertake most active mode appraisal at strategy level (e.g. for a regional authority area such as Greater Manchester, West Yorkshire, or Liverpool City Region) and shift scheme level appraisal to a 'light touch' approach focused on confirmation that the scheme is part of strategy delivery, is already appraised, and ensuring delivery/benefits realisation aspects are addressed at scheme level. This would contribute greatly to 'reducing the burden of scheme appraisal' for scheme promoters (Section 4(xi)).

4.(vi) Definition of the benefit:cost ratio - NHS cost savings and other impacts

The definition of the benefit:cost ratio (BCR) used in transport appraisals was last updated by DfT in 2009[42]. The definition was carefully considered at the time, and as discussed in the report accompanying the update:

> "The key point is that there is no necessarily "right" BCR metric or budget constraint as it will depend on particular circumstances ... determining the most appropriate BCR metric depends on what you deem the most appropriate budget constraint to be".
>
> "If decisions are to be taken from a "Government-wide" perspective, ... it may be sensible to define the budget constraint fairly broadly ... However, if decisions are taken more on a Departmental basis or over a specific resource base..., it may be better to define the budget constraint more "narrowly""[43]

The decision was made in 2009 to define the relevant resource base as the Broad Transport Budget, which included both central and local government transport expenditure, and the budgets of the arm's length public bodies (now including Active Travel England, National Highways and Network Rail).

The item of particular concern in 2009 was 'indirect tax revenues' from road use – i.e. fuel duty and the associated VAT. This impact, which accrues to HMRC and thence the Treasury (and not to the DfT budget) was often a positive revenue increase for highway improvements but negative for public transport improvements. Up to 2009, this item had been treated as negative contribution to the Present Value of Costs (PVC), but the decision in 2009 was to exclude it since it was not part of the Broad Transport Budget, and instead to treat it as part of the Present Value of Benefits (PVB) to society – outwith the broad transport budget. This change had the effect of increasing the BCR for most rail schemes and reducing it for most road schemes, as can be seen from Table 4.2 in the NATA Refresh document. This seemed more consistent with the aims of transport policy, and kept the DfT BCR focused on expenditure and revenues which were within (some degree of) DfT control.

The large health benefits of active travel schemes raise a new issue. Part of these health benefits are in the form of cost savings to the National Health Service, from:

- improved physical and mental health during people's lifetime (including reduced morbidity and risk of mortality);
- reduced casualties from road accidents – including ambulance costs and ongoing healthcare provision;
- as Zapata-Diomedi et al (2018) point out, the additional life expectancy from reduced mortality needs to be recognised as an offsetting factor which will partly, but not wholly, offset the health cost savings of a healthier population.

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[42] DfT (2009) NATA Refresh: Appraisal for a Sustainable Transport System.

[43] *op cit,* p45-46

At present these health cost savings are part of the Present Value of Benefits (PVB) and are not recorded separately – apart from the medical and ambulance costs of accidents. They are not part of the Broad Transport Budget and hence not part of the PVC. As long as the focus remains on best use of the Broad Transport Budget, this approach remains understandable. If the health cost savings were specifically estimated and counted as a reduction in a 'PVC to the whole of government', this would have the effect of increasing the benefit:cost ratio of active travel interventions. This may be something that government economists want to consider – perhaps as an example (and not the only example) of interventions with cross-departmental cost implications.

Also as the NATA Refresh put it:

> "It is also recommended that given there is no necessarily "right" answer when assessing each [BCR] metric, that an increased emphasis on the NPV [Net Present Value] of a scheme is given. This would help give an initial indication of the overall net welfare [impact] of a scheme".
>
> "However, in reality there are limited resources available, and so not all transport projects can be implemented. Therefore, we need some means of comparing competing schemes to ensure we maximise welfare from these limited resources. ... The BCR allows us to make [these] comparisons ...".

4.(vii) Active travel as an access mode

The current tools are rather vague about walking, cycling and wheeling as access (and egress) modes. According to an analysis of National Travel Survey data by DfT[44]:

- 27% of all walking stages are part of a multi-stage trip by another main mode;
- 5% of cycling stages are part of a multi-stage trip by another main mode.

Table 10 shows the average number of stages per trip by the main mode of the trip, and the % of trips involving a walk stage and the average length of a walk stage in each case. Notably two-thirds of rail trips include a walk stage, and the length of this walk stage is on average 0.59 miles, around 1230 steps, and around 7.5 minutes at average walking pace – or double these numbers for a return trip. The walk stages of underground and bus trips are somewhat shorter on average.

[44] DfT (2014), National Travel Survey 2014: Multi-stage trips

Table 10: Access mode stages by different main modes, 2014

Main mode of trip	*Average number of stages, including active mode stages*	*% of trips involving a walk stage*	*Average length of walk stage, miles*
Rail (National Rail)	2.75	65%	0.59
London Underground	2.49	67%	0.40
Bus in London	1.74	47%	0.29
Bus outside London	1.46	32%	0.39
Car	1.03	-	-
Cycle	1.01	-	-
Walk	1.00	-	0.78

Source: DfT (2014). Note: trip stages below 50 yards were not counted in the data, nor were trip stages off a public highway. '-' indicates data not reported.

Transport authorities including TfL are interested in the complementarity between active modes and public transport services, and some preliminary research has shown that a range of measures including the following are potentially useful tools in encouraging people to shift towards public transport with walk or cycle as an access mode:

- cycle highways linked to rail stations and transport nodes (implemented in the Netherlands, for example);
- secure cycle parking at stations;
- bike sharing schemes;
- showers and locker rooms in workplaces;
- built environment features including visual design of public space, trees and planting, and lighting[45].

