

Active Mode Benefits: Theoretical Framework

Report to Active Travel England

March 2026

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Summary

Active Travel England (ATE) and the Department for Transport (DfT) commissioned this research to develop a theoretical framework including travel time, place quality/public realm, safety, health and journey ambience benefits for active modes. The framework sets out how to value these impacts in appraisal without double-counting, and is intended to enable and inform subsequent empirical research. The framework is also designed to align with separate research on morbidity impacts and a new health benefits tool¹.

Context and main study objective

To help make the case for specific active mode investments, DfT provides guidance and tools for assessing the benefits and costs. This includes the Active Mode Appraisal Tool (AMAT) (see Table 1 for a list of the main sources of guidance).

ATE and DfT now plan to update the evidence base and appraisal methods used for active mode investments. The main objective of this piece of research is to provide a theoretical foundation for this work. The report sets out how double-counting can be avoided, addressing an issue raised by Börjesson and Eliasson (2012) in relation to health benefits, and identifies and addresses other potential issues in relation to safety, journey quality and place quality benefits. The framework's central purpose is to provide clarity about the measurement of overall benefits for active mode schemes. It also helps to inform the design of empirical research (e.g. on the value of journey quality improvements and travel time changes for walking and cycling) by specifying equations, including alternative functional forms, for further analysis.

Approach

The framework takes the existing DfT Transport Analysis Guidance (TAG) as given. Where additional theory is needed:

- concepts are defined, and these are grounded in the literature;
- we set out key variables, the relationships between them and links to data.

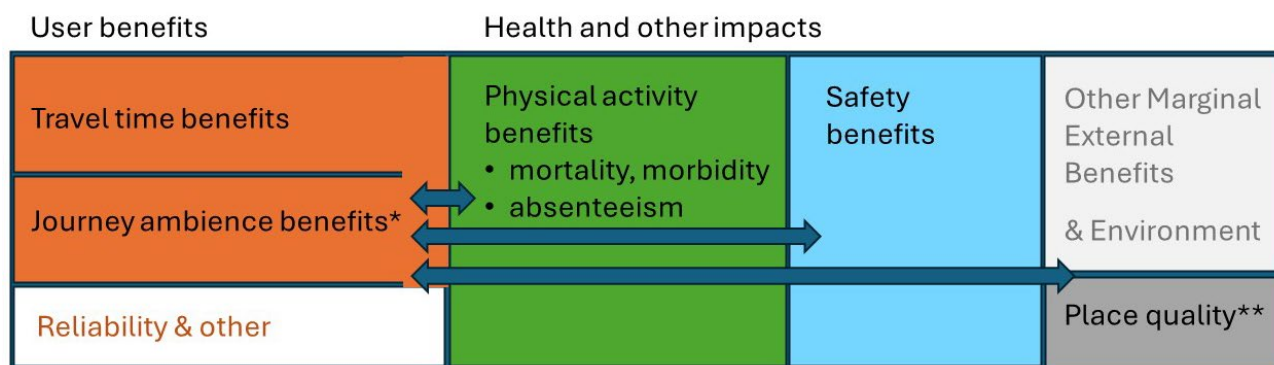
The overall scope is shown by Figure 1 (overleaf). This includes all the benefits currently valued in AMAT plus the morbidity benefits that are part of the new health benefits tool, and any potential place quality benefits². The left hand column shows the user benefits to current and new users when particular travel options are improved, while the remaining columns show the health, safety and other impacts which flow from the travel choices made.

There are interactions between the user benefits and the downstream health, safety and other outcomes. Individuals may perceive that their actions can have consequences, e.g. they may be aware of the health benefits available from active travel, or of the safety risks associated with cycling on the roads between their home and a regular workplace. The theoretical framework seeks to clarify the nature of these interactions, and their implications for counting overall benefits (and not double-counting benefits).

1. Study title: Morbidity Impacts in Active Modes Appraisal (TATE3030).

2. Place quality is discussed in §1.3, §2.2.3 and §3.4.

Figure 1: Simple schematic of active mode benefits.



Main findings and recommendations

i. Trip purposes

For active mode appraisal, four trip purposes are potentially needed (versus the three usually used for other modes): the fourth is exercise/pleasure trips, for which the purpose is in the trip itself – e.g. going for a walk/jogging/walking the dog/cycling for pleasure – rather than to undertake an activity at the destination. We believe these trips are largely captured in NTS data (in terms of trip numbers) however the categories within the NTS data could be clearer. This fourth purpose represents a significant proportion of active mode trips (up to 30%).

ii. Trip utility

The theory follows the same basic concepts of trip utility and generalised cost used in transport modelling and appraisal, e.g. in Ortúzar & Willumsen (2011) and in TAG. Trip utility for active modes is a combination of in-trip and trip end factors (see (iii) below for the latter). In-trip utility is driven by four main categories of factors:

- i. travel time (t)
- ii. perceived safety (s)
- iii. physical effort (e) – in METs (Metabolic Equivalent of Task)
- iv. other journey ambience factors (c for comfort)

Of course, money cost (in £) is also relevant if it is present, e.g. the cost of cycle hire.

How, then, do active modes differ from motorised modes? Effort, e , plays a larger role and money cost a much smaller one; perceived safety, s , is a key issue for vulnerable road users including pedestrians and cyclists (e.g. ATE, 2025); and as active mode users are not inside a vehicle, they are more exposed to the ambience of the street.

iii. Trip utility functions

A general form of the trip utility function, for route r , would be

$$U_r = f(\alpha_i, t_r, s_r, e_r, c_r, \omega_j)$$

where α_i are pre-trip elements, e.g. cycle storage at home;

ω_j are trip-end elements, e.g. cycle parking at the destination.

A specific form of the trip utility function, converted into generalised cost, would be

$$GC_r = \frac{\alpha_i}{\beta} + \sum_{n=1}^N (v_t t_n \bullet m + v_s s_n + v_e e_n + v_c c_n) + \frac{\omega_j}{\beta}$$

where n are trip sections (links or junctions), the v 's are marginal values of each factor, and β is a marginal utility of income, to convert the trip end utility terms into money amounts³.

The report suggests and discusses other variants, and empirical research would test alternative forms.

iv. Lifetime utility

The theoretical framework is based on an understanding of lifetime utility for members of the population (Hammitt, 2013; Murphy & Topel, 2006; Rosen, 1988). Both short- and long-term utilities are relevant to lifetime utility, e.g. both changes in the trip utilities (generalised costs) for the trips made by the individual in a given year (y), and the impact on the individual's long-term health outcomes (including mortality and morbidity). Future health outcomes, $H_{y+1}, H_{y+2}, H_{y+3}, \dots$ may be forecast using a Markov model, discrete event simulation or other techniques.

In this respect the theoretical framework is different from Flügel et al. (2021) whose theoretical model did not address the lifetime utility of the individual, or the consequences of the health benefits being in the future and uncertain. Instead their model assumed that all utility and all time allocation is within one representative day. It was based on an earlier model by Jara-Díaz and Guevara (2003).

v. Health impacts

There is a link between trip utility and the individual's future health outcomes. If the individual perceives a proportion of their own future health benefits, θ , it will appear in their individual trip utility (and be taken into account in their individual choice making). If $\theta > 0$, this is the part which needs to be deducted from the overall benefit calculation to avoid double-counting.

3. Further details are given in §3.1.

We considered the evidence:

- the rate of perception of future health impacts is embodied in health-specific private discount rates (Matousek et al., 2022) – these are high;
- future health benefits are uncertain – this implies higher private discount rates (Andersen et al., 2008);
- initial analysis based on the literature suggests θ may be as low as 0.1–0.2 (see §2.3.1);
- behaviour may be explained not only by discounting under uncertainty: further down-weighting of future health effects may be due to habits, addictions, and other features of human neurology/psychology (Borghans & Golsteyn, 2006; Bickel et al., 2012);
- information asymmetry is another potential issue: some people may not be aware of, or not be aware of the magnitude of, potential long-term impacts (§2.3.2).

Our recommendation for now is to continue with TAG practice, in line with other European countries, in other words to undertake the appraisal assuming θ is close to zero (i.e. assume that trip utility does not double-count with health benefits). For future research, we recommend investigating the value of θ further, building up from the theoretical arguments (time preference, risk/uncertainty, information asymmetry), potentially using a combination of evidence review and new experiments.

vi. Effort and exercise

The theoretical framework unpacks the physical activity term in trip utility ($v_e \bullet e_n$). This contains other effects in addition to the future mortality and morbidity impacts:

$$v_e \bullet e_n = \tilde{v}_e \bullet e_n - \hat{v}_e \bullet e_n - \theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{\text{social}}^\tau)$$

where $v_e \bullet e_n$ is the user's own overall valuation of the change in physical effort/exercise (e_n in MET-h)

$\tilde{v}_e \bullet e_n$ is the user's valuation of the *negative* effects of effort in the short-term (these are described by Flügel et al., 2021, in their choice experiment, as: panting; sweating; getting physically tired; and getting sore muscles)

$-\hat{v}_e \bullet e_n$ is the user's own valuation of the *positive* effects on mood/wellbeing/fitness/weight in the short-term (see §3.1.4 in the report, and again this aligns with Flügel et al., 2021, who identify: feeling in good shape; achieving a desired activity level; and burning calories)

$\Delta h_{h,\tau}$ are the user's own *individual* long-term mortality and morbidity benefits in year τ , which are discounted and summed over years y to T .

The last term in the equation above, $\theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{\text{social}}^\tau)$, links the individual's short-term trip utility to their future health benefits (see (v) above). The positive effects of exercise in the short-term ($\hat{v}_e \bullet e_n$) are part of trip utility (hence user benefits) and do not double-count with the long-term mortality and morbidity benefits.

We recommend econometric research, using discrete choice experiments as the main data source, taking either of two approaches:

- i. estimation of the values and parameters in the equation above as part of trip utility; or
- ii. a pragmatic alternative – estimation of the value of physical exercise/effort under specific infrastructure conditions and for specific trip types (and for specific population segments), including cases where physical effort is elevated.

It may be difficult to separately estimate all three components on the right hand side of the equation above (e.g. Flügel et al., 2021, did not attempt to separate the last two – the “positive effects” of physical effort). Nevertheless, approach (ii) would yield useful evidence about the positive or negative contributions of physical effort and exercise to trip utility for active modes in various practical situations.

vii. *Safety impacts*

Changes in the safety of active travel are felt in two ways as part of lifetime utility. Firstly, in *trip utility*, perceived safety risks are a source of disutility. Secondly, when accidents and casualties actually happen (*safety outcomes*), those affected experience large negative utility impacts. The theoretical framework breaks these down into effects that are internal versus external to the individual (Table 10).

We found evidence⁴ that people are very sensitive to perceived safety on active modes – particularly cycling. This is reflected in large willingness-to-pay (WTP) values for time spent cycling on safer types of infrastructure (e.g. see the TAG Data Book values in Table 7 of this report). This creates a serious risk of double-counting between (i) the WTP for perceived safety at trip level and (iii) the WTP for safer outcomes.

At DfT’s suggestion, we have compared the TAG value for ‘Off-road segregated cycle track’ (16.28p/min) with the expected safety outcome benefits of an off-road segregated cycle track, and found that the perceived safety value is approximately 2-4 times the expected safety outcome benefit.

The recommendations on safety impacts, to avoid double-counting, are therefore:

- for now, capture *internal* safety benefits to AT users through perceived safety values *where available* – e.g. journey ambience values for safer infrastructure in TAG (e.g. Data Book Table A4.1.6 and future developments of those values)
 - the external components of safety benefits may still be counted, even for users’ own safety outcomes (i.e. the NHS medical and healthcare costs, net lost output, police costs, etc), but the WTP should not be
- where there is *no perceived safety value available* (e.g. for pedestrian crossings, or advanced stop lines) an interim approach would be to use the TAG safety benefits method (TAG Unit A4.1), based on outcomes
- continue to value Safety benefits from mode shift through Marginal External Costs (MECs)

4. E.g. see ATE (2025) Critical Safety Issues, and the National Travel Attitudes Survey (NTAS, Wave 9 – DfT, 2024)

- for future research, investigate and quantify the perceived safety benefits of a wider range of safety measures, including: pedestrian crossings; advanced stop lines; and the range of safety conditions described in the *ATE Critical Safety Issues* (ATE, 2025).

viii. Place quality and urban realm

The report finds that double-counting can be avoided by following the 'Welfare appraisal under land use change' recommendations and equations (Nellthorp et al., 2025). This means:

for each trip stage, be clear if it is included within the transport model, in which case urban realm/place quality effects are counted within trip utility (journey ambience values);

if it is not included in the transport model (it may be an unmodelled short trip or another activity entirely, e.g. outdoor eating and drinking, social interaction, recreation or pop-up retail), treat and value as place quality effects at the destination *j* or origin *i* (e.g. in the local High Street or at home). An extended rule-of-a-half can be used to measure these benefits (Nellthorp et al., 2025). Note that TAG and AMAT already include air quality and noise benefits from a shift towards active travel (with some limitations – see §3.4), and these are implicitly place quality improvements.

Also note: NTEM v7.2 and 8.0 include all trips in NTS, so they potentially include short trips within local centres/high streets down to 50 yards. Valuation of such trip stages should carefully include them in either the transport model (journey ambience benefits) or the attractiveness of the location (place quality).

Our recommendations for valuation research are:

- for *valuation of urban realm attributes while travelling*, we recommend the use of stated preference (SP) and discrete choice experiments (DCE) to elicit values for important journey ambience attributes – see Table 14
- for *valuation of place quality attributes at the destination or origin*, we recognise that both revealed preference (RP - primarily hedonic pricing) and stated preference methods are potentially useful to derive values. If the value is on a 'per annum' basis, this will be ideal for effects at residential home locations, and for visits to destinations such as local or city centres a 'per trip' or 'per hour' value will be ideal (interpolation may be required depending on the research method)
- *specifically for air quality and noise*, explore the most appropriate methodology for quantifying and valuing air pollution and noise exposure improvements while walking, wheeling and cycling. The current valuation methods have limitations: the noise values are based on exposure at home locations only, not during travel; while the air quality 'impact pathway' values do not focus on exposure during different activities (travel or others).

ix. *Journey ambience impacts for walking and cycling*

Table 14 summarises our recommendations for valuation of journey ambience. Detailed review evidence on journey ambience is included in Appendix A.

It is important to capture the trip utility variables identified in this report, i.e. perceived safety, effort/exercise-related utility, and other comfort/quality/environment factors that feed into user benefits. We identify two possible research strategies: (i) measure those variables directly; or (ii) bundle them into a set of practical alternatives, e.g. time spent on different infrastructure types, exposed to different speeds and volumes of traffic. We suggest the latter may be a more efficient strategy – similar to the approach taken in the Netherlands – ‘value of time, reliability and comfort’ study (Kouwenhoven et al., 2023) – see Appendix B.

Some key considerations highlighted by the report are:

- Junctions and crossings are poorly addressed for both pedestrians and cyclists in current TAG & AMAT. Stopping/starting is a key factor for cycling, and could be addressed by including this in UK research, building on previous research in Sweden (Börjesson and Eliasson, 2012). Crossing movements are a key issue for pedestrians and up-to-date empirical research could build on the useful but >10 year old values in TfL’s ABC tool and TfGM’s PEAT tool (Nellthorp, 2025)
- exposure to traffic needs to be incorporated – evidence is quite clear that this is important (§3.5.4). It can be seen how this is done in the Dutch CBA in Appendix B
- other potentially important factors are, e.g., footway widths/lane widths (see Appendix A and ATE, 2025; and design guidance such as: Manual for Streets⁵; LTN 1/20⁶; and Inclusive Mobility⁷); surfacing; and greening (street trees and travel through green spaces)
- walking values should be subject to an approach more aligned with the current cycling values – including a set of attributes or infrastructure types based on the literature (see Appendix A and ATE, 2025) and practice guidance (WSP et al., 2003; DfT, 2020; DfT, 2021).

See §3.5 for further discussion and §4.2.1 for recommendations.

x. *Further implications for empirical research*

The report also touches on the ‘safety in numbers’ effect – particularly for pedestrians, also for cyclists – see §2.2.1.

Appropriate segmentation of the empirical analysis is likely to be important, e.g. by trip purpose; mode; age; sex/gender; household car ownership; past-week walking and cycling; local authority; distance.

The cycle mode should be disaggregated to show e-bikes and unpowered cycles separately, due to differences in effort and safety characteristics.

5. WSP et al. (2003)

6. DfT (2020)

7. DfT (2021)

xi. Implications for appraisal

The above sections contain many implications for appraisal. Building on those, the report suggests four key questions for ATE and DfT to consider (§4.3.1).

The report then considers the eleven types of intervention in ATE's 'Infrastructure scheme taxonomy', and finds that most of these types of interventions will bring perceived safety benefits, while the pattern of other user benefits (time savings, changes in effort/exercise and other comfort/journey ambience benefits) varies across scheme types (§4.3.2). The report suggests a renewed focus on safety (valuing improvements) across a wider set of walking, wheeling and cycling interventions – values appear to be large.

The recommendations on valuation of safety impacts ((vii) above) will allow those benefits to be fully valued, without double-counting. This should improve the appraisal of crossings and junctions, and dedicated cycle and pedestrian routes, for example.

Interventions which make active mode routes quicker or more direct (e.g. new connections, more priority, more responsive signals, better permeability and improved routes through the urban environment) will involve the use of values of travel time (VTT) to measure the benefits. This will apply to commute, business and other non-work utility trips. It is unlikely to be relevant for the fourth trip purpose (exercise/pleasure trips) where we expect the marginal VTT to be zero (footnote 79).