Considering the magnitude of the benefits of encouraging walking and cycling (Section 3) particularly the health benefits, but also the journey quality benefits, decongestion, air quality benefits, decarbonisation, and so on, it would be interesting and timely to focus some effort on the potential to grow public transport+active travel mode shares, including rail, light rail and bus, with access by cycling, walking and wheeling. It would also be useful to consider whether the benefits that come with access by active modes are sufficiently considered in rail and bus scheme appraisals[46].

[45] Ramadhanty (2022)

[46] At present TAG Unit A5.3 Rail Appraisal mentions values of time for walk and cycle access to rail services, but not the beneficial health impact of rail use with walk/cycle access.

4.(viii) Embodied carbon in infrastructure and vehicles

Appraisal methods and tools have until recently focused on carbon emissions from use of vehicles, to the exclusion of embodied carbon in infrastructure and vehicles. This situation is now changing[47]. National Highways has a carbon calculator tool that may be applied to estimate the embodied carbon in strategic road schemes, and Network Rail has an equivalent tool relevant to rail schemes[48]. DfT has sponsored Phase 1 of a research programme to produce a more widely applicable carbon tool, addressing a range of modes including active mode infrastructure – this Shared Digital Carbon Architecture (SDCA) programme has completed prototype development and is now awaiting progress to Phase 2 (Giesekam et al, 2022). Tools such as this are needed by local and regional authorities to simplify and where possible automate the process of estimating embodied carbon implications of schemes.

For active mode appraisal, the savings in carbon emissions from reduced car traffic are part of the Marginal External Costs calculation that is already built into AMAT and other comparable tools (Section 3). The embodied carbon in cycles is not currently included in AMAT and comparable tools, but data is available: for example, Trek (2021) report an average of 174kg CO_2e across all their range including e-bikes; while evidence for cars indicates a range of 5-35tonnes CO_2e, or around 30-200 times greater[49].

A useful approach - bearing in mind that vehicles will generally be used over a lifetime measured in years - is to estimate lifecycle CO_2 emissions in g/km *including* the embodied emissions in the vehicle, and then apply that to the different categories of vehicles in an appraisal. Research by Philips et al (2020), bringing together existing data sources, finds that the lifecycle emissions for e-bikes is around one fifth that of an electric car and less than one tenth that of a typical European petrol car (Table 11). Given that the range of an e-bike is substantial compared with the average length of a commute trip in England, around 9 miles[50], these results highlight why substitution of e-bikes for cars, and provision of bike/e-bike lanes not only in cities but to surrounding towns and villages is potentially attractive[51].

Table 11: Lifecycle emissions of e-bikes versus cars, grammes per km travelled

Vehicle	*Lifecycle CO_2 emissions, g/km*
e-bike	22
Battery electric car – Nissan Leaf	104
Hybrid car – Toyota Prius	168
Petrol car – EU average	258

Source: Philips et al (2020)

47 see e.g. DfT (2023d) TAG Unit A3 Environmental Impact Appraisal, which recommends a proportionate Whole Life Carbon (WLC) assessment – consultees pointed to the existence of some tools for this, although a simplified WLC tool would be useful at regional level.

48 https://nationalhighways.co.uk/suppliers/design-standards-and-specifications/carbon-emissions-calculation-tool/ and https://www.rssb.co.uk/sustainability/net-zero-carbon-rail/rail-carbon-tool

49 Berners-Lee (2020)

50 DfT (2022) Table NTS0403. The data point for 2021 was markedly lower at 8.2 miles, during the COVID-19 pandemic. https://www.gov.uk/government/statistical-data-sets/nts04-purpose-of-trips

51 Philips et al (2020) note that this option is being pursued in Denmark.

The comparison between e-bikes and conventional unpowered bikes is interesting, since the embodied carbon is fairly similar (229kg CO_2e versus 116-153kg CO_2e[52]), while the lifecycle emissions in electricity serve to balance the lifecycle emissions from food required to 'power' a conventional bicycle. The widely-quoted carbon emissions from a conventional cycle are around 21g/km[53]. Of course this does not reflect the relative health benefits, however the substitution (for car use) may be easier in many cases with e-bikes: the average distance cycled by conventional pedal cycles on commute trips was between 3-4 miles in most recent years[54].

To take this area forward, ATE and DfT may wish to consider adding some evidence and functionality into AMAT around lifecycle emissions from e-bikes, relative to those from conventional cycles and larger vehicles (particularly cars), and to incorporate some demand estimation capability for e-bikes into the tool, alongside work on demand for conventional cycling (Section 3). There are some complexities here around future changes in embodied carbon as vehicle manufacturing evolves, and the relationships between a scheme and vehicle purchasing/scrapping behaviour.

For embodied carbon in infrastructure, research is required to gather evidence on the inputs to different types of active mode scheme, and the carbon footprint associated with those inputs – following the template of the prototype SDCA, and the highways and rail industry carbon calculators. Functionality to allow appraisers to 'draw' scheme alignments in map-based tools would help to reduce the burden on appraisers, along with default values for scheme inputs and automation of the process of benefit estimation as far as possible.

One important outcome of that research would be a better understanding of the embodied carbon implications of relatively 'light' infrastructure measures such as pavement widening, coloured surfacing, installation of segregation, lane marking, crossings, signals and other features for the benefit of active modes, as well as the construction of completely new cycleways and walking routes.

4.(ix) Cashable and non-cashable benefits, and distributional benefits

One aspect of scheme impacts that comes to the fore when thinking about the cost of living, public sector finances and the goal of levelling-up, is the extent to which the benefits are cashable. TAG/AMAT contain in the background the necessary information about which benefit types are cashable, and calculations could be made to identify the cashable benefits and the beneficiaries. Table 12 explores the scope for quantification of cashable benefits across each element of AMAT.

[52] data from Trek (2021)

[53] e.g. https://ecf.com/news-and-events/news/how-much-co2-does-cycling-really-save

[54] DfT (2023) Table NTS0409 https://www.gov.uk/government/statistical-data-sets/nts04-purpose-of-trips

Table 12: Cashable and non-cashable benefits of active mode investment - scoping

Benefit category	*Cashable benefits (& beneficiary)*	*Non-cashable benefits*
User benefits	Vehicle operating cost savings (e.g. mode switchers, destination switchers) Business travel time savings (businesses – cost savings/increased output)	Travel time savings (commute/other)
Journey quality		All
Decongestion	Vehicle operating cost reduction (all drivers/operators) Business travel time savings (businesses – cost savings/increased output)	Travel time savings (commute/other)
Infrastructure	Maintenance & operation cost savings (local highway authority/National Highways)	
Accidents	Lost output (employers*/employees**) Ambulance and medical costs (NHS) Accident related costs (transport users, infrastructure manager, emergency services)	WTP/Human costs
Local air quality	Lost output (employers*/employees**) Healthcare costs (NHS)	WTP/Human costs
Noise	Lost output (employers*/employees**) Healthcare costs (NHS)	WTP/Human costs
Health (physical activity)	Absenteeism (employers*/employees**) Lost output (employers*/employees**) Healthcare costs (NHS)	WTP/Human costs
Decarbonisation	Marginal abatement cost (HM government)	
Wider economic impacts	Productivity – agglomeration impacts (employees/employers) Local retail spending (business - employees/ employers) Tourism and active modes (business - employees/ employers)	

Notes: *depends on sick pay arrangements including statutory sick pay – assuming these cover the period of injury; **e.g. for self-employed people.

One implication of the cashable benefits to households (active mode users, other transport users, other residents, employees and self-employed people) is that these are relevant to a distributional analysis and potentially to distributional weighting – if the income profile differs from the median equivalised income of average taxpayers[55]. That in turn could lead to an increase in monetised benefits of active mode schemes, in places where they create cashable savings or income increases for lower income people. It has not been the practice to use the Green Book distributional weights in transport appraisal to date. We anticipate that a process to carefully review the appraisal guidance step-by-step would be needed, in order to draw conclusions about the feasibility of adopting distributional weights in this context.

[55] HM Treasury (2022), p96-98.

4.(x) Journey quality improvements

ITS undertook a literature review and scoping research on walk and cycle journey quality in 2019-20[56] which identified gaps in journey quality measurement for active modes. These gaps matter because:

- the appraisal process uses values for journey quality attributes to help estimate the benefits of a scheme to users – therefore some benefits are missing from the BCR; and
- the demand growth due to the scheme would also, in practice, be related to the degree of improvement in journey quality offered by the scheme.

At present, TAG and AMAT value a subset of journey quality improvements[57]. TfL's Ambience Benefit Calculator (ABC) and TfGM's Programme Entry Appraisal Tool (PEAT) cover a wider range of journey quality attributes, but still have some gaps. There is also an international literature which contains evidence on some of the remaining gaps, but is not based on UK conditions so there *may* be some differences in values.

Among the most important gaps are those shown in Table 13, for cycling and walking respectively. These are based on a careful specification of journey quality for each mode, and then a review of available evidence on each element of journey quality (the detail is given in Appendix B). A similar review for wheeling would be another useful step.

Table 13: Journey quality gaps

Cycling	*Walking*
Lane width (of off-road or on-road cycleways)	Pavement width
Continuity (of cycle routes)	Clear pavement (absence of clutter)
Frequency of stops	Crossing facilities and conditions
Advanced stop lines	
Turn facilities (e.g. protected turn lanes)	
Traffic exposure (perceived threat, not only costs of accidents) – related to: • proximity to traffic lanes • traffic speeds, volumes and HGV%	Traffic exposure (perceived threat, not only costs of accidents) – related to: • proximity to traffic lanes • traffic speeds, volumes and HGV%
Air pollution and noise experienced on street	Air pollution and noise experienced on street
Urban greening and other street environment characteristics	Urban greening and other street environment characteristics

In moving forward, there are a number of easy wins here, notably:

- incorporation of best practice evidence from TfL's Ambience Benefit Calculator (ABC) and TfGM's Programme Entry Appraisal Tool (PEAT) into national guidance – this should help to address the gaps around lane and pavement width, advanced stop lines and pavement width, for example;

[56] Nellthorp et al (2020), 1-942 – Social Impacts of Transport Infrastructure in Built Up Areas – Strengthening of Guidance – Final Report.

[57] see DfT (2023c) TAG Data Book Tables A4.1.6 and A4.1.7.

- consideration of whether other evidence from the international literature can be applied in England – e.g.:
    - Börjesson and Eliasson (2012) found that cyclists value a reduced frequency of stops – worth 1.1 cycling minutes per stop, in addition to any extra journey time;
    - Börjesson and Eliasson also found that cyclists value reduced time waiting at intersections 2.0 times as highly as general reductions in cycle journey time separately from the penalty per stop. This study was based in Sweden and used stated preference methods. The results have been peer-reviewed and published.

However, there are also notable gaps in the wider evidence base, for example exposure to traffic volume and vehicle mix as well as speed, and the proximity to traffic, are key factors for both cyclists and pedestrians – but values for these items are missing[58]. Continuity of cycle routes is an attribute recognised as important in the planning literature and in the design guidance (Local Transport Note LTN 1/20)[59], but not currently valued. Air pollution and noise impacts on people using streets are not yet being measured and valued[60]. The street environment is also known to be valued in terms of urban greening/street trees and there is evidence on this, however the evidence is not currently being used in transport appraisal[61].

Figure 5: Image showing exposure to traffic and provision of advanced stop lines

Source: Ulrich Lamm (2014) - details see p43.