There is evidence that exercise and health are important motivations for many existing active mode users (§2.2.1, §3.2.1 and §3.2.3), and more exercise/health conscious individuals tend to exhibit lower VTTs (Flügel et al., 2021; and see §3.2.3). However, saving travel time is unlikely to be the primary driver of increased active mode use – it is implicit from Table 15 that tackling critical safety issues (ATE, 2025) and improving perceived safety for active modes is seen as a high priority. It is also worth noting that individuals who do not currently use active modes, and who the interventions seek to encourage to switch modes, will not necessarily exhibit the same values – care is needed to understand VTTs for potential switchers.

Some interventions are likely to improve the ambience/comfort of active mode journeys – see (ix) above – and some interventions may involve changes in physical effort required, e.g. reductions in stopping required by cyclists; and new pedestrian/cycle routes which are flatter (in hilly terrain).

All these interventions will increase trip utility for active modes (i.e. reduce generalised cost) – the associated user benefits may be calculated using the trip utility functions in this report (§3.1) and appropriate user benefit measures (DfT, 2025, *TAG Unit A1.3*).

Any scheme which increases the attractiveness of active travel is likely to increase take-up and hence is also likely to bring long-term health benefits in terms of both mortality and morbidity – measured using the new health benefits tool (TATE3030) – and reductions in absenteeism. MECs would continue to capture mode shift benefits from changes in road traffic (DfT, 2022). Any other place quality benefits would need to be measured in addition (§2.2.3; Nellthorp et al., 2025).

1. Introduction and scope

1.1 Background to the project

Active Travel England (ATE) and the Department for Transport (DfT) commissioned this research to develop a theoretical framework including travel time, place quality/public realm, safety, health and journey ambience benefits for active modes. The framework will support determining how to value these impacts in appraisal without double-counting, and is intended to enable and inform subsequent empirical research. Research on morbidity impacts and a new health benefits tool has been commissioned separately⁸, and the need for alignment with those has been taken into account from the start.

1.1.1 Active Travel England's role

Given the positive impacts of active travel on health and wellbeing, Active Travel England (ATE) has a remit to increase the number of journeys being walked, wheeled or cycled through: i) its statutory role in planning for infrastructure and development - complementing local authorities' Local Cycling and Walking Infrastructure Plans; ii) investment in active travel schemes across England; iii) ensuring design quality in active travel infrastructure; (iv) focusing on inclusivity and accessibility; and (iv) supporting the provision of state-of-the-art data and analysis to use in active travel planning and design⁹.

1.1.2 Active travel appraisal and modelling guidance

To help make the case for specific active mode interventions, DfT have guidance and tools for assessing the overall benefits and costs of proposed walking and cycling interventions, ranging from capital investments to behaviour change programmes. Table 1 provides an overview of this guidance.

Table 1: Main sources of active travel appraisal and modelling guidance.

Source	Description of content
TAG Unit A5.1 Active Mode Appraisal	Contains the main appraisal guidance for active modes, covering: Forecasting of active mode trips Calculation of key impacts Reporting Sensitivity testing Monitoring and evaluation
Active Mode Appraisal Toolkit (AMAT) +AMAT User Guide	AMAT is a spreadsheet tool applying the appraisal guidance from TAG Unit A5.1
Uplifts Tool [unpublished]	DfT's Uplifts Tool was developed as a default approach for local authorities to estimate numbers of cycling/walking trips with an intervention, based on the CWIS models (Sloman et al., 2019). A brief outline of the tool is given in Nellthorp (2025) , p7-8.

8. Study title: Morbidity Impacts in Active Modes Appraisal (TATE3030)

9. <https://www.activetravelengland.gov.uk>

Source	Description of content
TAG Unit A4.1 Social Impacts Appraisal	Unpacks the methods for physical activity impacts and journey quality impacts, along with other relevant impacts
TAG Unit A5.4 Marginal External Costs	Unpacks the methods for decongestion benefits and reductions in air pollution, noise, infrastructure costs and accidents
TAG Unit A1.3 User & Provider Impacts	User benefits of active modes are analysed using the method in TAG Unit A1.3, either as the main mode or as part of a multi-modal trip
TAG Data Book	Source of essential appraisal parameters, including values of journey quality attributes and values of time, diversion factors (between modes) and Marginal External Cost values.

Note: TAG is the [Transport Analysis Guidance](#).

1.2 Study purpose, objective and scope

ATE and DfT have plans to update the evidence base and appraisal methods used for active mode investments. It is intended to develop methods to quantify additional benefits (e.g. time, safety, public realm and morbidity) and update the approach to valuing journey ambience benefits given the current evidence is up to 30 years old and does not include many of the types of infrastructure schemes delivered today.¹⁰

ATE has already commissioned work to develop a tool that will enable the full physical activity health benefits of walking and cycling to be quantified. This will mark a step change from current practice in which only reduced risk of premature death (i.e. mortality benefits) can be estimated based on national averages. The new tool will account for local health profiles, recognising that the greatest health gains are for those moving out of a state of inactivity. It will also allow for health-related quality of life (i.e. morbidity benefits) to be included in economic appraisals for the first time. The health benefits included in this tool will relate to physical activity only – air quality impacts and safety benefits would be quantified outside the tool.

In this context, the purpose of this study is to develop a theoretical framework for active mode travel time, place quality / public realm, safety, health and journey ambience benefits. The framework will help ATE and DfT understand how to value the different impacts of active travel without double-counting benefits.

The study will help ATE and DfT to scope, commission and deliver a separate body of primary research within which would capture the values of time, safety, place quality / public realm, journey ambience and morbidity. Some of these values may be delivered via the next national Value of Travel Time study while others are likely to require separate studies. The key objective for the current project is **to develop a cohesive theoretical framework within which it would be possible to value the various benefits without double-counting**. This will help to design the future primary research studies such that it can be clearly demonstrated which elements are being valued within each study and ensure results from the different studies are additive.

10. E.g. the evidence in TAG Data Book Table A4.1.6 for cycle journey ambience is from Hopkinson and Wardman (1996) and Wardman et al. (1997), while evidence in Table A4.1.7 for pedestrians is from Heuman (2005).

The framework will take as its starting point that physical activity health benefits will be valued using the new tool but recognise that other health-related impacts (e.g. safety, perceptions of safety, air quality) will be valued outside that tool.

1.3 Reasons for potential double-counting

The invitation to tender (ITT) for this research cited two recent studies which each highlighted different reasons for potential double-counting in the appraisal of active travel interventions. The first is from a value of travel time perspective. In the scoping study on *Updating the Value of Travel Time* for the UK, Dekker et al. (2025) noted that: “The different national [value of travel time] studies provide consistent estimates that journey ambience improvements – provided in the form of appropriate walking and cycling infrastructure – reduce the travel time disutility. The challenge, however, is that it is difficult to disentangle these quality improvements into pure comfort factors, health benefits (e.g. being further away from cars and hence air pollution) and safety concerns”.

Meanwhile, the report by Nellthorp (2025) for ATE on *Estimating the benefits of active travel investment* noted that: “Place quality improvements can be quantified and valued, and indeed local accessibility to different activities and opportunities can be valued as part of it. However, it sits somewhat uneasily with the standard transport appraisal toolkit...with its focus on movement and user benefits, and then other impacts arising from that. 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 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”. Nellthorp (2025) also unpacks the journey quality factors which Dekker et al. pointed to, building on an earlier review of the literature (Nellthorp et al., 2020) – but without getting deeply into the theory.

Taken together, these studies indicate that there is potential for double-counting between some of the main benefits of active mode investments: time; place quality/public realm; safety; health; and journey ambience. The current study is tasked with disentangling the issues in theory, ready for future empirical work to establish the corresponding values.

1.4 Active travel context

Based on National Travel Survey data, 31% of trips in England are made by active modes as the main mode (see Table 2). A further 9% of trips approximately¹¹, which are not shown in the ‘Walk’ and ‘Cycle’ rows of Table 2, are multi-modal *and* involve at least one active travel stage – for example, this includes trips which are by rail, bus, or car as the main mode, for which there is also an active mode access or egress stage to complete the end-to-end journey.

11. National Travel Survey table NTSQ09073 shows 6.1% of trips having at least one active mode stage while not having an active mode as the main mode (2024 data). In addition, 2.9% of trips are shown as having main mode bus/rail/London Underground and no other mode reported – we think it is reasonable to assume that most of these trips have an active mode stage (access or egress) that was not reported. Walks of under 50 yards are not recorded in NTS: some of these 2.9% will be in this category, however probably not all – given the spacing of public transport stops it seems unlikely that many PT trips have a walk of <50 yards at both ends.

Table 2: Active mode trips by mode and purpose, as a % of all trips (England, 2024).

Main mode	Trip purposes (for TAG appraisal)				ALL purposes
	Commuting	Business	Other non-work		
	-	-	Utility	Exercise & pleasure	
Walk	1.5%	0.2%	18.1%	6.2%	26.0%
Cycle	0.5%	0.0%	1.1%	3.0%	4.6%
All modes	12.1%	2.7%	76.1%	9.2%	100.0%

Notes: (i) Walk and Cycle trips shown in Table 2 are trips where the active mode is the main mode; (ii) the Walk mode includes non-motorised wheelchair use as well as pedestrian trips; (iii) 'Other non-work: Utility' includes education, shopping, personal business, escort and leisure (including visiting friends at home and elsewhere, entertainment, sport, holiday and other trips out to a destination to engage in a leisure activity); (iii) Exercise and pleasure - see footnote 12.

1.4.1 Trip purpose for active modes

In TAG, travel is analysed by trip purpose, since there are substantial differences in travel behaviour and in responses to policy interventions by trip purpose. The existing three trip purposes in TAG are shown in Table 2, i.e. commuting, business and other non-work. This data shows that:

- around 70% of active mode trips are for travel as a derived demand, i.e. to access opportunities including employment (commute trips) and other activities (classified as 'other non-work'). Only a small share, roughly 1% of active mode trips across the country as a whole, are for business purposes, e.g. walking or cycling from a workplace to another business activity. In particular locations – city centres, for example – the proportion of walking and cycling trips for business purposes is likely to be higher, and if active stages of multi-modal trips are included, higher still
- a substantial proportion (up to 30%) of active mode trips¹² are for exercise and pleasure purposes rather than 'utility trips' – i.e. the main purpose of the trip is not to reach a destination in order to undertake an activity, but to gain exercise and/or pleasure from the trip itself. This is distinct from other modes, where the analysis usually assumes that travel is a derived demand, the travel itself carries some disutility, and the utility or benefit is gained from the activity at the destination (work, education, shopping, etc).

The theoretical framework needs to recognise that all these trip purposes contribute to the total health benefits of walking and cycling, as well as contributing to the demand for use of walking and cycling networks. The 'exercise and pleasure' purposes are not part of the current analytical framework in appraisal.

12. with active mode as the main mode. This is based on data from the National Travel Survey (NTS), table NTS0409 (2024 data), and also Active Lives Survey (ALS) data to help estimate the number of cycle vs walk trips in this category. The italics in the 'Exercise and pleasure' column of Table 2 reflect the use of multiple data sources here – the total (9.2%) is based on NTS data and is believed to be a reasonably robust estimate, while the breakdown between walk and cycle is not known from NTS, the 3.0% is derived from ALS and should be treated as an approximation, hence the 6.2% for walk is a residual and also an approximation.

1.5 Types of active mode interventions

Table 3 presents the eleven types of active mode infrastructure scheme in ATE's taxonomy. We will assume that these are among the main interventions to which the framework will be applied. We note that these include schemes addressing:

- links in the network (e.g. lengths of footway, cycle routes and walking routes);
- junctions and crossings in the network (often combined with links within a scheme); and
- area-wide interventions (e.g. traffic management).

In addition, we note that the CWIS Active Travel Investment Models review (Sloman et al., 2019) identified a wide range of interventions and packages of measures which may increase active travel take-up, e.g. cycle training and hire schemes. In principle, it would be helpful for the framework to be applicable to these as well as to infrastructure schemes specifically. We have developed the framework with this also in mind.

1.6 Structure of this report

The rest of this report is structured as follows:

- **Section 2** – the overall theoretical framework, including overview of TAG benefits and key concepts;
- **Section 3** – theoretical framework components, including trip utility, health benefits, safety benefits, and place quality and urban realm benefits;
- **Section 4** – including conclusions and implications for the later empirical work.

Table 3: Active Travel England's infrastructure scheme taxonomy.

Scheme categorisation	Complexity (this sub-category reflects the challenge of delivery from both a technical and political perspective)	What does this scheme sub-category look like?	How will this be measured?
New segregated cycling facility	High	Urban, high density, complex junctions, side roads	Miles of cycle route, number of junctions
	Medium	Suburban, medium density, fewer junctions/turning movements	Miles of cycle route, number of junctions
	Low	Out of town location, low density, few/no junctions	Miles of cycle route, number of junctions
New junction treatment	High	Separation in time and space for all active travel movements, protected junctions	Junctions treated
	Medium	Protection of key movements for walking and cycling across a junction	Junctions treated
	Low	Minor advantages to enable defensive positioning	Junctions treated

Scheme categorisation	Complexity (this sub-category reflects the challenge of delivery from both a technical and political perspective)	What does this scheme sub-category look like?	How will this be measured?
New permanent footway	High	Large-scale town centre pedestrianisation including area-wide traffic and car parking removal	Miles of footway
	Medium	Conversion of carriageway to footway on a medium to large scale	Miles of footway
	Low	Addressing severance in existing walking routes	Miles of footway
New shared use (walking & cycling) facilities	Medium	Provision of a traffic-free rural or suburban route linking settlements as an alternative to hostile road conditions	Miles
	Low	An off-road route for example through parks or green spaces. Schemes should connect settlements and/or tackle severance in walking/cycling networks	Miles
Improvements to make an existing walking/ cycle route safer (includes essential maintenance schemes)	Medium	Use of permanent kerbs, side road treatments, junction improvements for walking/cycling	Miles of improved walking or cycle route, number of improved junctions
	Low	Installation of infrastructure (e.g. wands), or changes to speed limits to improve conditions for walking and cycling	Miles of improved walking or cycle route, number of improved junctions
Area-wide traffic management (including by TROs (both permanent and experimental))	High	Large scale, area-wide traffic removal in a highly populated/town centre location OR very large scale fast/heavy traffic removal from rural 'quiet lanes'	Size of area improved for walking/cycling
	Medium	Area-wide through traffic removal on a smaller/less ambitious scale, including smaller town centres	Size of area improved for walking/cycling
	Low	Modal filtering that is not part of an area-wide scheme	Size of area improved for walking/cycling
Provision of secure cycle parking facilities	Medium	Large-scale provision of free and publicly accessible on-street cycle parking or secure parking at schools/workplaces/hospitals/ transport interchanges	Number of parking spaces
	Low	Sheffield/Hornsey stands or similar in public places	Number of parking spaces

Scheme categorisation	Complexity (this sub-category reflects the challenge of delivery from both a technical and political perspective)	What does this scheme sub-category look like?	How will this be measured?
New road crossings	Low	Crossing addresses a severance issue and will create a continuous walking/cycling route (e.g. new signalised crossing of a main road between LTN cells)	Number of new road crossings
Restriction or reduction of car parking availability (e.g. controlled parking zones), usually only as a component of other schemes.	Low	E.g. Introducing a pedestrian phase on existing signalised crossing, side road treatments, only if part of high propensity walking route	Number of new road crossings
School Streets	Low	Timed restriction of motor vehicle access to a road or roads outside or close to a school, including in rural areas	Number of school streets

Source: Active Travel England.

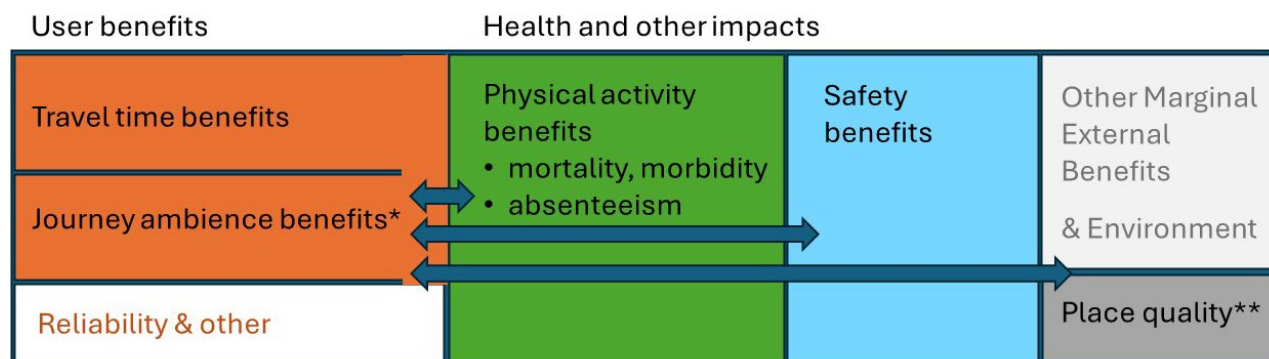
2. Overall theoretical framework

2.1 Overview of TAG benefits

The simple schematic diagram (Figure 1) identifies the TAG benefits which are included in this framework, and brings out some of the framework's basic features.

- i. the user benefits in the left hand column relate to travel choices, such as 'by which mode shall I travel to work' and 'which route shall I take'? The TAG analytical framework is set up to capture the benefits to current and new users when particular travel options are improved
- ii. the health and other impacts to the right of the table flow from the choices made in the first column. For example, health benefits including reduced mortality risk and reduced morbidity flow from increased physical activity associated with the use of active modes
- iii. there are interactions between the user benefits and the downstream health, safety and other outcomes. Individuals may perceive that their actions can have consequences, e.g. they may be aware of the health benefits available from active travel, or of the safety risks associated with cycling on the roads between their home and a regular workplace. The theoretical framework seeks to clarify the nature of these interactions, and their implications for counting overall benefits (and not double-counting benefits).

Figure 1: Simple schematic of active mode benefits.



Changes in travel time and journey ambience for active modes are already included in TAG. For example, the values of travel time in the TAG Data Book may be used to capture the benefit of journey time savings during commute, other non-work¹³ or business travel – however these values are not specific to walkers or cyclists. The values of journey ambience in the TAG Data Book measure, for example: the benefit per minute spent cycling on an off-road segregated cycle track (compared with no cycle facilities in a standard width, mixed traffic lane); and the benefit per trip of having secure cycle parking available at the destination (compared with not available). The composition of journey ambience is addressed in this report (§3.1, §3.5 and §4.2.1).

13. i.e. trips to a destination for a given purpose (see Table 2 'Other non-work: utility' trips).

The TAG framework also includes reliability of journeys, and in principle there is nothing to prevent the reliability ratio method being applied to active mode benefits, as it is to private car and turn-up-and-go public transport trips¹⁴. The reliability ratio parameter varies between modes, so this would require empirical work to establish a suitable parameter value, however a key point is that walk and cycle journeys are among the most reliable of all modes. It is not generally expected that active mode interventions will increase the reliability of active mode journeys, therefore for the purposes of this study, reliability is treated as outside the scope. It remains very much part of user benefits across multi-modal transport as a whole, however.

The first arrow in Figure 1, between user benefits and health impacts from physical activity, reflects the interaction between these categories of benefits, for example a person may have in mind their future health when they make choices about how to commute to work. Similarly, the arrow between user benefits and safety benefits reflects the fact that people may have in mind their risk exposure when making travel choices.

The third arrow, between user benefits and ‘Other marginal external benefits and environment’, reflects the impact of active travel on the use other modes and on noise and air pollution for example (from left to right). At the same time active mode users could face a journey ambience impact from traffic reduction and from noise or air pollution (if this is perceived by them – the arrow going from right to left). The third arrow also reflects the interactions involved in redesigning public realm¹⁵. On one hand, active travel-friendly streets will feed into journey ambience for local active mode travel (* in Figure 1), and on the other hand will feed into wider benefits to the population, including the value of non-travel activities, food & drink, recreation, and other aspects of place quality (**).

These interactions require some scrutiny and some unpacking, in order to construct a defensible theoretical framework. We begin this in §2.2.

2.2 Previous theoretical models

The approach in this framework builds on existing conceptualisations, theory and evidence including from Dekker et al. (2025), Flügel et al. (2021), Börjesson and Eliasson (2012), Nellthorp et al. (2025) integrating travel- and place-based effects within a common theoretical framework, and Nellthorp (2025, §4(i), 4(x) & Appendix B) updated journey ambience and place quality review.

2.2.1 User benefits, health and safety

Dekker et al. (2025) identified that, as with any other transport mode, the (dis)utility of travel time for active travel depends on the inherent resource value of time and the quality/ambience of travel conditions. In the active travel context, the nature of quality/ambience factors is complex as better infrastructure – for example – improves not only perceived journey ambience, but also safety and health outcomes. Representing this properly is at the heart of this framework.

14. DfT (2025) TAG Unit A1.3, §6 and Appendix C.

15. including street design.

As shown by Flügel et al. (2021) using a choice experiment, there is some interaction between traveller attitudes to health and values of travel time (VTT), i.e. health-conscious travellers tend to exhibit a significantly lower VTT. Hence one key insight to carry forward from Flügel et al. is that individuals are heterogenous in their response to active mode interventions and segmentation is likely to be needed (see §4.2.3). The research on morbidity impacts¹⁶ is building up a synthetic population for each local area, and it will be useful to link the segmentation in relation to user benefits and safety, to the segmentation needed for health benefits.

Flügel et al. (2021) also provide a theoretical model, which adopts and combines earlier theoretical models by Jara-Díaz and Guevara (2003) and Cawley (2004). Flügel et al. used this to inform their experimental design and explain the empirical findings. This is extremely helpful in showing:

- how a utility maximising individual would allocate time and expenditure to activities including work and travel (active travel and other), subject to a budget constraint, a time constraint (24 hours in a day), minimum time constraints for necessary activities and transport, and a function of goods needed to sustain a leisure activity (e.g. sports equipment, tickets, etc.);
- how this maximisation problem links back to key components of the theory underpinning transport analysis, i.e.:
 - the theory of time allocation (especially Becker, 1965, and de Serpa, 1971);
 - general consumer theory (e.g. Varian and Melitz, 2024);
- how the public health literature has conceptualised time allocation – Cawley (2004) is a key contribution, in which the utility function includes five uses of time: sleep (S); leisure (L); occupation, i.e. paid work (O); transport (T) and home production, i.e. unpaid work (H)¹⁷.

Bringing these strands together, Flügel et al. (2021) set out their mathematical model in an appendix¹⁸. This model shows that:

$$(1) \quad \left| \frac{\kappa_{TAc}}{\lambda} \right| = \frac{\mu}{\lambda} - \frac{\frac{\partial E}{\partial TAc}}{\lambda} - \frac{\frac{\partial H}{\partial TAc}}{\lambda}$$

where

$\left| \frac{\kappa_{TAc}}{\lambda} \right|$: represents value of travel time saving for active transport

$\frac{\mu}{\lambda}$: represents the opportunity cost

$\frac{\frac{\partial E}{\partial TAc}}{\lambda}$: represents the marginal value of the enjoyment of active transport (“comfort”)

$\frac{\frac{\partial H}{\partial TAc}}{\lambda}$: is the value of the health benefits

16. TATE3030.

17. Cawley’s model differs from Flügel et al. in that: it contains just three constraints (budget constraint, time constraint and a biological constraint in which weight changes are determined by calorie intake versus calorie expenditure in various activities); it contains additional variables for weight, food (calorie) intake; both food intake and weight influence utility directly; and weight is affected by the time allocated to different activities.

18. see p14-15 of Flügel et al. (2021).

A key limitation of both the Jara-Díaz and Guevara (2003) and Flügel et al. (2021) models is that they do not address the lifetime utility of the individual, or the consequences of the health benefits¹⁹, H, being in the future and uncertain. Instead the model assumes that all utility and all time allocation is within one representative day. This turns out to be a key omission, and we develop an approach to lifetime utility in §2.3.

Flügel et al. (2021) also do not focus on safety, however, safety is both one of the key drivers of increased active travel demand (Active Travel England, 2025) and one of the largest costs associated with the transport network (e.g. Jansson, 1994, p32). Vulnerable road users, including active mode users, tend to suffer the largest average utility losses in accidents (DfT, 2025 *TAG Data Book*, Table A4.1.2).

The relevant theory on safety is contained in a large body of literature – a useful summary of this, and the implications for appraisal – is provided by van Essen et al. (2019)²⁰. Among the key points are:

- some accident costs are internalised through insurance (of vehicles and drivers) – however it needs to be considered in this framework that many active mode users do not have such insurance, and the largest costs to active mode users (the human costs of accidents) are generally not covered by insurance;
- accident costs are partly internal to the individual user (e.g. own injuries and their effects) and partly external (e.g. injuries to others) – the degree of externality can differ between modes²¹
 - the burden of some types of accident costs also falls on third parties (e.g. medical and healthcare costs to the NHS; and net lost output to the economy²²)
- risk anticipation is not perfect – in their choice behaviour, people may respond to the objective accident risk or may ‘misperceive’ the risks;
- marginal accident costs may not equal average accident costs (the risk elasticity measures how accident risk responds to additional traffic); and
- a relevant effect not discussed by van Essen et al., is that active modes exhibit a safety-in-numbers effect – i.e. casualties increase less than proportionately with the number of active mode users, and this effect is stronger for pedestrians than for cyclists (Jacobsen, 2003; Elvik and Goel, 2019; Heydari and Elvik, 2023).

Not all of these points are fully addressed in current appraisal methods (whether in the UK, the EU or elsewhere) due to gaps in evidence. However, current practice does include careful measures of:

- costs per accident and per casualty, including: human costs (through willingness-to-pay); lost output; medical and ambulance costs; police costs; material damage; administration and other costs (see TAG Unit A4.1);
- marginal external costs of accidents due to mode shift – e.g. additional walking and cycling lead to traffic reduction and hence reduced accidents (TAG Units A5.4 and A5.1, and AMAT).

¹⁹. and potentially the safety benefits

²⁰. and in an earlier version (CE Delft, 2011, §3.2) – note: this area of theory has evolved over time

²¹. e.g. the internalisation of risk: 80% internal for motorcyclists, 16% internal for bus occupants (van Essen et al., 2019, Appendix B, p205)

²². i.e. not including consumption losses, which would be counted by the individual

TAG also recognises the safety-in-numbers effect although this is not built into AMAT, and TAG concludes that: “The evidence base for this requires expanding through further research and monitoring” (DfT, 2022, TAG Unit A4.1, §2.3.4-5).

2.2.2 Journey ambience

Nellthorp (2025) updated the reviews by Nellthorp et al. (2020/1) on journey ambience/ journey quality. These are the non-travel time factors which influence the utility of journeys (and choice). There are many possible ways of grouping these factors, however the grouping in Nellthorp (2025) does bring out three variables of key importance in this framework:

- *health* – e.g. “Positive payoff from the exertion (METs, calories) of active travel. The extent to which this is perceived by users is uncertain”²³;
- *environment* – e.g. “Air pollution and noise exposure – traffic related. Other environment factors including urban greening, character, visual amenity and soundscape”;
- *safety* – including “Danger/threat from traffic... interaction with on-street parking...” and turning and crossing movements;
- *other* – including comfort, crowding, information.

See Appendix A in this report for details.

2.2.3 User benefits and place quality

Nellthorp et al. (2025) addresses a different aspect of the problem, which is how to bring place quality into the analysis, and to link urban realm/public realm with journey ambience in a formal framework in which the total benefit to the individual is measured (without double-counting).

In a framework where individuals are maximising their utility across a whole range of transport choices and also residential location choices, we can measure their utility as follows. Household h 's utility, if living at location i , can be expressed as

$$(2) \quad U_{hi} = U_i(\mathbf{x}_h, \mathbf{z}_i, \Lambda)$$

where $\mathbf{x}_h$ is a vector of non-housing goods and services consumed, $\mathbf{z}_i$ is a vector of location-specific attributes at i , and the characteristics of the housing unit (Λ).

Utility is driven partly by accessibility to opportunities, at any distance (locally or far afield) and of all types (employment, education and training, shopping and services, healthcare, recreation, greenspace...) and partly by place quality at home – including a range of variables (examples shown in Table 4):

$$(3) \quad \mathbf{z}_i = \mathbf{z}(\mathbf{A}_i, \mathbf{Q}_i)$$

where $\mathbf{A}_i$ are accessibilities to a range of opportunities from i , and

$\mathbf{Q}_i$ are place quality variables at home locations i .

²³. see Appendix A in this report

Table 4: Place quality variables at residential locations (examples).

Variable	Evidence sources
Crime and antisocial behaviour	Heeks et al. (2018); Nellthorp et al. (2019)
Air quality	TAG Data Book (DfT/Defra); Nellthorp et al. (2019)
Noise	TAG Data Book (DfT/Defra); Nellthorp et al. (2019)
Severance	Anciaes & Jones (2018); Millard et al. (2018)
Safety	TAG Data Book (note: threat of collisions not yet valued)
'Blue and green infrastructure' - Bodies of water - Street trees/urban tree canopy	Day and Smith (2017) Netusil et al. (2010); Defra (2013); Day and Smith (2017); Millard et al. (2018); eftec & SQW (2024)
Urban realm design	Millard et al. (2018)
Historic character	Millard et al. (2018)
Land use disamenities, e.g. landfill & industry	Nellthorp et al. (2019)

Source: Nellthorp et al. (2025), Table 6.

Place quality also applies to destinations, Q_j , e.g. high streets or city centres, where urban realm improvements or reduced traffic exposure can raise location attractiveness and increase the utility of a trip to that location. Both Q_i and Q_j therefore need to be counted. In order to avoid any double-counting, an individual's exposure to the urban environment while they are travelling through it (trips represented in a transport model) should be represented by journey ambience. Time spent at the origin or the destination is valued using Q_i and Q_j – an example of the latter would be time spent window-shopping or walking between shops in a town centre, or time spent having a meeting or social interaction in an urban square.

In this framework:

- travel time and journey ambience are part of the generalised cost of travel, g_{ijmk} , between origin i and destination j by mode m for trip purpose k ;
- an individual's utility is influenced not only by the generalised cost of accessing opportunities at destinations, j , but by the attractiveness of those destinations including
 - the utilities of the opportunities available, R_{jk} , driven by for example the number of jobs at j , and
 - the place quality of j as a location, Q_j , reflecting e.g. public realm quality and air quality at j ;
- an individual's utility, U_{hi} , is influenced by their residential (home) location i , both through its accessibility to a whole range of opportunities including employment, business opportunities, education and training, retail and services, healthcare, recreation, social opportunities, etc. and its own place quality, Q_i .

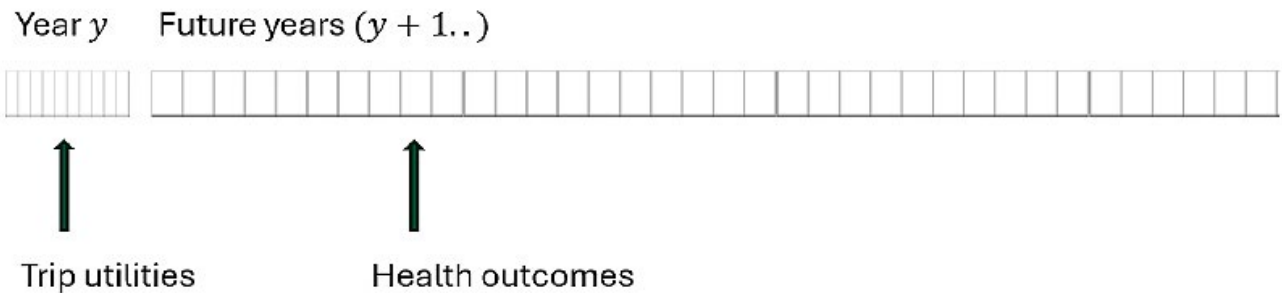
These elements can all be incorporated into the welfare function in appraisal without double-counting, and formulae are provided for this in Nellthorp et al. (2025). Of particular importance here are:

- that changes in urban realm and environment which are experienced *during walk and cycle journeys* are valued and included in the generalised cost of travel, g_{ijk} , and hence in user benefits – we will set out the formulae for this in §3.1.3 below;
- that changes in place quality variables experienced at the *destination*, j , are incorporated in Q_j and in an extended version of the rule-of-a-half which includes place quality at the destination²⁴;
- that changes in place quality variables experienced at the *home location* are incorporated in Q_i and in an extended version of the rule-of-a-half which includes place quality at the origin²⁵;
- that these three items are additive terms in household utility.

2.3 Lifetime utility

The overall framework is based on an understanding of lifetime utility for members of the population²⁶. As shown in Figure 2, an intervention which changes trip utilities and potentially travel choices in year y may also lead to changes in health outcomes or other changes in future years $y + 1$, $y + 2 \dots$ and so on.

Figure 2: Lifetime utility arising from an active travel intervention.



In practice, the intervention will change the generalised costs (trip utilities) for some or all of the trips made by the individual in a year (y).

24. E.g. if there is no logit model from which to calculate logsums, and if people do not change their home

location, then the formula is
$$UB = \sum_{ijk} \frac{1}{2} (g_{ijk}^0 - g_{ijk}^1) (T_{ijk}^0 + T_{ijk}^1) + \sum_{ijk} \frac{1}{2} (x_{jk}^1 - x_{jk}^0) (T_{ijk}^0 + T_{ijk}^1)$$
 where $(x_{jk}^1 - x_{jk}^0)$ is the increase in destination attractiveness of zone j for purpose k in £/trip and T_{ijk}^0 and T_{ijk}^1 are the numbers of trips without and with the project respectively. This increase in attractiveness could be caused by e.g. changes in urban realm or air quality at the destination, Q_j , or to the ‘size variables’ R_{jk} . See Nellthorp et al. (2025), §2.4 for more on this.

25.
$$\Delta CS(Prd) = \frac{1}{2} \sum_i (P_i^0 + P_i^1) (q_i^1 - q_i^0)$$
 where $\Delta CS(Prd)$ is the additional benefit associated with the trip production zone location, P_i^0 and P_i^1 are trip productions at i without and with the intervention, and q_i^0 and q_i^1 are origin attractiveness measures in money units at i without and with the intervention.

26. Note that this is the stance taken in economic appraisal generally (albeit often with a horizon year based on the economic life of the assets created, e.g. DfT, 2025 TAG Unit A1.1) and in the public health literature, e.g. Cawley (2004, p117).

NTS data shows that an average individual will make 922 trips in the course of a year across all modes²⁷. It is common practice in appraisal to sum the utilities across all these trips, assuming that the utilities are additive. We can expect changes in trip utilities throughout the appraisal period²⁸.

These changes in trip utility will drive changes in travel behaviour, with consequences over the long-term for health outcomes (including mortality and morbidity). Future health outcomes, H_{y+1} , H_{y+2} , etc, may be forecast using a Markov model, discrete event simulation or other techniques.

In Hammitt (2013), a person's overall utility function is a sum across time periods (years), each with a consumption outcome and a health outcome (the equation includes mortality and morbidity). This shares with Flügel et al. (2021) the inclusion of health outcomes as a determinant of utility, and with Cawley (2004) health outcomes as a determinant of lifetime utility.

$$(4) \quad U = \sum_{\tau=0}^T \delta^{\tau} s_{\tau} U(h_{\tau}, c_{\tau})$$

where h_{τ} is the health outcome in year τ ;

c_{τ} is consumption in year τ ;

δ^{τ} is the discount factor applying to their utility in year τ ²⁹;

s_{τ} is the probability of surviving to year τ (taking account of mortality impacts); and

T is a maximum possible age.