[58] see Appendix B
[59] DfT (2020c)
[60] Jiang and Nellthorp (2020) and Jiang et al (2022) explore the scope for valuation of noise reduction and soundscape improvements.
[61] Defra (2013) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/226561/pb14015-valuing-local-environment.pdf

Bearing in mind that the existing evidence base contains much material that is older (pre-2010[62] - when public perceptions of active travel and understanding of facilities may have been different), is spread across different studies in different contexts, and that some journey quality factors are missing, it should be a priority to undertake new research to complete and update the values of journey quality, providing a consistent set of evidence for appraisers to use.

4.(xi) Reducing the burden of scheme appraisal

Finally, bringing together a number of the findings from this report, we can summarise the potential for reducing the burden of scheme appraisal:

- Predicting take-up of active travel schemes is a key burden on practitioners, which the CWIS investment models and uplift tool have begun to address – building on existing tools such as the Propensity to Cycle Tool and Datashine. There is scope for further development of such tools, aiming for ease of use and flexible application to scheme design and optimisation, and better integration with the rest of the benefit estimation process. Further discussion of this can be found in Section 3.
- Functionality to allow appraisers to 'draw' scheme alignments and area-based schemes in map-based tools would help to reduce the burden on appraisers, along with default values for scheme inputs and automation of the process of benefit estimation as far as possible. This was raised in the context of estimating carbon benefits, but would be of wider use across the tool to specify the geographical scope of the interventions. Further software development work will be needed to implement this type of advanced functionality and calculate the benefits (potentially over a 1-3 year time horizon), although prototypes exist from previous initiatives.
- Time savings for pedestrians and cyclists may be important in certain circumstances – e.g. new pedestrian/cycle links across railways, waterways, roads, geographical barriers, and also priority measures which offer substantial travel time benefits to walking and cycling. At present these are allowed in the appraisal but are not included in the AMAT spreadsheet tool, and we recommend work is done to incorporate them in a straightforward way – possibly using a simplified but consistent version of the TUBA multi-modal method. This should be a relatively easy win.
- In order to make the current methods and tools more applicable to cases of roadspace reallocation, we have recommended that work be undertaken to synthesise the available evidence on traffic evaporation, and to issue suitable guidance based on that. This would be a help to local authorities who are currently reliant on case specific modelling to address what is in fact a very widespread issue.
- It was suggested that a discussion be held around whether active mode appraisal is best undertaken at area strategy (or plan) level (e.g. for a regional authority area such as Greater Manchester, West Yorkshire, or Liverpool City Region) and shift scheme level appraisal to a 'light touch' approach focused on confirmation that the scheme is part of strategy delivery, is already appraised, and ensuring delivery/benefits realisation aspects are addressed at scheme level. (This was an extension of the idea of 'strategy on'/'strategy off' appraisal at scheme level, where 'strategy on' appraisal is particularly useful. The question could be reframed as: whether or not a

[62] the values in TAG date from 1996-2007

decremental appraisal of individual schemes within a strategy is necessary to demonstrate the business case for each scheme as a component of the strategy).

- Evidence now exists on the lifecycle carbon emissions of each road-based mode (including e-bikes), per km travelled. Incorporating this evidence into TAG and AMAT could help to make the case for investment in regional networks for cycles and for e-bikes in particular.

5. Conclusions and Prioritisation

In each of the sections of this report, broad recommendations have been made about potential solutions to the issues discussed, and in this final section these recommendations are summarised along with some consideration of the likely timescale needed to address them, what sort of scale the impact on the BCR might be, and which types of scheme are likely to benefit most from each change (see Tables 14&15).

Mostly these recommendations are addressed to Active Travel England and in some cases DfT, since DfT TASM Division is the lead body on the appraisal framework (TAG) and DfT Local and Regional Transport Analysis is the lead body on AMAT. Collaboration with the major regional transport authorities and with relevant research funders (e.g. NIHR, EPSRC, ESRC), would be highly productive, in taking this whole field forward. Other government departments will have an interest where the topics overlap with their remit, e.g. place quality with DLUHC, and public health impacts with DHSC.

While the main motivation for this report has been to improve appraisal methods, undertaking work in these areas should also contribute directly to policy development by providing evidence of what works, in terms of health outcomes, economic outcomes, decarbonisation and other relevant impacts on human welfare/wellbeing. The research recommended should lead to:

- systematic reviews of the existing evidence;
- new monitoring and evaluation evidence, focusing on active mode strategies and schemes - as requested by NAO (2023) and using methods outlined in the new TAG Unit E-1 (DfT, 2022e), e.g. the Cycle City Ambition evaluation (Sloman et al, 2019b);
- new empirical parameters, e.g. for journey quality attributes; and
- improved tools for demand forecasting and impact assessment - including updates to AMAT/PEAT/ABC.

Table 14: Summary of potential solutions and recommended approaches

Topic	**Page # in report**	**Recommended approaches**
Morbidity benefits	4	A phased approach: (i) systematic review of evidence on morbidity benefits of active travel interventions, including impact pathways, empirical evidence, and outcome metrics (e.g. DALYs/QALYs), focusing on evidence relevant to UK conditions; (ii) commissioning of additional specific evaluation work if required - e.g. on alternative interventions in the UK; (iii) development of methodology and guidance for appraisal. Note that some authorities (e.g. TfGM in Greater Manchester) use a rule of thumb for morbidity benefits - a possible interim solution for other authorities. Note also that practice in Australia includes morbidity benefits (Zapata-Diomedi et al, 2018).
Travel time savings for active modes	5	Further development of the AMAT spreadsheet tool to include active mode time savings, applying the existing TAG method for user benefits (Unit A1.3). Update AMAT guidance.
Safety for active mode users	3	Take on board the additional impacts in PEAT, to update AMAT.