What equation (4) lacks is the other, non-marketed (non-consumption) items in utility, which are important in transport, including time allocation and the externalities set out in §2.4.

2.3.1 Time preference (discounting)

The lifetime utility is a function of the utility in each year of life. The summation over time in a **welfare appraisal** is determined by the **social discount rate** (HM Treasury, 2026a,b), so δ^{τ} is a social rate, e.g. 1.5% for health impacts and 3.5% for transport cost savings. This is what we have assumed in the appraisal as part of this theoretical framework.

We also need to allow for the fact that **private discount rates** may differ and influence behaviour. This can play a significant role in active mode choice, since health benefits are felt over the long-term.

27. Table NTSo308 (2024 data).

28. 40 years is the standard appraisal period for active travel infrastructure recommended by ATE; 60 years is the standard appraisal period for transport infrastructure recommended by DfT (2025) *TAG Unit A1.1*, p6, however DfT (2022) *TAG Unit A5.1* states: "Most walking and cycling schemes will have finite project lives and/or significant uncertainty around the longevity of impact (particularly for demand management schemes) so that the sixty year appraisal period recommended for large-scale infrastructure projects might not be applicable"; as Table 2 in *TAG Unit A1.1* shows, the expected economic asset lives associated with footways and cycleways are comparable with roads generally – and it is worth bearing in mind that when rights of way and space allocation are changed, they tend to be changed permanently/for the foreseeable future, unless/until a specific decision is made to change them again, and much of the benefits flow from that. There is a discussion of this in Nellthorpe and Ojeda Cabral (2021) p38-39.

29. In fact we will require two different discount factors, one for health and one for consumption – both for the appraisal application and when thinking about individual behaviour. See below.

Since Chapman and Elstein (1995) there has also been a recognition that private discount rates for health may differ from private discount rates for money. Private discount rates vary across the population, however some patterns are evident. According to the meta-analysis by Matousek et al. (2022), private discount rates are high (much higher than the HM Treasury social discount rates) and discount rates for future health benefits are higher than money benefits. E.g. illustrative empirical rates are shown in Figure 4, for both conventional exponential discounting (at a constant compound rate) and for hyperbolic discounting (greatest discount in the early years). This means that over a 60 year appraisal period³⁰, the perception of future health benefits, due solely to discounting, could be as shown in Table 5.

The literature also indicates that greater uncertainty and risk around future benefits tends to reduce their value in the present, with higher private discount rates being reported if uncertainty and risk are not controlled-for (Andersen et al., 2008). A similar phenomenon is seen in the field of investment decision-making – when discount rates are allowed to vary with risk, risky discount rates are higher than risk-free ones³¹ (Lind et al., 1982).

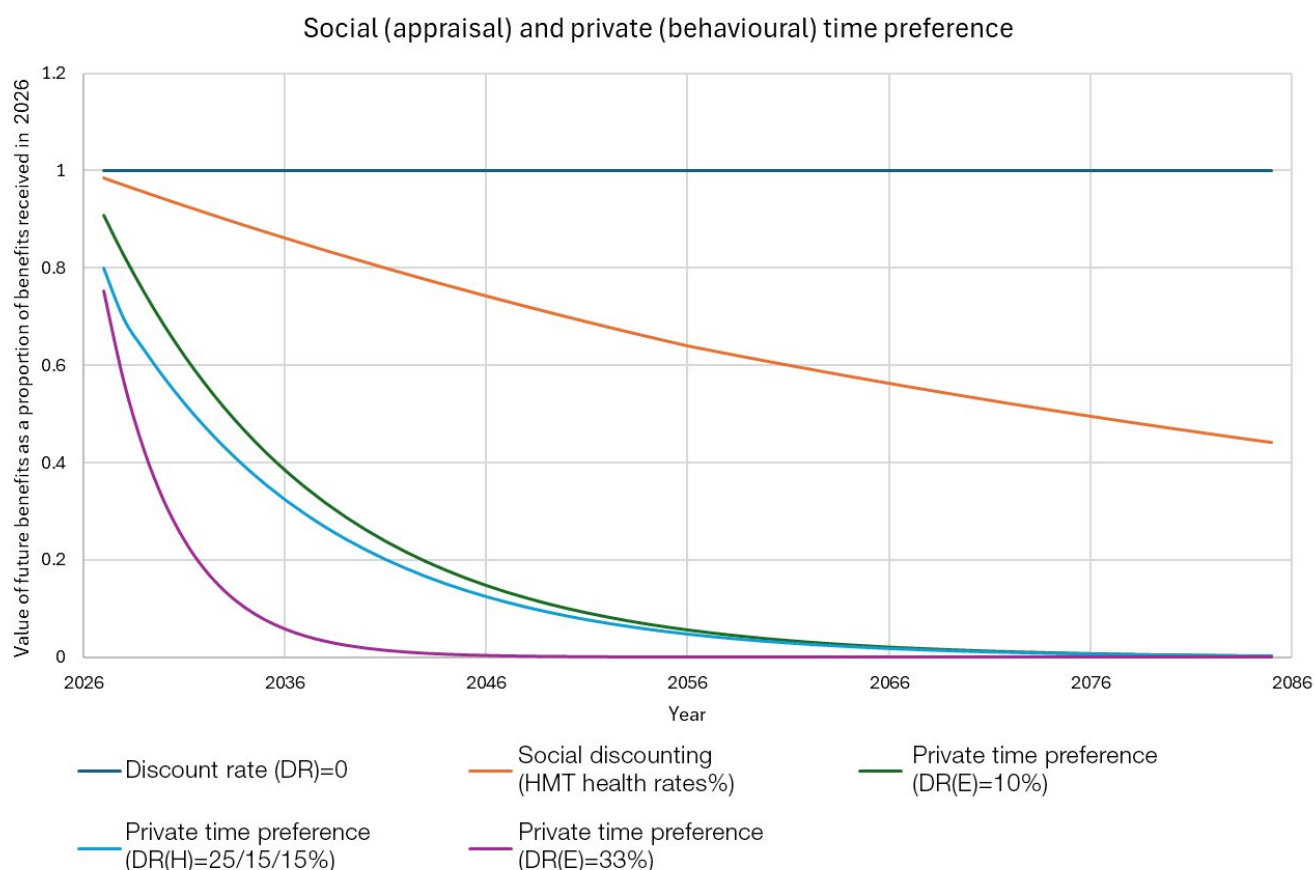
There is a deeper discussion in the literature about what exact neurological or social processes are at work here. The observed down-weighting of future health effects may be due to habits, addictions, and difficulties managing expenditures, for example (e.g. Borghans & Golsteyn, 2006). Some authors have even argued that this is a 'trans-disease process' across different types of behaviour (Bickel et al., 2012).

The implication is that, whatever the exact causal and functional relationships involved (and the evidence suggests they are complex), future health benefits from exercise, and from lower intake of calories, alcohol and drugs for example, tend to be systematically under-weighted by many individuals.

30. Note that ATE's current standard period is 40 years.

31. and it is often argued that risk is better dealt with in appraisal through Quantitative Risk Analysis (QRA) than through elevated discount rates.

Figure 3: Effect of behavioural (private) discounting on perceived future health benefits (illustrative).



Note: DR(E)=10% indicates exponential discounting at a constant 10% rate; DR(H)=25/15/10% indicates hyperbolic discounting at 25% in the first year, 15% in the second year and 10% thereafter.

Table 5: Consequences of behavioural discounting on sum of perceived future health benefits (illustrative).

	Social discounting (HMT health rates)	Private time preference (DR(E)=10%)	Private time preference (DR(H)=25/15/10%)	Private time preference (DR(E)=33%)
% of Undiscounted	67%	17%	14%	5%
% of HMT	100%	25%	21%	8%

The illustrative numbers in Table 5 suggest that if a simple weight was used to express how much of future health benefits are ‘felt’ in present choices, the weight could be as low as 0.1–0.2. This is a rough estimate and would warrant further empirical investigation.

2.3.2 Information asymmetry

Alongside the issue of time preference under uncertainty, there is a further reason why perceived benefits may under-represent future *internal* benefits – seen from the perspective of the individual making choices around active mode use. This is information asymmetry – i.e. the individual does not have key information needed to assess their current or future utilities; they may be wholly or partly unaware of the effect.

A leading example of this is ultrafine particle (UFP) pollution caused by combustion engines (among other sources) and a significant urban health problem. UFPs are too small to be seen, and the haze they create at high concentrations may also not be visible close-up in a typical urban environment.

They do not cause sneezing or irritation, and typically pass unnoticed into the lungs and bloodstream. The only perception of them may indeed come through their longer term health effects – and by then the connection with the initial exposure may be too remote to drive any meaningful behavioural change. A typical research finding is from Paas et al. (2016), who concluded: “At least in investigated concentration *magnitudes* there proved to be no connection between user assessment and physical values at all”. Another study in London, focusing on pedestrians’ perceptions of particulate air pollution and noise in street environments, found that people’s subjective perceptions were incompatible with objective data for air pollution, while for noise the match was better (Adriana, 2016).

The implication is that for some impacts, individuals do not have the opportunity to internalise them if they are unaware that they are being exposed.

For physical activity, there is evidence that most people ($\geq 90\%$)³² are aware that physical activity has health benefits, and awareness is also high for some of the specific benefits (e.g. maintaining healthy weight, improving mental health and managing stress) (O’Sullivan et al., 2025). Some of the long-term health impacts appear to be less well known. There is a low level of awareness of the contents of the physical activity guidelines – e.g. 63% of employed adults in England were unaware of the amount of physical activity recommended in 2014 (Knox et al., 2015). This is suggestive, although does not prove, that people’s awareness of the *magnitudes* of the health benefits of physical activity is probably inaccurate and possibly biased.

It seems possible that information asymmetry is a contributory factor to the steep private discount rates in early years after the intervention (in §2.3.1). For example, people may be aware of the short-term benefits for their body weight and mental health, but they are also aware those effects will not last into the long-term – being overtaken by later period levels of physical activity. The longer term benefits may be the ones that people are less aware of (as the literature above suggests), or that they underestimate the magnitude of the most.

Based on the evidence available, it is difficult to separate out exactly how much of people’s perception of future health benefits is due to each of the three factors discussed: time preference; uncertainty; and information asymmetries. Nevertheless, there is evidence that long-term health benefits are down-weighted substantially by individuals, and there appears to be variation across individuals in terms of their response.

We carry this finding forward to §3.2 on health benefits.

2.4 Externalities

Externalities form a key component of the welfare change calculation in appraisal:

$$(5) \quad \Delta SS = \Delta CS + \Delta PS + \Delta GS + \Delta Ext$$

where ΔSS is the change in social surplus, ΔCS is change in consumer surplus, ΔPS is change in producer surplus, ΔGS is change in government surplus, i.e. the Public Accounts table in TAG, and ΔExt is the change in externalities (e.g. Boardman et al., 2018). Changes in externalities are generally not subject to the rule-of-a-half when estimated.

32. in Northern Ireland and Republic of Ireland

In this context, there are some important externalities to take into account:

- air quality and noise impacts of travel are generally treated as entirely externalities – that is, external from the trip decisions of those operating motor vehicles to those who experience the range of effects caused by exposure to air pollutants and noise;
- safety impacts are partly internal and partly external (see §2.2.1) – in current appraisal practice, they are treated largely as externalities³³;
- health impacts are also partly internal and partly external – to the extent people are aware of the internal health benefits of cycling and walking they should include this factor in their choice utilities, subject of course to their discounting of the future since many health impacts are longer term (§2.3)
 - changes in future health also have implications for the health service (and hence for the public accounts) (Zapata-Diomedes et al., 2018), through
 - reduced morbidity (beneficial)
 - longer life expectancy (an offsetting effect)
 - changes in future health have spillover effects on family members – any reduction in serious family illness could positively impact the mental health and wellbeing of family members (Henry and Cullinan, 2021)
 - changes in absenteeism are an external impact on businesses, and are included in TAG and AMAT³⁴; and
 - changes in future health may have wider implications for (lost) economic output, a proportion of which (roughly 20%) is not felt by individuals but by firms³⁵ – this too is an externality from the individual's perspective.
- the 'marginal external costs' of changes in road traffic are part of TAG³⁶, and include a set of other external effects beyond those listed above (including decongestion, infrastructure cost savings, changes in greenhouse gas emissions and changes in indirect tax revenues to HM Treasury).

2.5 Incorporating these aspects in the framework

We now go on to incorporate these aspects in the theoretical framework in more detail, using additional terms where necessary and proposing some functional forms for testing. In relation to time preference, uncertainty and information asymmetries, we recognise that these may be difficult to separate in empirical research, and that a simpler formulation – such as a weight applied to all future health benefits – may be a useful way to proceed. All this is taken forward in Section 3.

In Section 4 we draw conclusions, including general comments about the potential to use econometrics to test the significance and magnitude of key variables, and to test the suitability of alternative functional forms.

33. we set this out in more detail in §3.3

34. In the UK system with widespread sick pay and Statutory Sick Pay (SSP) from the 1st day of absence (from April 2026), employees will generally not lose out. Self-employed people, however, amount to around 13% of the UK working population and for these individuals the absence costs will be internal.

35. this is included in UK appraisal for injuries due to accidents, although not for physical activity impacts – see DfT (2022) TAG Unit A4.1, p7 – this is the 'Net output' item in DfT (2025) TAG Data Book, Table A4.1.1.

36. DfT (2025) TAG Unit A5.4

3. Theoretical framework components

3.1 Trip utility and user benefits

The first component of the theoretical framework to be specified in more detail is trip utility.

3.1.1 Behavioural responses to improved active travel infrastructure

In the short-term we are interested in the trip utility experienced by the person travelling. This is because it is a measurable component of social welfare, which is the basis for the appraisal³⁷.

Like any other mode of transport, we assume that user benefits accrue to those using an improved piece of active travel infrastructure. For example, when a journey by walk or cycle becomes quicker, we represent the utility change in the theoretical framework – based on the opportunity cost of the time saved and the relative disutility of time spent in different activities.

In the active travel context, there are a wide range of behavioural responses which could arise in response to improved active travel infrastructure, or conditions for active travel being improved in other ways. Some of these are regularly represented in transport planning models³⁸:

- *Route choices*: cyclists and pedestrians are drawn towards shorter, safer and better quality routes;
- *Mode choices*: with improved infrastructure and conditions on offer, users may be inclined to switch to active travel modes, as opposed to using cars or public transport;
- *Destination choices*: with improved access to certain facilities travellers may change their destinations, particularly those by active travel as the main affected mode.
- *Trip frequency*: as the generalised cost of travelling decreases, we may also observe changes in the number of trips made.

Other more complex behavioural responses can also be considered. This includes changes in trip chaining behaviour, or changes in activity choices. The latter may be of particular interest as active travel can sometimes be considered as an activity in its own right, as opposed to being solely a derived demand (i.e. a means to access an activity at location j) (see purpose shares in §1.4). Note, however, that to forecast these kinds of user benefits, tour-based and activity-based travel demand models might be needed and this goes beyond the traditional four-stage model form that is usually available.

There are also longer-term demand responses which may also take place, in the form of residential sorting (people moving home) and work location choices. These responses are within the scope of the ‘Welfare appraisal under land use change’ study and alternatives to the conventional rule-of-a-half (RoH) benefit measure are available in that context (Nellthorp et al., 2025).

37. The Green Book sets this out as follows: “Appraisal is concerned with the welfare and wellbeing impacts of spending” (p38); “The social value of a proposal is the value it brings to residents of the United Kingdom. This is not limited simply to financial returns, but all the benefits, costs and risks that affect people’s wellbeing” (HM Treasury, 2026a, p4). Equation (5) in §2.4 of this report sets out the change in social welfare in terms of its major components – changes in trip utility feed into the change in consumer surplus (ΔCS).

38. These are the four stages of the conventional 4-stage transport model (e.g. Ortúzar & Willumsen, 2011).

To avoid unnecessary complication we do not consider these kinds of responses further here, and they are not explicitly considered in many standard transport models or appraisals in practice³⁹.

When developing the future appraisal framework for active modes, it could be advantageous for ATE and DfT to consider the desired modelling and valuation methods simultaneously. That would help, for example, to align the ability to forecast demand changes in response to key trip utility variables, with the ability to value the same variables in appraisal using robust empirical values.

3.1.2 *Generalised cost, the rule-of-a-half and the logsum*

It should be clear from the start that this theoretical framework does not intend to reinvent the wheel, and standard transport economics concepts are considered to remain relevant and are applicable to the domain of active travel. When we come to measure the benefits of improved active travel infrastructure, we will make use of the concept of generalised cost (GC) of travel, which is an integral part of TAG (both for appraisal and modelling). Wardman and Toner (2020) refer to GC as “a measure of the attractiveness of travel alternatives”. Thus improving the quality of active travel infrastructure makes it more attractive to use specific routes and travel options, and the GC is the monetised reflection of this improvement of utility. The advantage of expressing quality changes in GC units is that demand functions can be developed, in this case for active travel, and the area underneath the demand curve can be used to measure changes in consumer surplus expressing the user benefits in monetary terms. The widely-used linear approximation to the change in consumer surplus is the ‘rule-of-a-half’ allowing for easy calculation of the user benefit, only relying on ‘with project’ and ‘without project’ measures of the demand and generalised costs. There has recently been research to extend the range of contexts in which the rule-of-a-half is applicable (Nellthorp et al., 2025).

Similarly, the concept of the ‘logsum’ (de Jong et al., 2007) is a commonly used metric to reflect how improvements in utility at the route level affect decisions at higher levels of the four-stage model. For example, if the quality of travel on a specific active travel route is improved, it improves the ex-ante expected maximum utility of travelling using active travel modes, regardless of knowing which route will be chosen. As such, it increases the choice probability (hence mode share) of active modes of travel, and like the GC method, the principles of consumer surplus can be used to obtain a monetary expression of the user benefits in a mode choice context when active travel routes are improved (logsum-based benefit measures are also included in Nellthorp et al., 2025).

With these user benefit measures at our disposal, the challenge at hand is to identify how the utility of travelling by active modes (and hence generalised cost) is affected by changes in active travel infrastructure and conditions.

3.1.3 *The challenge at hand – trip utility function*

The main challenge at hand is to derive an appropriate utility function for a journey (or trip) using an active mode of travel, and to relate that to the wider set of benefits in TAG without double-counting. We determine here the utility of a selected route, r . We acknowledge that factors at the start and end of a trip may influence the decision to make use of active modes of travel for this trip.

39. i.e. Level 1 and Level 2 appraisals.

For example, Wardman et al. (2007) show that the availability of secure cycle parking or shower facilities at the end of a trip may significantly influence mode choice, but also preparation time at home to make sure that all equipment (e.g. helmet, locks, clothing, tyre pressure) is in order can influence the mode choice decision. These factors can be analysed in conjunction with infrastructure improvements at the route level⁴⁰.

A trip/journey/route therefore has a given start and end point, and along the way various factors influence the utility of the overall trip. We begin by presenting a general form of trip utility function. We then give a specific form, which fits with the general form of trip utility in TAG at present. Through empirical testing (of this and potentially other functional forms), it should be possible to establish a robust approach to quantifying and valuing active mode trip utility and user benefits.

3.1.4 General form of trip utility function

$$(6) \quad U_r = f(t_r, s_r, e_r, c_r)$$

where U_r is the individual's utility from choosing route r .

$f()$ is function which could take various forms, one of which is the linear additive form indicated below – other forms are possible and empirical work will be needed to establish what is the best form to represent these relationships

t_r is the journey time by route r

s_r is the safety of route r

e_r is the physical effort of taking route r , in MET-hours

c_r is the comfort (other than safety and effort effects) of taking route r .

Equation (6) omits the random component of utility ε_r which will be relevant in a choice modelling context. Also the subscript h for the individual or a for population segment is omitted (for clarity).

The term c_r includes remaining journey quality/ambience factors such as whether travelling through greenspace, pavement width/lane width, and perceived surface quality.

While equation (6) may be suitable in a route choice context, in a mode choice context or any wider choice context, we would also want to include trip end terms, α_i and ω_j

$$(7) \quad U_r = f(\alpha_i, t_r, s_r, e_r, c_r, \omega_j)$$

where trip utility comprises:

- pre-trip elements, including cycle ownership/hire, cycle storage at home or cycle parking, represented by utility term α_i
- in-trip utility, including
 - Time spent travelling, t_r
 - Perceived safety, s_r

⁴⁰ and benefits estimated using the RoH or logsum approach. The logsum may have an advantage if higher-level choices are involved such as cycle ownership (Nellthorpe et al., 2025, encompasses both approaches).

- effort, or exercise (METs) in travel, e_r – this may have both positive and negative elements, e.g.:
 - exercise may be the prime motivator for jogging and some recreational cycling, and appears to be a positive motivator for choosing to make utility trips by active modes⁴¹ – the underlying reasons for this positive utility of exercise which are identified in the literature include:
 - immediate and short-term positive effects on mood/wellbeing⁴²;
 - an interest in maintaining or improving fitness and body weight through physical activity⁴³ – each trip contributes towards maintaining fitness and body weight⁴⁴, and the literature suggests that fitness and body weight changes are achievable within 3-4 months⁴⁵;
 - potentially the long-term health benefits of physical activity (in terms of morbidity and mortality) – such as those captured by the health benefits tool⁴⁶;
 - effort may also be a key source of disutility in many contexts, e.g. Parkin et al. (2008) show that overall, hilliness is a significant negative factor in cycle commuting demand, and Flügel et al. (2021) identify panting, sweating, getting physically tired and getting sore muscles as potential negative effects of active travel;
 - the perception as well as the occurrence of these effects may differ between individuals as well as between trip purposes
- (dis)comfort of time spent travelling, c_r – as above, is affected by many other factors (see §3.5 for more detail)
- stops, junctions and crossings – like interchange during PT journeys, these are more than just ‘in-vehicle time’, e.g. Börjesson and Eliasson (2012) quantify the value of stopping for cyclists (a question for the future empirical research is whether this is associated with the time term t_r , the effort term e_r , or both); junctions and crossings may have effects associated with the safety term, s_r and the time term t_r
- post-trip utility including secure cycle parking at destination, and in some cases changing facilities (both in TAG already), ω_j .

41. e.g. Félix et al. (2019), Fig.3

42. There is a body of evidence that exercise can produce immediate, short-term mood/wellbeing effects, see Basso and Suzuki (2016), Reed and Ones (2006). The pattern does not appear to be as straightforward as some narratives suggest, e.g. various combinations of intensity and duration appear to have different effects. Even quite short exercise sessions (7-10 mins) may have some positive effect, although durations around 30-35 mins appear to have larger effects (Basso and Suzuki, 2016). Another interesting finding is that “The effects of aerobic exercise on [positive activated affect] appear to last for at least 30 min after exercise before returning to baseline” (Basso and Suzuki, 2016).

43. e.g. see Björklund, G. and Mortazavi, R. (2013), Appendix

44. WHO (2020); different forms of exercise contribute different numbers of METs (Herrmann et al., 2024)

45. e.g. Buchan et al. (2011); Wenger and Bell (1986).

46. TATE3030

3.1.5 A specific form of trip utility

The following form is linear additive in components and resembles the current TAG approach to time and journey ambience. It is expressed in units of generalised cost:

$$(8) \quad GC_r = \sum_{n=1}^N (v_t t_n \bullet m + v_s s_n + v_e e_n + v_c c_n)$$

where GC_r is the individual's generalised cost from choosing route r (we assume utility can be converted into generalised cost by dividing by the appropriate marginal utility of income, β)

n are route sections, indexed 1. . N and these may be links (e.g. lengths of footway or cycleway) or nodes (e.g. junctions or crossings)

v_t is the individual's value of travel time (for trip purpose k , subscript suppressed for clarity)

t_n is the journey time along route section n

m is any relevant value of time multiplier from TAG – in particular access/egress time as part of a motorised transport trip (rail/bus/car for example), currently 2.0⁴⁷

v_s is the individual's marginal value of perceived safety

s_n is the perceived safety of route section n

v_e is the individual's marginal value of effort (£/MET-hour)

e_n is the physical effort of taking route section n , in MET-hours

v_c is the individual's marginal value of comfort (other than safety and effort effects)

c_n is the comfort level (other than safety and effort effects) of route section n .

The trip end utilities could be added as follows

$$(9) \quad GC_r = \frac{\alpha_i}{\beta} + \sum_{n=1}^N (v_t t_n \bullet m + v_s s_n + v_e e_n + v_c c_n) + \frac{\omega_j}{\beta}$$

where β is a marginal utility of income, to convert the trip end utility terms into money amounts.

This type of function would have the attraction of alignment with the generalised cost approach which is widely used in TAG. Whether it is too restrictive (in its linear additive form) is a question which could be addressed empirically⁴⁸.

47. DfT (2025) TAG Unit A1.3. See Wardman et al. (2026) for a new meta-analysis of evidence.

48. e.g. Wardman and Toner (2020) discuss the empirical validity of the generalised cost form in the context of rail demand data.

3.1.6 Other potential functional forms of trip utility

Another approach would be to avoid separating out the determinants of trip quality (i.e. perceived safety, effort and other comfort factors), and instead to bundle these together in certain infrastructure types and facilities. This is essentially what the TAG Data Book table on cycle schemes does at present (Table A4.1.6) and this table is widely used and understood.

The challenge would be that for a larger range of infrastructure schemes (see Table 3) and a combination of different trip utility issues including safety⁴⁹ and others, a longer table with more rows will be needed. In this sort of approach, we could assume the trip starts at time $t = 0$ and ends at time $t = T$. We have chosen to use time here to represent the progress of the trip, but analogous formulations using distance can easily be developed. The trip utility of taking route r could roughly be determined by three factors:

$$(10) \quad U_r = \int_{t=0}^T q(t) - e(t) - \beta dt$$

where $q(t)$ is the quality of the infrastructure at point t , e.g. segregated off-road cycle track, through greenspace, to LTN1/20 desirable minimum width standard⁵⁰

$e(t)$ is the effort required at time point t , which would be related to hilliness in particular, and to stopping/starting for cyclists – potentially different for electric bicycles

β is the opportunity cost of time while travelling.

$q(t)$ recognises that the traveller will experience varying qualities of transport infrastructure along a given route varying from segregated cycle lanes to shared traffic, to intersection, and differences in the journey ambience. Similarly, travelling by active modes requires effort but this varies by the geographical characteristics of the journey where hills increase the amount of effort required⁵¹. Assuming that most active travel journeys are relatively short we assume that the opportunity costs of time are constant, but non-linear forms can be accommodated too. Again, it should be noted that apart from the inclusion of the effort term, the structure of such a utility function does conceptually not differ from journeys made by car or public transport users. Car drivers also tend to prefer routes which are both quicker and provide a better quality of driving in the form of road and journey layouts.

Equation (10) is an integral function across potentially quite a detailed and complex route in terms of differing $q(t)$ and $e(t)$ as the trip progresses – this remains a ‘bottom-up’ calculation requiring data for the route. In many respects, however, this and the linear additive function above, equations (8) & (9), share a lot in common with the section-by-section approach in AMAT.

49. see ATE Critical Safety Issues (ATE, 2025)

50. this has a specific meaning, e.g. 3.0m wide for a 2-way path suitable for up to 1000 users per hour in total (sum of both directions)

51. simultaneously the amount of effort may also be reduced due to the use of electric bicycles. Weather may vary across days and seasons – at present this is not widely addressed by models, and so we do not consider the effects of weather here. This is a potential future research issue.

3.1.7 Alternative approaches for the safety component of trip utility

The level of risk varies along the route and hence the notion of a survival function has some appeal, but would require refinement before it could be quantified or applied. A survival function expresses the probability $S(t)$ of *not* experiencing a harmful event up to time t . There are two alternative ways to integrate this into the utility function, either by scaling all of utility or as a separate penalty term in the utility function.

The first option is denoted here:

$$(11) \quad E(U_r) = \int_{t=0}^T S(t) \cdot [q(t) - e(t) - \beta] dt$$

where dangerous crossings, road layouts etc. reduce the probability of making it safely to the end point and thereby reduce (or penalise) the expected utility of route r .

The second option makes use of the analogue of the survival function, i.e. the *hazard function* $s(t)$ the instantaneous probability of an adverse event:

$$(12) \quad U_r = \int_{t=0}^T q(t) - e(t) - \beta - \gamma s(t) dt$$

where $s(t) = -\frac{d \ln(S_t)}{dt}$ adds risk additively to the utility in the same way time, quality, or effort do. Equation (12) is consistent with equations (8) and (9) above, which is potentially useful for future application. This sort of approach would, conceptually, share some features with the way safety affects other modes of transport where car users may avoid specific junctions for safety purposes, or public transport users may avoid certain stations due to personal risks.

However, there are some important caveats: firstly, U_r represents *perceived safety*, and successful estimation of any of these functional forms will depend on how individuals perceive these factors and how their choices are determined; secondly, there are different severities of 'adverse event' from a fatal collision to a damage-only collision to a near-miss, for example – suggesting that in this type of approach, safety risks may need decomposing into distinct components.

3.2 Health benefits

Emerging from the health benefits tool⁵² is expected to be a profile of health impacts over years y [$0y \dots Y$], in other words the opening year through to the last year of the appraisal period, including years of life lost (YLL) and changes in morbidity (represented by years lived with/without a major non-communicable disease⁵³). These will be valued on entering the appraisal in AMAT, using HM Treasury Green Book-compatible values.

⁵². TATE3030

⁵³. e.g. heart attacks, stroke, cancers, asthma and diabetes

In this theoretical framework, these health impacts represent a long-term stream of social benefits:

$$(13) \quad B_h = \sum_{y=oy}^Y (\Delta h_y \bullet \delta_{2023}^y)$$

where B_h is the total health benefit in present value (PV) terms;

Δh_y is the health benefit in year y in undiscounted monetary terms, at 2023 prices, including changes in both mortality and morbidity;

δ_{2023}^y is the social discount factor for year y , at HM Treasury (2026b) health discount rates⁵⁴, using 2023 as the base year for discounting as well as prices – this is TAG standard practice;

oy is the opening year of the scheme and Y is the last year of the appraisal period, or horizon year.

This is in line with the lifetime utility approach (equation (4) in §2.3), curtailed to the appraisal's horizon year.

3.2.1 Double-counting

When we estimate the *internal* long-term health benefits to the traveller from their own choices, the risk is that a proportion of these internal health benefits, call this θ , will appear in individual trip utility (in individual choice making). If this occurs, then this is the part which needs to be deducted from the overall benefit calculation to avoid double-counting.

To be clear, the active mode user's perception of physical effort/exercise (in METs) is made up of three elements: (i) their disutility of effort in the short-term; (ii) any positive utility from the short-term mood/wellbeing effect and their fitness/body weight^{55,56}; and (iii) their anticipated future health benefits. In equation (9), for example, we can write

$$(14) \quad v_e \bullet e_n = \tilde{v}_e \bullet e_n - \hat{v}_e \bullet e_n - \theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{social}^{\tau})$$

where $v_e \bullet e_n$ is the user's own overall valuation of the change in physical effort/exercise (e_n in MET-hours);

$\tilde{v}_e \bullet e_n$ is the user's own valuation of the negative effects through *disutility of effort* in the short-term;

$\hat{v}_e \bullet e_n$ is the user's own valuation of the positive effects on mood/wellbeing/fitness/weight in the short-term;

$\Delta h_{h,\tau}$ are the user's own *individual*, internal long-term health benefits (mortality and morbidity) in year τ , which are discounted and summed over years y to T ;

subscript h indicates individual h ;

54. 1.5%/1.29% (HM Treasury, 2026b)

55. discussed in §3.1.4 and footnote 42

56. also discussed in §3.1.4

year y is the year in which the change in physical exertion happens, and year T is the last year of h 's life expectancy (so $T - y$ is the number expected life years remaining);

$\delta_{\text{social}}^\tau$ is the social discount factor in year τ , so viewing the individual's future health benefits through a social welfare lens;

θ is the rate at which the individual perceives these future health benefits as a proportion of their social value⁵⁷.

Whereas the whole⁵⁸ of $\sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{\text{social}}^\tau)$ will appear in the social welfare appraisal, only θ times this amount will appear in the individual's trip utility (user benefit). Therefore the amount of double-counting is

$$(15) \quad \theta \bullet \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{\text{social}}^\tau)$$

Currently, TAG implicitly assumes that $\theta = 0$, so there is zero double-counting. So do the appraisal guidelines of some other countries (see Flügel et al., 2021, p12; Björklund, G. and Mortazavi, R., 2013, p6). The reasoning and evidence above (§2.3) raises a question mark over this *in theory*: it seems possible that some of the active mode users will be aware of some positive proportion of their future health benefits when they make their choice, however the empirical values of θ suggested by Table 5 above are fairly small.

In order to understand this better, it helps to know how active mode users respond, when asked, about their motivations:

- many active mode users are motivated by physical exercise and/or health – e.g. in Börjesson and Eliasson's survey 52% of cyclists stated that exercise was the most important reason to choose bicycle; in Flügel et al. (2021) 65% of respondents stated that they prefer to cycle/walk as it gave them additional physical activity – and a large majority agreed with statements that cycling and walking helped them to “feel in good shape”, “achieve a desirable level of physical activity” and “burn calories” as well as “improving future health”; and in Félix et al.'s (2019) detailed study of motivations and barriers to urban cycling, both physical fitness and health improvement are among the most important motivations for cycling (alongside cost saving, speed and environmental concerns⁵⁹);
- to highlight the key point, it seems that many active mode users recognise and are motivated by the immediate feelings around physical exercise and fitness⁶⁰, including being fit enough to enjoy exercise, not only the long-term health benefits in terms of mortality and morbidity.

57. equivalent to the last row in Table 5, but potentially including information asymmetry as well as time preference under uncertainty

58. Also, importantly, the individual trip utility benefits are subject to the rule-of-a-half (or logsum-based) measures when calculations of social welfare change are made (DfT, 2025) TAG Unit A1.3.

59. see their Fig 3

60. e.g. CDC (2025): “Benefits of physical activity. • Physical activity has many immediate and long-term benefits.

• Physical activity helps you immediately feel better, function better, and sleep better. • Adults who sit less and do any amount of moderate- to vigorous-intensity physical activity gain some health benefits”.

The theoretical framework in this report contains two relevant terms, matching these two dimensions of perceived benefits from exercise:

- utility gained in the short-term⁶¹ – in terms of fitness, body weight, mood and wellbeing ($\hat{v}_e \bullet e_n$);
- utility gained in over the long-term – in terms of future health outcomes (mortality and morbidity) ($\theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{social}^\tau)$), the morbidity part of which relates to reductions in heart attacks, stroke, cancers, asthma and diabetes⁶²;
- these two components of lifetime utility are both legitimate components of value in appraisal, and further empirical research would lead to a better understanding of their relative size, for different segments of the population⁶³.

Now consider how these impacts are likely to feature in the TAG appraisal:

- TAG includes consumer surplus gains from reductions in generalised cost – these are the ‘User benefits’ in Figure 1. Equation (9) sets out a generalised cost function for active travel, and that includes a term for effort/exercise, $v_e \bullet e_n$. The health-related benefits perceived by an individual at trip level will appear in $v_e \bullet e_n$ through *both* the terms $\hat{v}_e \bullet e_n$ and $\theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{social}^\tau)$ (see equation (14)).
 - If $\hat{v}_e \bullet e_n > 0$, there is no double-counting between this benefit and the health outcome benefits (equation (13)) because they are different effects. Both should be counted in the appraisal.
 - If $\theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{social}^\tau) > 0$, the extent of double-counting with the health outcome benefits depends upon the value of θ between 0 and 1.