Demand forecasting tools	6-9	To bring forward the development of more flexible, easy-to-use tools for predicting take-up, ATE and DfT might consider different approaches - e.g. directly funding further development of existing tools (e.g. CWIS/Uplift Tool, PCT/CYIPT, Datashine), and/or setting out requirements for analytical assurance of other, diverse tools. Medium-long term: scope for a programme of monitoring and evaluation studies to add to the evidence base of the CWIS Investment Models and to address the recommendations of the NAO (2023). Also scope for behavioural research to underpin modelling assumptions about the design of interventions.
Place quality and urban realm	11-14	Programme of research required to develop the theoretical framework, undertake empirical research, and derive key findings for valuation of place quality and urban realm. Interim solutions include: synthesis of existing evidence on value of local facilities, greenspace, environmental quality and urban realm.
Destination shift	14-15	Linked to the solution for place quality/location attractiveness above. In the short term, the limitation of the user benefits method could be recognised and evidence on the value of *local* amenities admitted into the framework.
Roadspace reallocation	15-19	Rapid evidence review to summarise available evidence and produce suitable guidance on behavioural responses and traffic evaporation, updating Cairns et al (1998/2002). Potential for a targeted monitoring and evaluation effort engaging a range of authorities, if the evidence is found to be insufficient.
Economic benefits of active modes	19-21	Research is needed to develop robust evidence on the linkages between active travel, density (both commercial and residential), productivity, and incomes. There is evidence that denser locations have more active travel, meanwhile the relationship between effective density[63] and productivity is already included in TAG (Unit A2.4), however there is no tool in TAG or AMAT to link active mode investment to increases in density and productivity. Aside from density, there are research needs relating to: tourism impacts of active mode provision; retail impacts - where there is empirical evidence but also gaps around the treatment of displacement and the benefits of strengthening local retail; and the productivity benefits of better health.
Strategy and scheme appraisal	22-23	Potential updates to guidance around the link between strategy and scheme appraisal. In particular, to encourage the use of strategy-consistent (or 'strategy-on') assumptions, which can demonstrate substantially higher BCRs at scheme level.
Definition of the BCR - NHS cost savings	23-24	The treatment of NHS cost savings in the benefit:cost ratio could be reviewed, in the light of the principles established during the NATA Refresh, and considering the cross-departmental cost implications of active travel.
Active travel as an access mode	24-25	Develop methodology so that the benefits that come with access by active modes (including health) are taken into account in rail and bus scheme appraisals, and consider whether there is sufficient focus on multi-modal packages of investment including

[63] of employment

		active modes+public transport in the tools (e.g. AMAT) and guidance.
Embodied carbon in vehicles and infrastructure	26-27	Consider adding evidence and functionality into AMAT around life-cycle carbon emissions - including embodied carbon in vehicles - from cycles and e-bikes, relative to those from cars and other vehicle types. Research is needed to understand the embodied carbon in active travel infrastructure, and to develop practical tools (e.g. SDCA).
Cashable and non-cashable benefits, and distributional benefits	27-28	There is potential to identify the cashable (money) benefits of active travel investment for household budgets, relating this to local area incomes and potentially the use of Green Book distributional weights.
Journey quality improvements	29-31	In the short term, potential to incorporate journey quality benefits that are covered by existing evidence into AMAT (e.g. on walking and cycling priority measures). This includes evidence from TfL's ABC tool and from the international literature – see Section 4(x). Research is needed to provide evidence on the benefits of a wider set of journey quality attributes not currently included in AMAT or transferable from other existing evidence (see Tables B3&4). Wheeling needs to be included. Suitable research methods are available - e.g. building on Wardman et al (2007). It may be advisable to group the journey quality attributes so that a priority group is tackled in an initial phase of empirical research, leaving a wider set to be addressed in a second phase - given the total number of attributes.
Reducing the burden of scheme appraisal	31-32	Many of the recommendations outlined in this report would help to reduce the burden of scheme appraisal, including: • further development of demand forecasting tools, focusing on ease of use and flexible application to a range of contexts - and better integration with the rest of the benefit estimation process; • functionality to allow appraisers to 'draw' scheme alignments and area-based schemes in map-based tools, with automation of the process as far as possible (building on existing prototypes); • filling gaps in the existing appraisal tools, automating wherever possible, e.g. bringing the time savings calculation into AMAT, and bringing in lifecycle carbon emissions; • review the balance between strategy-level and scheme-level appraisal, and the potential to focus efforts on what matters most (e.g. scheme optimisation in the context of the overall strategy).

Table 15: Summary of potential actions and timescales

Topic	**Recommended actions and timescale**				**Potential impact on BCRs**	**Project types most likely to benefit from the change**
	Guidance update	Research/ development <1yr	Research/ dev't 1-3yrs	Research/ dev't >3yrs		
Morbidity benefits			*		Large	All
Travel time savings for active modes	*	*			Moderate	New walk/cycle links, priority measures
Safety for active mode users	*				Small/Moderate	All
Demand forecasting tools		*		*	Large	Area wide strategies
Place quality			*		Large	All
Roadspace reallocation		*	*		Large	Schemes which reduce mixed traffic capacity
Destination shift	*	*			Small/Moderate	Town centre schemes
Economic benefits of active modes		*	*		Moderate	All (built-up areas and visitor attractions)
Strategy and scheme appraisal	*	*			Large	Area wide strategies
Definition of the BCR - NHS cost savings	*				Small	All
Active travel as an access mode	*	*			Moderate	Station improvements, transport hubs, modal integration
Embodied carbon in vehicles and infrastructure	*	*			Small/Moderate	All, particularly active mode infrastructure
Cashable and non-cashable benefits, and distributional benefits	*	*			Small/Moderate	Levelling-up contexts
Journey quality improvements	*	*	*		Moderate/Large	All - cycle and walk
Reducing the burden of scheme appraisal	*	*	*		-	All – particularly smaller authorities; non-government promoters