We find, therefore, that:

- part of the benefits associated with physical exercise and health are not double-counting at all – the part associated with fitness, body weight, mood and wellbeing ($\hat{v}_e \bullet e_n$);
- part of the benefits may in theory double-count to some extent – the future health benefits will suffer from double-counting if $\theta > 0$, however there are reasons to assume that θ is small. We have recommended further research to investigate the value of θ , and how θ varies between population segments and trip purposes (§3.2.4 and §4.1).

The new health benefits tool covers the second term. There is no risk of double-counting in the first term – it features in the user benefits but not in the future health outcomes. The procedure for dealing with any double-counting from the second term would be as follows.

61. see §3.1.4 for timescales

62. covered by the health benefits tool (TATE3030)

63. Note that there could be some positive correlation between the two terms, ($\hat{v}_e \bullet e_n$) and $\theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{social}^\tau)$, however that in itself would not necessarily imply double-counting, since the source of utility is different. In the former, it is the experienced utility of exercise (footnote 42) and the associations between physical fitness and psychosocial measures of health and wellbeing such as life satisfaction or self-reported quality of life (e.g. Marques et al., 2017); in the latter case, the impact pathways run through various diseases to mortality and morbidity.

- i. exclude any *external* benefits. In TAG/AMAT this mainly involves excluding the absenteeism benefits to businesses. In theory there are other potential external benefits, e.g. reduced net NHS costs due to mortality and morbidity, any family spillovers, and any wider impacts on economic output (see §2.4), however since these are not usually included in the health benefits, there may be no action needed.
- ii. apply the factor θ to the internal health benefits $\sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{\text{social}}^{\tau})$.
- iii. deduct this from the total benefits of the intervention.

3.2.2 Comparison with Börjesson and Eliasson (2012)

In an earlier, influential article in this field, Börjesson and Eliasson (2012) took a different stance, which can be summarised using the following quotation from their Abstract:

“Bicyclists seem to take health largely into account when making their travel choices, implying that it would be double-counting to add total health benefits to the analysis once the consumer surplus has been correctly calculated” (p673).

To reconcile the theoretical framework in this report with the findings of Börjesson and Eliasson (2012) we would make two key points.

- firstly, looking at a range of evidence⁶⁴, it appears that people take into account to some extent *both* the short-term benefits of exercise – relating to fitness, body weight, mood and wellbeing – and the long-term health benefits relating to mortality and morbidity. It is the latter that is measured by the health benefits tool⁶⁵. The former will be taken into account in consumer surplus and does not imply any double-counting.
- secondly, the degree to which the latter – the future mortality and morbidity benefits – are anticipated when making travel choices is uncertain. We reviewed this in §2.3 and found that there are multiple reasons why the value of θ is likely to be less than one for many people. We recognised that there are different population segments, some characterised by a more health conscious approach than others. The proposed low value of θ is not, for most people, due to a lack of awareness that health benefits exist⁶⁶, rather it is due to the difficulty of fully feeling future health benefits today, the uncertainty surrounding those future benefits and their magnitudes, and way that human neurology/psychology affects choices around health – including habits and ingrained patterns of behaviour^{67, 68}.

Overall, we conclude that the potential for double-counting is more limited than Börjesson and Eliasson (2012) implied.

Börjesson and Eliasson (2012) themselves recognise that the conclusion is more nuanced:

64. see §3.2.1 and §3.1.4

65. TATE3030

66. We found evidence within the UK of $\geq 90\%$ awareness of the existence of health benefits, but lower awareness of the amounts & types of exercise required to stay healthy (§2.3.2).

67. see §3.2.1

68. It might also be taken to imply that there are no externalities within the total health benefits. In §2.4 we identified four examples of these in theory (NHS costs, family health spillovers, absenteeism costs and the non-consumption part of changes in economic output), however in practice the majority of the measured health benefits are probably internal.

“It is virtually impossible to know whether cyclists make a correct assessment of the health effects of cycling, and take this into account when making travel choices. But our results give us no reason to believe that cyclists are unaware of these benefits. On the contrary, the high share of cyclists stating exercise as the primary reason for cycling, and the fact that values of time do not differ between this group and cyclists stating other primary reasons, point to the conclusion that cyclists are indeed well aware of the beneficial effects of cycling” (p681).

We largely agree with this. We would add that:

- being aware of the beneficial effects of cycling does not imply making a correct assessment of the health effects, or taking those fully into account in current travel choices. It does not imply that $\theta=1$. As we noted above, individuals are likely to be responding to the short-term benefits of exercise (the $\hat{v}_e \bullet e_n$ term), not only the future health impacts ($\sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{social}^T)$);
- also those who currently cycle – despite the perceived dangers of the current infrastructure – are likely to be individuals who are more conscious of the benefits of physical activity than average in the population, and/or less sensitive to the safety risks. Those who we seek to attract to cycling through policy measures, will not necessarily share these characteristics. We should not base our judgements about values solely on the current cycling population.

Börjesson and Eliasson continue:

“That cyclists are “aware” of the health benefits does not necessarily mean that they are able to make an accurate judgment of them”. We agree.

“On the contrary, this seems highly unlikely: both under- and overestimations are likely to occur”. We have given some reasons why underestimates of future health benefits are more likely when making current travel choices (§2.3).

Börjesson and Eliasson conclude:

“Available evidence is far from conclusive, and it probably never will be – but the evidence we have indicates that health effects are indeed factored in when travellers make their decisions, and hence, health effects should not be included in the CBA, at least not entirely”.

We draw a different conclusion, based on the evidence presented and the theoretical framework developed: the presumption should not be that health effects should be excluded from CBA. We agree that some share of the individual’s internal future health benefit which we have called theta (θ) may double-count with the user benefits, however for moment we believe that a low value of θ is a reasonable working assumption, and that the current convention in appraisal of assuming $\theta=0$ is an acceptable interim position, for the reasons given above. It seems reasonable to aim for a more robust approach to this issue in future. We have made a series of recommendations below (in §3.2.4 and then in Section 4).

3.2.3 Effort and exercise, and the value of travel time

It is evident from equation (14) that an increase in MET-h not only increases the positive short-term effects of exercise, and long-term impacts on health, but also increases effort, which is often a source of disutility in the short-term⁶⁹.

⁶⁹. discussed in §3.1.4

We think the inclusion of these three effects in the theoretical model helps to clarify why the active mode VTT results in previous studies vary so widely across people and trip purposes⁷⁰.

(14), restated with text, signs changed both sides

$$\begin{aligned}
& \text{Perceived net benefit of changes in physical exertion (MET-h), } -\mathbf{v}_e \bullet \mathbf{e}_n \\
& = \text{Perceived short-term disbenefit of effort, } -\tilde{\mathbf{v}}_e \bullet \mathbf{e}_n \\
& + \text{Perceived short-term benefit through fitness/body weight/mood/wellbeing, } \hat{\mathbf{v}}_e \bullet \mathbf{e}_n \\
& + \text{Perceived future health benefits, } \theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{\text{social}}^\tau)
\end{aligned}$$

For example, somebody who is health-conscious and cycles/walks partly because they are aware of the health benefits (higher value of θ) is likely to have a lower overall value of effort, $\mathbf{v}_e$ (holding all else equal). This is likely to decrease their VTT for active travel, since the derivative of equation (8) with respect to travel time will have a smaller $\hat{\mathbf{v}}_e \bullet \mathbf{e}_n$ component. Conversely, someone who takes little account of the effects on their own future health (has a low θ) and who is also quite sensitive to the effort involved in cycling (relatively high value of $\tilde{\mathbf{v}}_e$) will have a higher value of effort, $\mathbf{v}_e$, and a higher VTT for active travel.

Flügel et al. (2021) gathered data through a choice experiment, effectively about respondents' values of positive exercise effects, $\hat{\mathbf{v}}_e + \theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{\text{social}}^\tau)$, on one hand, and negative effort effects, $\tilde{\mathbf{v}}_e$, on the other hand. They did not have an equation like (14) in their theoretical model – nor did they derive separate values for these terms.

In the second of two experiments, they offered respondents pairwise choices such as the following (see Figure 5). Through their choices, respondents revealed their sensitivity to "Positive effects of physical efforts" on one hand, and "Negative effects of physical efforts" on the other. The former included "contribution to desirable level of physical activity" and "number of calories burned", as well as "contribution to future health benefits", however the effect of each of these components was not tested separately. The strength of response to "Negative effects of physical efforts" allowed the respondent to reveal their short-term disutility of effort (i.e. $\tilde{\mathbf{v}}_e$).

Figure 4: Choice card from Flügel et al. (2021)'s choice experiment 2 (CE2).

	Please choose	
	Alternative A	Alternative B
Type of bicycle	Regular bicycle	Regular bicycle
Travel time on bicycle	32 minutes	40 minutes
Negative effects of physical efforts	Some panting, some sweat, somewhat sore muscles	Minor panting, minor sweat, no sore muscles
Positive effects of physical efforts	High number of calories burned, large contribution to future health, large contribution to desirable level of physical activity	Low number of calories burned, minor contribution to future health, minor contribution to desirable level of activity

70. Like equation (15) above, this is from an individual perspective and does not yet take in to account the rule-of-a-half, which would be applied across all the individual utility changes due to an ATE scheme – as part of the calculation of consumer surplus change.

Flügel et al. (2021)'s analysis of the data focuses on the effect on the value of time (VTT) (Table 6). By scaling the results of choice experiment 2 to match the average VTTs for cycle and walk emerging from choice experiment 1, they derived VTTs corresponding to all combinations of:

- three levels of positive effects - 1. no/few; 2. some; 3. large;
- three levels of negative effects of effort (sweating, etc) - 1. no/few; 2. some; 3. large.

Table 6: Implied marginal (dis)utilities of travel minutes from CE2 and implied VTT when scaled to average values obtained in CE1 (Flügel et al., 2021).

	Cycling			Walking		
Side effects of physical motion	Marginal (dis) utility (minutes)	Relative to 'large' negative/'no/few' positive	"Scaled VTTs (NOK/h) ^a "	Marginal (dis) utility (minutes)	Relative to 'large' negative/'no/few' positive	"Scaled VTTs (NOK/h) ^b "
no/few negative - large positive	0.0026	-3.32%	-12.3	0.023	-44.06%	-1840.6
no/few negative - some positive	-0.0082	10.46%	38.9	0.0075	-14.37%	-600.2
no/few negative - no/few positive	-0.031	39.54%	147.0	-0.0043	8.24%	344.1
some negative - large positive	-0.0071	9.06%	33.7	0.0068	-13.03%	-544.2
some negative - some positive	-0.0246	31.38%	116.7	0.001	-1.92%	-80.0
some negative - no/few positive	-0.0448	57.14%	212.5	-0.0102	19.54%	816.3
large negative - large positive	-0.028	35.71%	132.8	-0.0098	18.77%	784.3
large negative - some positive	-0.0411	52.42%	194.9	-0.0082	15.71%	656.2
large negative - no/few positive	-0.0784		371.8	-0.0522		4177.5

^a Scaled such that the average value corresponds to the estimated value of 137.32 NOK/hour from CE1-cyc.

^b Scaled such that the average value corresponds to the estimated value of 412.59 NOK/hour from CE1-ped.

Focusing on cycling, and on the level "some negative [effort effects]", i.e. the middle three rows in the table, the authors observe that:

- taking an unweighted average of the VTT with "some positive [exercise/health effects]" and "large positive [exercise/health effects]" gives a VTT of 75 Norwegian Krone (NOK)/hour, which is around £6/hour;

- they infer that “health benefits decrease the VTTS roughly from 213 NOK/hour to 75 NOK/hour, i.e. by about 65%”. It is worth noting that their sample contains existing active travel users. These are people who we might expect to have a lower active mode VTT for the reasons given above.

It can also be observed that⁷¹:

- “large positive [exercise/health effects]” decrease the VTTS from 213 to 34 NOK/hour, i.e. by 84%;
- the value of an hour of “large positive [exercise/health effects]” without any travel time savings appears to be around 178 NOK/hour⁷²
 - compare this with around 147 NOK for an hour of cycle time savings if there are *no health benefits* and *no effort disutility* (perhaps comparable to a very easy cycle on the flat);
 - or compare it with the average VTT in the experiment of 137 NOK/hour.
- in a situation where there are “large positive [exercise/health effects]” and “no/few negative [effort effects]” – e.g. the person is already fairly fit so no unpleasant effects from cycling – the VTTS goes negative (-12NOK). To be clear what this means, *under these specific (and possibly rare) circumstances*, if the project leads the person to cycle further and proportionately longer, the person will feel a utility gain from this. Note that Flügel et al.’s experiment focused on utility trips (excluding pure exercise/pleasure trip purposes).

In broad terms, then, it has been shown through choice experiments that perceived benefits from physical exercise during active travel can in some cases be substantial (e.g. when compared with the benefits from time savings). It is unclear at this stage how much of this is due to shorter-term effects such as fitness/weight management and mood or wellbeing gains from the exercise itself, versus longer term expectations of better future health. This could depend on the population segment being studied (e.g. in terms of baseline levels of physical activity, or mobility, and their attitudes to the future) and potentially the trip purpose being studied.

3.2.4 Next steps

Our understanding of the relationships between these variables clearly needs to be strengthened. However, we envisage there are different ways of achieving that, and an interim position would be useful – until the results of empirical research are available.

For the interim:

- unless we are valuing positive exercise impacts in trip utility, $\hat{v}_e + \theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{\text{social}}^\tau)$, we do not need to worry about double-counting with future health benefits, $\sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{\text{social}}^\tau)$;
 - at present in TAG, we are not doing so explicitly;
 - nor are we doing so implicitly, since:

71. continuing to hold the level “some negative [effort effects]” unless stated otherwise

72. 212.5 NOK/hour – 33.7 NOK/hour. Note that if the same calculation is made at the other two levels of effort disutility, the results are 159 NOK/hour and 239 NOK/hour.

- VTTs for commute and other non-work are cross-modal and do not vary with exercise;
- Journey ambience values do not currently address exercise;
- for multi-modal trips, we use walk or access/egress multipliers on VTT⁷³ – the fact that these are >1 suggest that they may be picking up the negative effort effect ($\tilde{v}_e \bullet e_n$) and possibly other negative components such as perceived safety risks ($v_s \bullet s_n$), more strongly than any positive exercise effects
- nevertheless this is an assumption, and ATE & DfT may wish to disentangle these factors in trip utility through empirical research.

For the future, we see three broad options for estimation of relevant parameters and values.

1. as part of econometric research into trip utility functions, the intensity of physical activity (e in METs) could be allowed to vary. Further, the component effects of this could be varied, seeking elicit values for v_e and its components ($\tilde{v}_e, \hat{v}_e$ and $\theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{social}^{\tau})$). This is broadly the approach of Flügel et al. (2021) in their experiment 2, taken a step further. When combined with health modelling (or a simpler method) to estimate the individual's future health benefits $\sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{social}^{\tau})$ this could potentially shed light on the value of θ as well as the other components. We think this approach will be challenging, however, because two components may be correlated, $\hat{v}_e$ and $\theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{social}^{\tau})$ – Flügel et al. (2021) appear to have assumed that they are, and this would make separate estimation of the values and parameters difficult, including θ . The combination of two different data sources (subjective perceptions and modelled health impacts) could also cause difficulties
2. an alternative approach, more pragmatic and focused on the needs of appraisal, would be to specify conditions where a different level of effort (e) may be required or chosen, and investigate the implications for trip utility. Examples could include hilliness/gradient⁷⁴, trip distance (by active modes)⁷⁵, and certain exercise trip purposes (e.g. jogging, running, and cycling for exercise). As in other parts of this framework, we expect different individuals in the population⁷⁶ to have potentially very different utilities for the same active travel conditions, and the utilities will clearly differ by active mode, and potentially by trip purpose.

If θ cannot be investigated through trip utility (i.e. the 2nd, not the 1st, approach to trip utility is taken), then:

3. a direct investigation of θ could be undertaken, building up from the theoretical arguments (time preference, risk/uncertainty, information asymmetry), potentially using a combination of evidence review and new experiments, to gain a better understanding of where θ is likely to lie in the range $[0,1]$, and what share of the health benefits can be assumed to be internal.

73. DfT (2025) *TAG Unit A1.3*; Wardman et al. (2026)

74. Also, it could be of practical use to gather evidence on how conditions, especially hilliness, affect the level of effort required for walking and cycling. This would help to inform, for example, the planning of flatter routes following contours, in hilly locations.

75. Jansson (2013) points out that different modes serve to minimise GC over different distances, and while walking is very efficient over short distances, for example, it is at a disadvantage over longer distances, and this is due not to its money cost, but to the time cost and the physical effort involved - consider walking 1 hour to work, for example.

76. e.g. age, gender, attitudes.

Once new trip utility functions are estimated and updated values are available for journey ambience and travel time⁷⁷, and the outputs of the health benefits tool are available, it will be more feasible to compare the implied WTP for exercise & health benefits (in trip utility) with the expected future health benefits for the individual. In other words, inferences about the value of θ could be drawn, reflecting on the body of research, once complete. Again, we expect θ to vary across the population, and potentially by trip purpose. Note that this will require calculations at the individual user level, and a breakdown of the individual's health benefits into internal and external components.

In the short-term, to recap, prior to any new empirical research findings, would recommend the following:

- for now, continue with TAG practice, in line with other European countries. Undertake the appraisal assuming θ is close to zero⁷⁸
- this means that trip utility (user benefits) and health benefits do not double-count and can be added together.