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About the author

Dr John Nellthorp is a Senior Research Fellow at the Institute for Transport Studies, University of Leeds, where he specialises in appraisal and evaluation. Early in his career, John co-authored the multi-modal appraisal guidance which was introduced as part of the New Deal for Transport under the 1997-2001 government - this gave an equal footing to public and private transport, introduced carbon and many other omitted impacts into the appraisal framework, and strengthened the case for investment in rail and urban public transport. He has worked on the issue of streets and walking and cycling appraisal since 2010, alongside a range of other topics including wellbeing and health measurement, journey quality, community noise exposure and the value of place and accessibility. In total he has 29 years' experience in research, teaching and consultancy. He has worked for DfT, the European Commission, the World Bank, TfL, TfGM, WYCA, TfN, National Highways, EPSRC, and governments in Ireland, Canada, Scotland and Wales. He has supervised PhD students on a range of topics including demand for electric vehicles and the impact of urban mass transport on migration. He leads teaching on modules related to economic appraisal and economic performance at the University of Leeds, and delivers professional training on transport appraisal through the Transport Investment Appraisal short course.

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Images

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Appendix A
Measurement of benefits when trips switch destination and mode due to place quality changes

In standard transport user benefit analysis, including TAG Unit A1.3 and the TUBA software, the benefits are calculated in a matrix, defined by a number of origin-destination pairs *ij*, a number of travel modes *m*, a number of time periods *t* (e.g. days of the week and peak/off peak hours), and potentially other disaggregations. In each cell of the matrix, the benefit measure - usually the rule-of-a-half - is applied, and then the benefits are summed across cells in the matrix.

$$\text{User benefit}_{ijmt} \approx \text{Rule-of-a-half}_{ijmt} = 0.5\,(GC^0_{ijmt} - GC^1_{ijmt})\,(T^0_{ijmt} + T^1_{ijmt}) \qquad (2)$$

$$\text{Total user benefit} = \sum_{ijmt} \text{Rule-of-a-half}_{ijmt} \qquad (3)$$

Graphically (see Figure A1) the shaded area is the user benefit measured using the rule-of-a-half, when there is a small reduction in generalised cost of travel in the 'near' market - for example due to active travel investments reducing journey times to the local centre. By contrast, if the local centre is improved in ways that are not part of the generalised cost of travel in appraisal - e.g. through pedestrianisation, urban realm improvements, or an increase in the range of shops and facilities offered - then there may be no measured user benefits in the 'near' market (Figure A2). Whether there are any benefits in the 'far' market would depend on whether there is any decongestion (AMAT currently assumes that there is a certain amount of decongestion when car trips are replaced by active mode trips). However, the saving to users in money and time, between GC_{Far} and GC_{Near} is not counted because the initial improvement in place quality is not part of GC, and because of the way that switchers (between modes and destinations) are treated.

Figure A1: Rule-of-a-half user benefit measure - active travel improvements within local area

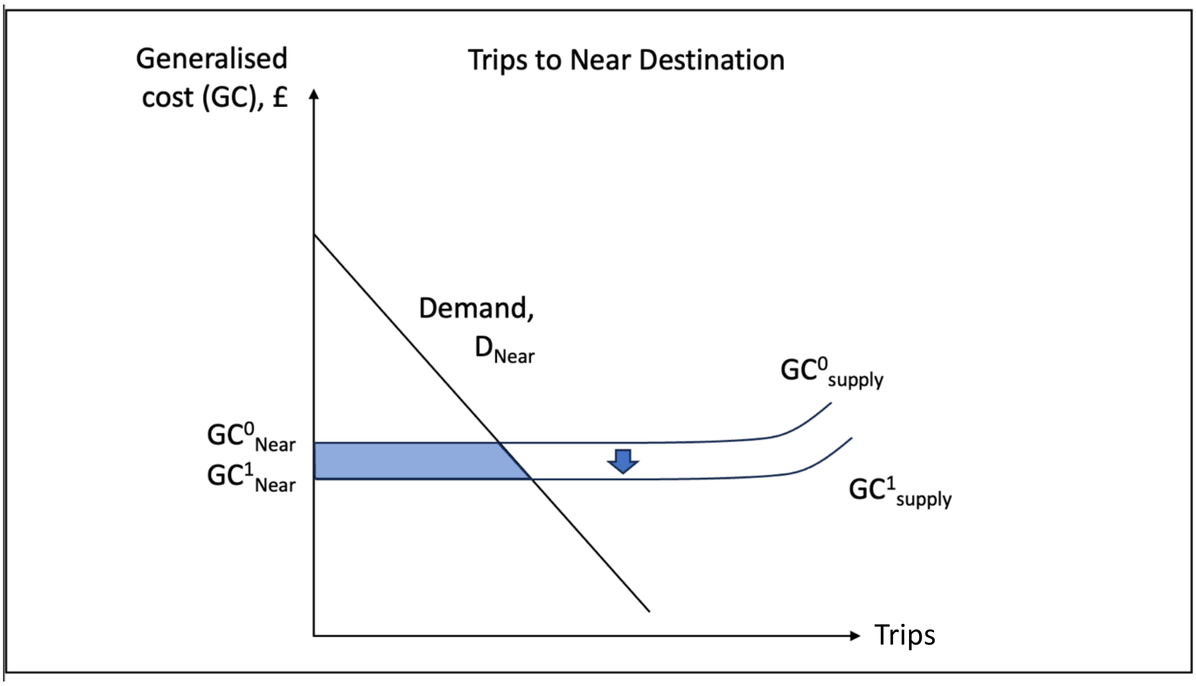
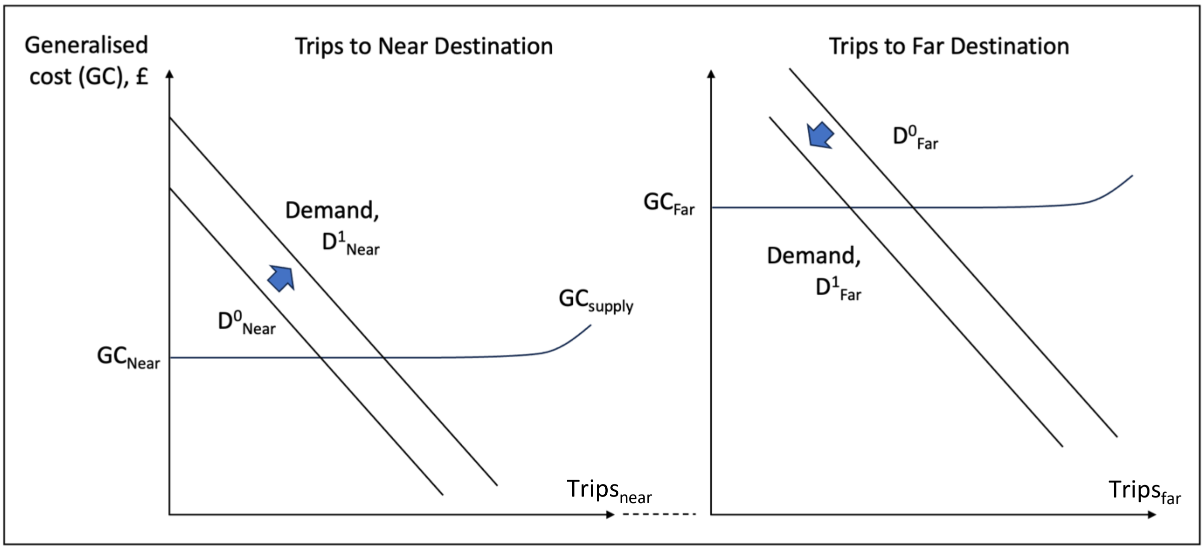