3.3 Safety benefits

Changes in safety are felt in two ways as part of lifetime utility. Firstly, *in the trip utility*, safety risks are a source of disutility – reflected in, for example, the different values per minute spent cycling on different types of infrastructure in the current TAG Data Book (from Hopkinson and Wardman, 1996 and Wardman, Hatfield and Page, 1997) (Table 7).

The final two columns in Table 7 are added to provide a comparison with values of time, which are £15.48/hour for commuting and £7.06/hour for other non-work (at 2023 prices). As Hopkinson and Wardman (1996) put it “facilities which reduce risk seem to be relatively highly valued, and risk reduction for a given journey time would appear to be more important to cyclists than reducing journey time”⁷⁹.

77. including variations in safety and effort attributes

78. Note that – to be specific – θ is not the ratio of the user benefits to the total health benefits in a TAG/AMAT appraisal. It is the ratio of the user's perception of their own future health benefits to their own internal health outcome benefits (as in equation (14)).

79. A reviewer challenged whether it is acceptable for the ambience value per minute to exceed the value of travel time (VTT). We agree that there is an issue here, and that for most trip purposes – i.e. utility trips – there are reasons for thinking this should not occur. It seems illogical for a person to be WTP more to improve the safety of a minute's travel than to eliminate that minute's travel entirely. Note that the cycle facility values in Table 7 (from TAG Data Book) are not split by journey purpose – this means that when VTT by purpose is compared with the value of cycle facilities (not by purpose), the ratio can exceed 100%. The authors of the original research, Hopkinson and Wardman (1996), recognised that splitting the values by trip purpose would be a useful thing to do in future (p248), and this may resolve the immediate issue with the numbers in Table 7.

Two caveats are worth mentioning. Firstly, for the fourth trip purpose (exercise/pleasure trips), what is the value of reducing trip duration for such trips? Potentially it should be assumed to be zero, assuming that individuals have optimised their time use – the trip utility per minute is positive across the trip right up to the last minute, at which point the marginal utility must fall to zero. For example, consider a jogger: if the local authority makes their route shorter they will presumably adjust their route to restore the original length (all else equal). A further caveat is that if people are gaining some positive utility from exercise – even during a utility trip – that adds another (opposite sign) component into their value of time saving (see e.g. equation (9) and replace the n subscript with a time subscript). We think that rather than discussing these matters further here, what is needed is to estimate equations like those in §3.1 on travel behaviour data and learn empirically about these factors – differentiating carefully by trip purpose and population segments.

Table 7: TAG values of journey ambience benefit of cycle facilities relative to no facilities (2023 prices & 2023 values).⁸⁰

Scheme type	Value p/min	Source	% of commute VTT, £/hour	% of other non-VTT, £/hour
Off-road segregated cycle track	16.28	Hopkinson & Wardman (1996)	63%	138%
On-road segregated cycle lane	5.71	Hopkinson & Wardman (1996)	22%	48%
On-road non-segregated cycle lane	5.22	Wardman et al. (1997)a	20%	44%
Wider lane	3.47	Hopkinson & Wardman (1996)	13%	29%
Shared bus lane	1.28	Hopkinson & Wardman (1996)	5%	11%

Scheme type	Pence	Source	% of commute VTT, £/hour	% of other non-VTT, £/hour
Secure cycle parking facilities	168.49	Wardman et al. (1997)	11%	24%
Changing and shower facilities	36.69	Wardman et al. (1997)a	2%	5%

Secondly, when accidents and casualties actually happen (*safety outcomes*), those affected experience large negative utility impacts. TAG already recognises and values these (TAG Data Book Tables A4.1.1 and A4.1.2)⁸¹. Table 8 shows the average value of preventing one casualty, across all casualties and by severity class (fatal, serious or slight). Table 9 shows the average value of preventing one casualty, for users of each mode, including pedestrians and pedal cyclists.

Table 8: TAG average value of prevention per casualty by severity and element of cost (£, 2023 prices & values).

Casualty type	Net output	Willingness to pay*	medical & ambulance	Total
Fatal	167,396	2,474,341	1,437	2,643,174
Serious	32,246	242,221	19,534	294,001
Slight	3,409	17,731	1,446	22,586
Average, all casualties	10,172	83,891	4,511	98,575

80. These values would benefit from being updated, and it could be useful to explore how the value of safer infrastructure interacts with some other attributes. For example, the value of an off-road segregated cycle track may differ depending on whether it is routed through green space; or alongside a railway line (as in Hopkinson and Wardman, 1996); or alongside the same road as the “on-road segregated cycle lane” – if so with what separation.

81. In appraisals, they are often forecast over the appraisal period, e.g. using COBALT software. In active mode appraisals, the external safety impacts on other modes are captured in the Marginal External Costs as part of AMAT. “Note that AMAT does not currently estimate changes in accidents from changes in numbers of cyclists or walkers or changes in infrastructure type e.g. introduction of segregated cycle lanes” (DfT, 2022, AMAT User Guide, p21).

Table 9: TAG average value of prevention per road casualty by class of road user (£, 2023 prices & values).

Road user class	Average value
Pedestrian	151,648
Pedal cyclist	97,505
Bus and coach occupants	68,302
Goods vehicle occupants	93,325
Car and taxi occupants	74,566
Motorised two-wheeler rider and passengers	164,988
All motor vehicle users	88,193
Average, all road users	98,541

3.3.1 Components of safety benefits

In the theoretical framework, there are potentially four components of safety benefits that are relevant for the appraisal of ATE investments and other active travel interventions. These are shown in rows (i) to (iv) of Table 10.

Table 10: Safety benefits of an active travel intervention, in appraisal, from changes in trip utility and safety outcomes.

Trip utility changes	Internal	External
1. Own trip utility related to safety, for route r in equation (7), S_r or S_n for route section n in equation (9)	Yes	-
2. External impact on others' trip utility related to safety, S_l	-	assumed = 0

Safety outcomes	Internal	External
3. Own disutility from safety outcomes, $\sum_{y=0y}^Y S_{h,y} \cdot \delta_{social}^y$	Yes	-
4. External impacts of safety outcomes $\sum_{y=0y}^Y S_{l,y} \cdot \delta_{social}^y$	-	• From own injuries; • Family & loved-one spillovers; • Medical costs (NHS); • Net output*; • Insurance administration**; • Property damage to others***; • Police costs. • From injuries to others: • ALL costs, including Human costs and Lost consumption to the individuals involved.

Notes: oy is the opening year of the scheme; Y is the last year of the appraisal period; $S_{h,y}$ are individual h's own safety outcomes over years y; δ_{social}^y is the social discount rate in year y; ; $S_{l,y}$ are other individuals' outcomes resulting from injuries to them, or external effects of h's injuries; *Net output is the part of lost output which is experienced by employers/wider economy rather than individuals (who experience Lost consumption); **Insurance administration costs may be felt primarily by motor vehicle users who are insured; ***this is the part of Property damage costs which is felt by others.

For active travel trips, it can be assumed that (ii) is approximately zero and drops out. In other words, pedestrians and cyclists generally cause negligible increase in the risk of death and injury to people using motorised vehicles, and hence to the perceived safety of others. The cause tends to run the other way^{82, 83}.

So we are left with 3 components. (i) is the own trip utility impact of a safer journey by walking or cycling. We expect this to be a large item, e.g. in the recent National Travel Attitudes Survey (NTAS, Wave 9):

- “seven out of 10 people say they never ride a bicycle”
- “safer roads were the most popular factor that would encourage people to cycle more, chosen by 61% of all respondents”, and
- “safety concerns were cited as the main reason people are discouraged from cycling (48% of respondents)” (DfT, 2024).

A deeper question is: does the own trip utility impact go beyond mere reflection of the injury risk? The literature suggests that it may well do so. People appear to experience stress and anxiety at the prospect of cycling in urban areas in England. Cycling in these conditions requires great effort of concentration. Helmets are an example of defensive expenditures, which offer useful though limited protection in collisions. A study whose fieldwork took place between 2008-11⁸⁴, summarised the situation as follows – perceived conditions have almost certainly improved with investment since then, although the NTAS results indicate some way to go (DfT, 2024):

“The overwhelming message that emerges from our study of everyday travel in four English towns is that, with the exception of a small minority of committed cyclists, most people are deterred from cycling regularly on urban roads because of fear of traffic and their perception of the risk of serious injury”⁸⁵.

A useful analogy here is the treatment of the social costs of crime and antisocial behaviour in the UK (Heeks et al., 2018). That is another context where:

- it is not only the cost of crimes when they do occur that are relevant, but also the costs in anticipation of crime, including defensive expenditures on greater security which are embodied in many aspects of the economy and people's household behaviour;

82. more than 95% of pedal cycle casualties in Great Britain are from collisions involving motor vehicles (DfT, 2025 *Reported road casualties in Great Britain: pedal cycle factsheet*, 2024, Table 3).

One possible caveat here is the psychological and potentially physical symptoms experienced by drivers who have been involved in collisions (Lucas, 2003; Marasini et al., 2022). We note this without making any assumptions about responsibility for the collisions that occur.

83. Another issue here is whether e-bikes impose a greater collision risk on pedestrians than has been the case with unpowered cycles.

84. Pooley et al. (2011)

85. Pooley et al. (2013)

- there is an insurance system to spread some of the cost risks of theft, damage and injury, however the claims and payouts are not included (these are in effect transfers), while the costs of insurance administration and theft, damage and injury costs *are* all included.

For active modes of travel, some of the defensive expenditure may be in the form of concentration and effort to avoid having a collision, and that would appear in trip utility⁸⁶.

Turning to the methods by which (i) and (iii) are valued in TAG, a key issue is that both make use of individuals' willingness-to-pay (WTP) for safety improvements. This is included in some of the journey ambience values, e.g. the cycling facilities values in TAG Data Book Table A4.1.6 (Table 7 above). WTP is also the basis for a large proportion of the values for safety outcomes - see the WTP column in Table 8 above. This presents a very serious risk of double-counting between (i) and (iii).

As with health benefits in the previous section (§3.2), humans are poor at perceiving accurately the utility impact of effects which are: unpredictable; relatively rare⁸⁷; and may occur many years into the future⁸⁸. However, in the case of safety impacts, the threat of safety risks and the consequences of that outlined above (stress and anxiety, effort of concentration, and defensive expenditures) occur in the *present*. To this extent, the arguments about perception of future health impacts and the low value of θ do not apply here.

Turning to safety outcomes in Table 10, we do not separate (iii) and (iv) in appraisal in the UK. The TAG values for casualties and accidents include both the impact on the individual and the rest of society, hence (iii)+(iv) are all included together⁸⁹. In the EU there have been efforts to identify internal/external shares of each of the different costs (human costs, medical costs, administrative costs, production losses, material damage and other costs), and there are different approaches to how to do this. Some studies and guidelines focus more on allocating responsibility, with allocation of costs following on the basis of responsibility (CE Delft, 2011) while others focus more on the analysis of average and marginal costs, and how an additional vehicle on the road changes the accident risk to other road users (the 'risk elasticity', which may be estimated) (Lindberg, 2001; Ricardo-AEA, 2014, p19).

While these internal/external questions make no difference to the total social welfare impact of safety outcomes, they may have implications for the extent to which individuals are capable of taking into account all relevant social costs when making their own decisions and assessing their own trip utility. When assessing the treatment of safety benefits in TAG and AMAT in future, we need to bear in mind that while a large part of the costs are internal to the individual and therefore appear in both (i) and (iii) (raising the double-counting issue), other costs (a smaller part) occur to other road users and third parties (see Table 10, final column).

In summary, in a context like the present one, where we are considering including both trip utility changes due to safety improvements, and the longer-term changes in safety outcomes, there is a degree of judgement involved in whether these double-count each other.

86. Longer walk and cycle routes may also be taken in order to avoid riskier parts of the network (in the 'without project' scenario). Those might be captured by route choice changes if the active travel forecasting model is sophisticated enough.

87. DfT (2025) *Reported road casualties in Great Britain: pedal cycle factsheet, 2024* - suggests that the average number of miles cycled per fatal or serious injury is 903,342.

88. this is relevant because: the decision where to live, whether to purchase a bicycle, or a car, are not short-term decisions affecting only one trip – but decisions usually made with a multi-year planning horizon; the objective accident risks flowing from these decisions could lead to health changes over the individual's remaining lifetime.

89. Most countries, in their appraisal methods, take a similar view to TAG – that accident costs can in effect be treated like an externality.

However, in our view the over-riding consideration is the strong risk of double-counting between WTP for safety improvements through journey ambience values and WTP for own safety outcome benefits through the TAG safety values. This issue only arises if the journey ambience values do relate to, and capture the value of, a safety improvement.

In order to test the plausibility of our approach, we worked through an example of a safety improvement and compared the perceived safety benefit and the safety outcome benefits (measured using TAG values). The comparison was made between:

- journey ambience benefits from improved cycle facilities, measured using the TAG values for cycling (Table A4.1.6), specifically the value for cycling on an off-road segregated cycle track, versus "no facilities", i.e. cycling in mixed traffic on an average road;
- the implied own safety valuation using the TAG safety values, WTP component, for a plausible casualty rate reduction based on published and official data.

Our conclusion was that the journey ambience WTP appears to be 2-4 times larger than the individual safety benefit (if the latter was measured using objective casualty rates and TAG safety values). I.e. (i) > (iii). This reinforces the conclusions of this section, that including both WTP-based measures of safety benefits would create a serious risk double-counting the safety benefits of an active mode scheme, if safety-based journey ambience values are used.

In order to gain a more accurate understanding of the values and various relationships involved – particularly the internal/external nature of the costs, perception of safety risks, treatment of future effects and the extent of anticipation effects/defensive expenditures – further research is needed.

Some of the issues raised are particular to active travel, while some are general to safety analysis across all modes, e.g. the extent to which family & loved-ones spillovers should be taken into account, and the extent to which accident costs are internal/external (e.g. Jones-Lee, 1990, gives a still-relevant discussion of these issues - Sections II and V; and the European research already cited is helpful - including summaries in Ricardo-AEA, 2014 and van Essen et al., 2019).

To recap, a practical approach in appraisal for the time being would be as follows:

- if the project being appraised is an infrastructure improvement specifically to improve safety, and the journey ambience values capture this, then assume own WTP is measured through perceived safety, as part of journey ambience;
- if the project is a pedestrian crossing, or an area-wide cycle training intervention, for example, for which there are no relevant journey ambience values, use the TAG safety values (to calculate (iii) and (iv)) - a power function may be appropriate to capture the increase in safety as the number of walkers or cyclists increases;
- external impacts are still valid (Table A4.1.1) in any case, as these are not internalised in journey ambience.

3.4 Place quality and urban realm benefits

In §2.2.3 above, we set out how double-counting can be avoided between place quality and user benefits. Equations were included, from the source research studies.

To summarise, valuing urban realm improvements is often a concern in modern transport appraisal. The key to avoiding double-counting is to distinguish between:

- benefits which occur while walking or cycling on the transport network;
- benefits which occur while spending time at home;
- benefits which occur while spending time at destinations – including town and city centres, and high streets (for various purposes, e.g. employment, education and training, shopping, meeting for work or socially, eating and drinking, recreation, time spent in parks and open spaces, etc).

The first of these should be treated as part of trip utility, using the types of formulae set out above (equations (6)-(12)). In practice, this will count the benefits for the set of walk and cycle trips that are covered by the model or analytical tool being used (e.g. study area transport model or AMAT). The journey ambience values in TAG are directed towards this, although they arguably miss out some key benefits (see §3.5 below).

The second of these is represented by Q_i in §2.2, and Table 4 gave a list of potential items to be valued, citing studies where they have been valued. It is worth remembering that traffic noise impacts experienced at home⁹⁰ and air quality impacts in general⁹¹ are already included in TAG – both are capable of being quantified and valued, and are included in TAG Unit A3⁹².

It is possible that this captures the majority of the home-based welfare effects related to transport, and that other urban realm changes, such as wider pavements, street trees, crime and antisocial behaviour (where relevant⁹³), severance and perceived safety, are all better treated as part of trip utility (and hence generalised cost, and user benefits).

The third of these is represented by Q_j in §2.2. Place quality at destinations – such as local centres, town centres, city centres and high streets – is a substantial topic, which includes urban realm improvements as part of its scope (see Nellthorp et al., 2025, for further discussion and the results of a literature review). In principle, urban realm improvements in these locations could be valued using

- stated preference (SP) and discrete choice experiments (DCE) – an early example being Atkins and ITS (2011) which found significant values for traffic removal or pedestrian priority in local high streets, and also for improved surfacing (with materials like stone over tarmac), and for outdoor eating and drinking spaces to be available on-street;

90. Noise experienced while walking and cycling around the network is not currently valued (see Jiang and Nellthorp, 2020). This is a concern, since one of the benefits of traffic reduction (both speed and volume) should be a more attractive street environment in terms of noise level – we pick this up in §3.5. Noise will also affect the utility of time spent in public spaces at destinations (in Q_j below).

91. The air quality impact pathway approach (Defra, 2025) focuses on a range of different health, environment and economy impact pathways, but does not isolate the effect of exposure at home versus exposure during active travel versus exposure during any other activity.

92. DfT (2025) *TAG Unit A3*

93. e.g. the appraisal of the Elephant and Castle North Roundabout in London includes benefits from reduced crime and anti-social behaviour where a set of pedestrian underpasses were replaced by a surface level crossings (see Nellthorp, 2016).

- hedonic pricing (HP) methods – this would require the use of residential and also, potentially, commercial property market data, as was attempted by the early CABA (2007) study for London, again focusing on high streets⁹⁴; and the North of England study (Nellthorp et al., 2019), which found substantial values for local facilities and greenspace.