Figure A2: User benefits missing when a destination shift is caused by place quality changes



The underlying cause of this issue is the gap around place quality, however the mathematics of transport user benefit analysis provides a further barrier to measuring the benefits of shifting demand towards shorter, active mode trips. Solutions worthy of further discussion include revisiting the treatment of switchers[64] as well as incorporating place quality into appraisal and modelling.

[64] previously considered by Nellthorp and Hyman (2001) during the development of the multi-modal CBA framework.

Appendix B
Journey Quality factors

Tables B1 and B2 summarise the evidence base on valuation of journey quality factors. The first and second columns describe the components of journey quality for these modes, based on the literature review by Nellthorp et al (2020). The third column identifies what is included in TAG & AMAT, and what is not included. The fourth and fifth columns describe the wider evidence base, including: values gathered by TfL and included in both TfL's Ambience Benefits Calculators and TfGM's Programme Entry Appraisal Tool; values in the international literature, especially Borjesson and Eliasson (2012); and factors which lack values but are included in Level of Service (LOS) metrics – based on survey evidence with cyclists and walkers in the respective countries, which allow some comparison with other factors.

Table B1: Cycling journey quality factors – valuation evidence

General	*Cycle Journey Quality Factors*	*TAG*	*International evidence*	
Speed of progress through network	Frequency of stops		[1]	
Safety & Security	Danger from **traffic**: • traffic volume • traffic speed • %HGVs		[2]	LOS metrics
	• proximity of cyclists to traffic	'Wider lane'	[4]	
	• interaction with on-street parking			
	Cycle infrastructure:			
	• traffic-free cycleways	✓	[1,2,3,4]	
	• advanced stop lines		[3]	
	• right turn facilities			
	• routes to avoid roundabouts		[3]	
	Secure cycle parking	✓	[1,2,3]	
Comfort	Width of cycle lane: • for 2 or more cyclists / for 1		[3]	LOS metrics
	Congestion (cycle flow vs capacity)		[3]	
	Effort (exertion)		see below	
	Surface quality		[3]	LOS
Environment	Air pollution and noise exposure – **traffic related**			
	Other environment factors including urban greening, character, visual amenity and soundscape		[3] 'attractiveness'	
Information	Signage (a limited effect)		[3]	
Health	Positive payoff from the exertion (METs, calories) of active travel. The extent to which this is perceived by users is uncertain/emerging.	✓ in Physical Activity valuation		

Note: Evidence sources: [1] Börjesson and Eliasson (2012a); [2] Wardman et al. (2007); [3] TfL (2019) Ambience Benefit Calculator; [4] Hopkinson and Wardman (1996). LOS metrics based on the US BLOS (National Research Council, 2016), Denmark (Jensen, 2007) and the BCI (Harkey et al., 1998).

Table B2: Walking journey quality factors – valuation evidence

General	*Walk Journey Quality Factors*	*HE / TAG*	*TfL (2019)*	*PLOS*	
				US	*DK*
	Crossing roads				
Speed	Crossing times	HE Severance toolkit	✓	✓	✓
Safety & Security	Danger from traffic:	HE Severance toolkit			
	• traffic volume		~	✓	✓
	• traffic speed		✓	✓	✓
	• %HGVs				
	Pedestrian infrastructure:				
	• Pedestrian-controlled signalised crossings (e.g. Pelican)		✓	✓	✓
	• Zebra-type crossings				✓*
	• Other crossing facilities		✓	✓	✓
	Movement along roads				
Safety & Security	Danger/threat from **traffic**:				
	• traffic volume		~	✓	✓
	• traffic speed		✓	✓	✓
	• %HGVs				
	• proximity to traffic			✓	✓
	Lighting	~	✓		
Comfort	Pavement width		✓	✓	✓
	Crowding (pedestrian flow vs capacity)	~	~	✓	✓
	Clear pavement (lack of clutter)		✓	✓	
	Effort (exertion)				
	Surface quality & levels (kerbs)	~	✓	✓	✓
Environment	Air pollution and noise exposure – **traffic related**			Traffic	Traffic
	Other environment factors including urban greening, character, visual amenity and soundscape		Plants, public art		Trees
Information	Signage (a limited effect)	~	~		
Health	Positive payoff from the exertion (METs, calories) of active travel. The extent to which this is perceived by users is uncertain.	✓ in Physical Activity valuation	✓		

	See Chapter 3 ‘Physical Activity’.				

Notes: TAG refers to TAG Unit A4.1 Journey Quality section and Data Book values; TfL (2019) refers to Ambience Benefit Calculator; both are supplemented by Physical Activity valuation; main international sources are National Research Council (2016) for the US, and Jensen (2007/12) for Denmark; ‘~’ indicates that units of measurement are not quantified (where this would be possible).

Tables B3 and B4 focus on identifying a more complete set of journey quality factors for future valuation research, based on the work by Nellthorp et al (2021) combined with AMAT/ABC/PEAT and the cycle infrastructure design guidance LTN1/20. Key points to note are that:

- although ABC/PEAT are more complete than AMAT in relation to walk journey quality, a synthesis of the published literature and evidence finds that there are other important factors not yet included (e.g. exposure to traffic, buffer width from the road, delay time at crossings). A review of the scope would be a useful first step for any research, and this could potentially be informed by a factor analysis;
- in relation to cycling journey quality, the design standards guidance LTN1/20 published by DfT in 2020 is much more comprehensive than the valuation evidence currently included in ABC/PEAT and AMAT. Undertaking a new valuation study could serve two goals: to help complete AMAT; and to bring it more in line with design guidance, LTN1/20.

Table B3: Journey Quality Factors for Walking, by source

Journey Quality Factor	Synthesis (Nellthorp et al, 2021)	Current valuation methods	
		ABC/PEAT	AMAT
Walking Along Links			
1. Effective Pavement Width (m)	Y	Y (2 people side by side)	-
2. Traffic Volume (AADT)	Y	-	-
3. Traffic Speed (85th perc. mph)	Y	-	-
4. HGVs (AADT)	Y	-	-
5. Buffer Width (m)	Y	-	-
6. Crowding (ppmm)	Y	Y (many people/some/largely deserted	Y
7. Lighting (% Lit)	Y	Y (qualitative)	Y
8. Gradient (%)	Y	-	-
9. Crossfall (%)	Y	-	-
10. Surface Quality (% Defects)	Y	Y	Y
11. Headroom (m)	Y	-	-
12. Street Trees (avg. gap, m)	Y	Y (plants alongside street)	-
13. Air Pollution (PM_{10} μ g/m^3)	Y	-	-
14. Noise (dB Lden)	Y	Y (only at crossings)	-
	***	***	***
Crossing			
1. Delay Time (seconds)	Y	-	-
2. Traffic Volume (AADT)	Y	-	-
3. Traffic Speed (mph)	Y	Y (20/30mph)	-
4. Crowding (ppmm)	Y	-	Y
5. Crossing Facilities	Y	Y (countdown, green man crossing, zebra, refuge, subway)	-
6. Crossing Side Road Facilities	Y	-	-
	***	***	***

*** the complete set of journey quality factors includes further factors: e.g. ‘benches’, ‘directional signage’, ‘information panels’ and ‘kerb level’, which are currently included in AMAT; ABC & PEAT also include additional factors. There is overlap here with urban realm (see Section 4(i)).

Table B4: Journey Quality Factors for Cycling, by source

Journey Quality Factor	Synthesis (Nellthorp et al, 2021)	Current valuation methods		Design guidance
		ABC/PEAT	AMAT	LTN1/20
Cycling Along Links				
1. Potential speed of progress through the network (km/h)	Y	-	-	Y
2. Directness (deviation factor)	Y	-	-	Y
3. Frequency of stops (per km)	Y	-	-	Y
4. Traffic: volume (AADT, 2 way)	Y	Y (traffic free/not)	-	Y
5. Traffic: speed (mph)	Y	-	-	Y
6. Traffic: HGVs (AADT, 2 way)	Y	-	-	Y
7. Separation (buffer width vs traffic lane, m)	Y	-	-	-
8. Segregation	Y	Y	Y	Y
9a. Carriageway lane width (m, per direction)	Y	-	Y ('Wider lane')	Y
9b. Cycle lane width (m, per direction)	Y	Y (narrow/2 cyclists)	-	Y
10. Advanced stop lines	Y	Y	-	Y
11. Roundabouts (per km, excl. mini)	Y	-	-	-
12. Side roads & driveways crossed (per km)	Y	-	-	Y
13. Parked cars (% of roadside)	Y	-	-	-
14. Cycle congestion (cycle flow per direction, peak hr)	Y	Y (crowded/busy/largely clear)	-	-
15. Surface quality (RMSVA, m/s^2)	Y	Y	-	Y
16. Signage (% of signing schedule in place)	Y	Y (regular intervals/not)	-	Y
17. Lighting (% of section length lit)	Y	-	-	Y
18. Cycle parking	Y	Y (options)	Y	Y
Crossing/Turning				
1. Right turn facilities	Y	-	-	Y
2. Traffic: volume (AADT, 2 way)	Y	-	-	Y
3. Traffic: speed (mph)	Y	-	-	Y
4. Right turn delay (secs)	Y	-	-	Y

Note: the table shows a finite list of factors - the 'complete' set of journey quality factors includes further factors beyond this, e.g. the design of side road crossings.