When applying values it will be important to draw a clear line between:

- trip stages that form part of the model or analytical tool being used – valued using the trip utility approach, and ensuring that the journey ambience values used include the relevant attributes⁹⁵;
- any short movements within the destination j that are not picked up by the model, and which will instead need to be picked up in the value of Q_j .⁹⁶

By clearly separating and valuing trip utility (U_r), place quality at the origin (i) and place quality at the destination (j) double-counting can be avoided between the trip utility benefits and the place quality benefits in appraisal.

Finally, note that the trip utility benefits are subject to the rule-of-a-half (or logsum benefit measures⁹⁷). The research on welfare appraisal under land use change has shown that place quality changes (Q_j or Q_i) can be included within the benefits, using an extended rule-of-half measure or using logsums. Details can be found in §2.2.3 above, and further in Nellthorp et al. (2025).

3.5 Journey ambience impacts for walking and cycling

The (dis)comfort – in the most general terms – of time spent travelling is often characterised as journey ambience or journey quality. TAG includes journey ambience values for both walking and cycling: the current cycling values were shown in Table 7 above; and the walking values are shown in Table 11 below.

94. results were not significant at 95% confidence but showed promise, and were qualitatively supported by a range of other evidence (see Nellthorp, 2016 for more discussion). To value Q_j fully, it would be necessary to undertake a wider-ranging valuation study than has yet been attempted, including such features as: parks/parklets; public squares and open spaces; eating and drinking space; and other exchange space (e.g. markets). However, given the focus of this report on active travel, the more immediate and essential elements to measure are those relating to the experience of walking, wheeling or cycling within the local centre/city centre.

95. e.g. urban realm design elements that are part of Manual for Streets (WSP et al., 2007), Inclusive Mobility guidance (DfT, 2021) and other relevant design guidance, including surface materials and levels, widths and space, coherence, continuity, and greening (including street trees).

96. NTEM v7.2 and 8.0 include all trips in the National Travel Survey (NTS), so they potentially include short stages within local centres/high streets down to 50 yards. However, it would still be important to know whether the specific tools being used to forecast active travel in an appraisal actually capture all these stages.

97. see §3.1.2

Table 11: TAG pedestrian environment values (2023 prices and values).

Scheme type	Value p/km	Source
Street lighting	5.8	Heuman (2005)
Kerb level	4.1	Heuman (2005)
Crowding	2.9	Heuman (2005)
Pavement evenness	1.4	Heuman (2005)
Information panels	1.4	Heuman (2005)
Benches	0.9	Heuman (2005)
Directional signage	0.9	Heuman (2005)

In the theoretical framework in this report, we have set out how differences in trip utility from one setting to another can be explained in terms of differences in a combination of variables, including: perceived safety (s); physical effort/exertion (e); and other comfort/experience variables (c). For example, see equation (6). Arguably, some of the more important variables in pedestrian journey quality are not represented in Table 11.

In this section, we attempt to identify the key gaps in the current treatment of pedestrian and cycle journey ambience in TAG, and hence where new empirical estimates are needed. In doing so, we take account of literature to date, we try to take a complete view of journey ambience in order to understand what is missing, and we identify a set of 'other' journey ambience variables – other than safety and effort – that could be important within " (other comfort/experience variables in equation (6)).

3.5.1 Literature

Nellthorp et al. (2020/1) and Nellthorp (2025) provide an assessment of walk and cycle journey ambience factors based on an extensive review of the literature. From that work, we include four tables at the end of this report in Appendix A.

- tables A3&4 list the journey ambience factors for walking and cycling, respectively.
 - the walking table lists the journey ambience factors for
 - walking along links;
 - crossing (roads) – a large amount of evidence demonstrates the importance of crossing movements in determining perceptions of the pedestrian journey.
 - the cycling table lists the journey ambience factors for
 - cycling along links;
 - crossing (roads) / turning.
- tables A1&2 are from a valuation perspective, and they summarise what we know about the structure of journey ambience from valuation studies, and from studies using other related metrics such as 'level of service' (LoS) studies where these are evidence-based and relevant.
 - these tables list the journey ambience factors, grouped into
 - safety and security;
 - comfort – e.g. pavement condition, surface, clutter, crowding and continuity/turns/directness⁹⁸;

⁹⁸. this last variable was not highlighted in Tables A1-A4, but its importance is made clear in LTN1/20 (DfT, 2020)

- environment – e.g. air pollution, noise and greening;
 - information – e.g. signage;
 - health – the perceived payoff from physical activity (we have expanded on this in the 'Health benefits' section above, §3.2).
- some variables are on the borderline between travel time (t) and journey ambience, including delays at crossings and junctions, and stopping for cyclists. We discuss these issues further in the following sections.

3.5.2 Stopping/starting – a key factor for cycling

Börjesson and Eliasson (2012) found using an SP experiment in Stockholm that cyclists value time waiting at stops (e.g. at traffic signals/junctions) 2.0 times as highly as cycle journey time in general. This is not currently part of the calculation for cycle time savings in TAG. Appraisal methods for other modes (public transport) do allow for a wait time or interchange time multiplier, so there would be some consistency in allowing this for AT.

Börjesson and Eliasson (2012) also found that cyclists value reduced frequency of stops – over and above the time taken (i.e. over and above the multiplier of 2.0 on wait time when stopped). The value of stopping/starting in its own right is found to be the equivalent of 1.1 cycling minutes per stop. This is probably associated with the braking and accelerating effort/inconvenience of stopping. It may be one very convenient way of incorporating effort (e) into journey ambience for cycling, in cases where there is no quantitative data on effort available.

Alongside this, it could be worthwhile investigating the specific effect of hilliness on effort and hence on valuation of journey options. The policy applications of this would be to planning and appraisal of cycle routes and cycle networks in hilly areas where alternative routes with/without steep gradients (possibly longer) are often available⁹⁹.

3.5.3 Crossing movements – a key factor for walking

The findings of the review show that safe and quick crossings of roads in the urban environment are key to high trip utility (Nellthorp et al., 2020/1; Nellthorp, 2025). Values for crossing facilities are already included in the Transport for London 'ABC' tool and the Transport for Greater Manchester 'PEAT' tool, based on SP research, although they are not included in TAG. It would be advisable to undertake new SP research both in order to bring the values in ABC & PEAT up to date (they are believed to be greater than 10 years old) and to produce empirical estimates which fit together consistently across all journey ambience elements, and journey time.

3.5.4 Exposure to traffic – a key factor for walking and cycling

A common factor across walking and cycling is exposure to traffic. This is not only an issue for cycling safety – addressed by, for example, building segregated cycling facilities – but also for walking, where proximity to traffic, traffic speeds, traffic volumes, and traffic mix (%large vehicles) are significant factors in trip utility (Nellthorp et al., 2020/1). Substantial values emerge from rough calculations for the value of traffic reduction on urban streets.

and other academic sources (e.g. Cervero et al., 2019 for urban areas in Great Britain).

99. Also, if appraising a proposed AT facility that was unattractive due to hilliness, that might be picked-up at the modelling/appraisal stage if hilliness was included. Obviously this is much more of an issue in towns and cities with hilly terrain, than in flat ones.

3.5.5 Evidence gaps

The following table is taken from Nellthorp (2025), and it highlights some of the gaps in current TAG valuation evidence.

Table 12: 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

Source: Nellthorp (2025), Table 13.

3.5.6 Next steps

Reflecting on the findings here relating to journey ambience, there is clearly scope for empirical research to fill in the identified gaps, and to update the (richer) evidence contained in TfL's ABC and TfGM's PEAT tool.

One additional observation from the above, is that in practice the TAG values of cycling facilities (Table 7 above) have turned out to be very useful, and widely applied, partly because they reflect a set of common, practical scheme types. One way forward would be:

- to develop a similar table of values for walking which reflects common improvements – including crossing facilities;
- for both tables, give rather more differentiation between scheme types and conditions – e.g. recognise the value of width standards, greening/greenspace exposure, and the role of reducing traffic exposure (flow/speed) particularly for walking;
- address the value of stopping/starting for cyclists;
- ensure that the value set is capable of being applied to the full range of scheme types and interventions, including such measures as advanced stop lines, protected turning facilities, side road treatments, and management of on-street parking and loading.

4. Conclusions and implications

In this final section we will summarise the main conclusions (in §4.1) and will discuss the implications, both for the empirical research that is needed (in §4.2) and for appraisal (in §4.3).

The theoretical framework, including some key formulae, has been set out in Sections 2&3 – this final section is more concerned with the implications for empirical estimation of key parameters and values which would be needed to implement these formulae in practice. We will consider the contexts in which the framework and values would be applied, and any particular opportunities and challenges that we can identify for the future.

A question that we have discussed repeatedly in reaching these conclusions is:

- what balance of detail versus simplicity should be taken forward, across the various benefit categories and elements?

In other words, what is proportionate, in the economic analysis of active travel interventions.

4.1 Theoretical framework and double-counting

The first conclusion is that it is possible to construct a consistent theoretical framework in economics for the benefits of active travel. This was set out in Sections 2&3. In the process, we have included all the components of value in TAG and AMAT plus morbidity benefits and place quality¹⁰⁰, and have looked hard at the linkages between components, some of which are potential sources of double-counting. Our theoretical model differs from that in Flügel et al. (2021): (i) by including lifetime utility, whereas Flügel et al. assumed optimisation within one representative day (based on earlier model by Jara-Díaz and Guevara, 2003); and (ii) by unpacking the value of physical effort, $v_e \bullet e_n$, into three components: one for the short-term positive effects of exercise; one for future health impacts; and one for the negative effects of effort.

Having done this work, it is possible to draw a set of conclusions about double-counting of specific benefits in TAG. These conclusions and the associated recommendations are set out in Table 13. These are working recommendations which should be subject to review as more evidence becomes available. For health impacts, a crucial variable is θ , which represents the extent to which individuals take account of their future health benefits in their WTP for time savings or journey ambience.

100. We have also considered whether the scope of TAG & AMAT needs to be expanded in any way to address all the key impacts, and have suggested some relatively minor increases in scope: i.e. to specifically include the effects of junctions and crossings (on perceived safety, journey times, and effort); and to recognise the effects of on-street noise and air quality.

Table 13: Conclusions and recommendations relating to potential double-counting.

Impact type	Conclusions and recommendations
Health impacts	Conclusion: assume that θ is generally very small Recommendation 1: For now, continue with TAG practice, in line with other European countries. Undertake the appraisal assuming θ is close to zero. Assume that journey ambience does not double-count with health benefits. Recommendation 2: For future research, investigate further: • econometric research, using discrete choice experiments as the main data source, focusing on either (i) estimation of the values and parameters in equation (14) as part of trip utility; or (ii) estimation of the value of physical exercise/effort under specific infrastructure conditions and for specific trip types where physical effort is elevated • the value of θ building up from the theoretical arguments (time preference, risk/uncertainty, information asymmetry), potentially using a combination of evidence review and new experiments.
Safety impacts	Conclusion: users are generally very sensitive to perceived safety, and this is a deterrent to active travel¹⁰¹. When the WTP for safety improvements is included in journey ambience values and the WTP for safety is included in the safety benefits, there is a serious risk of double-counting. Recommendation 3: For now, continue to value Safety benefits from mode shift through Marginal External Costs (MECs, already part of AMAT). Recommendation 4: For now, capture internal safety benefits to AT users through perceived safety values where available – e.g. journey ambience values for safer infrastructure in TAG (e.g. Data Book Table A4.1.6 and future developments of those values). • the external components of safety benefits may still be counted, even for users' own safety outcomes (i.e. the NHS medical and healthcare costs, net lost output, police costs, etc), but the WTP should not be. Recommendation 5: Where there is no perceived safety value available (e.g. for pedestrian crossings, or advanced stop lines) an interim approach would be to use the TAG safety benefits method (TAG Unit A4.1). Recommendation 6: For future research, investigate and quantify the perceived safety benefits of wider range of safety measures, including: pedestrian crossings; advanced stop lines; and the range of safety conditions described in the ATE Critical Safety Issues (2025).

¹⁰¹. E.g. the NTAS results (2024) and ATE Critical Safety Issues (2025) – see §3.3.1.

Impact type	Conclusions and recommendations
Urban realm and place quality impacts	Conclusion: double-counting can be avoided by following the ‘Welfare appraisal under land use change’ recommendations and equations. Recommendation 7: For each trip stage, be clear if it is included within the transport model, in which case urban realm/place quality effects are counted within trip utility (i.e. journey ambience values); if it is not included, treat and value as place quality effects, at the destination j or the origin i (e.g. in the local High Street or at home). Recommendation 8: For valuation of urban realm attributes while travelling, we recommend the use of stated preference (SP) and discrete choice experiments (DCE) to elicit values for important journey ambience attributes - see Table 14 below. Recommendation 9: For valuation of place quality attributes at the destination or origin, we recognise that both revealed preference (RP - primarily hedonic pricing) and stated preference methods are potentially useful to derive values. If the value is on a ‘per annum’ basis, this will be ideal for effects at residential home locations, and for visits to destinations such as local or city centres a ‘per trip’ or ‘per hour’ value will be ideal (interpolation may be required depending on the research method). Recommendation 10: Specifically for air quality and noise, explore the most appropriate methodology for quantifying and valuing air pollution and noise exposure improvements while walking, wheeling and cycling. The current valuation methods have limitations: the noise values are based on exposure at home locations only, not during travel; while the air quality ‘impact pathway’ values do not focus on exposure during different activities (travel or others).

If these conclusions and recommendations are followed, there is no reason for concern around double-counting in active mode appraisals. Further research should help to clarify where the assumptions made can be refined¹⁰².

4.2 Implications for estimation of values

Through empirical testing of the equations and functional forms above, and potentially other functional forms, it should be possible to identify the most suitable functional forms, test the significance of key variables and measure the magnitude of the values and parameters.

4.2.1 Values of time and journey ambience

Values of journey ambience are important because they capture the trip utility variables identified in this report, i.e. perceived safety, effort/exercise-related utility, and other comfort/quality/environment factors that feed into user benefits.

Functional forms for this were discussed in §3.1.3 and equations (6)-(10).

There is a choice to be made in designing the empirical research: will the variables above be represented directly (e.g. a safety measure, an effort/exercise measure and various comfort/quality/environment); or will they be bundled into a set of practical alternatives – e.g. infrastructure types? We think the latter is likely to be the more efficient research strategy. This is also more in line with the valuation approach taken in the Netherlands, within their ‘value of time, reliability and comfort’ study (Kouwenhoven et al., 2023).

102. If in future it was established using a suitable statistical test that θ is significantly greater than zero (perhaps for a particular population segment or a particular context), then the procedure to avoid double counting would

be: to measure the perceived internal future health benefit to the individual, $\theta \sum_{\tau=y}^T (\Delta h_{h,\tau} \bullet \delta_{\text{social}}^{\tau})$, noting that this excludes any external components of health benefits in TAG/AMAT; to deduct this from the total benefits of the scheme – it does not matter whether we think of this as a deduction from the user benefits or from the health benefits, the point would be to avoid double-counting it through both categories.

We recommend that the empirical strategy for the future includes testing the value of different levels of the following variables – focusing on the levels that are most relevant in practice to represent the ‘with project’ and ‘without project’ scenarios in appraisal (Table 14). Not shown in the Table are values of time (VTT), which should include values of delay time for active modes (at junctions and crossings). The variables in the table could be represented by multipliers on VTT (as in the Dutch CBA method – see Appendix B).

Table 14: Valuation of journey ambience – relevant variables.

In-trip factors on Links	In-trip factors at Junctions and Crossings
Traffic free – walk/wheel/cycle-only facilities	Traffic free – walk/wheel/cycle-only facilities
Segregation – e.g. form of segregation; distance from the nearside traffic lane	Segregation – e.g. form of segregation; distance from the nearside traffic lane
Traffic speeds and flows – e.g. 40/30/20mph; >/<2500vpd	Traffic speeds and flows – e.g. 40/30/20mph; >/<2500vpd
-	Crossings and junctions – facilities, e.g., side streets treatment; advanced stop lines; amount of stopping (cycles, pedestrians)
Parking – parked cars; roadside activities	-
Width (footway/cycleway)	Width (footway/cycleway)
Other in-trip factors, including: • greenspace – e.g. street trees, or going through parks¹⁰³ • lighting • surfacing • clutter - a key issue for pedestrians • information • seating/benches – e.g. for resting	Other in-trip factors, including: • greenspace – e.g. street trees, or going through parks¹⁰⁴ • lighting • surfacing • clutter - a key issue for pedestrians • information • seating/benches – e.g. for resting
Trip-end factors: e.g. shower availability, parking for cycles	Trip-end factors: e.g. shower availability, parking for cycles

This is based on reviews of journey ambience carried out over the last 5 years, which include the DfT guidance on cycle design (LTN1/20) and Manual for Streets among the source material, as well as a wide range of other sources (Appendix A).

- TAG Data Book already offers a set of values in this sort of format for *cycling* – but these could be more refined, and updated, e.g.:
- nothing on different traffic speeds and flows, whereas the Dutch appraisal values differentiate by traffic speeds (Appendix B);
- nothing on footway / cycle lane width – whereas the Dutch values do for walk (not cycle);
- nothing on surfacing;
- nothing on crossings, junctions, stopping – so e.g. no values for ASLs and protected right turn facilities – no values for replacing roundabouts with signalised junctions.

¹⁰³. this has a benefit in daytime but potentially a disbenefit at night-time

¹⁰⁴. this has a benefit in daytime but potentially a disbenefit at night-time

TAG Data Book already offers a value set for *walking*, which could be replaced by values in a consistent format with cycling, tailored to the specific issues faced by pedestrians and unpowered wheelchair users, e.g.:

- incorporating suitable levels of the variables shown in Table 14 - particularly levels that relate to design standards; and
- incorporating values relating to crossings and junctions which are currently absent.

ATE and DfT could consider to what extent they wish to differentiate the values in relation to other journey ambience factors. E.g. the Dutch appraisal values, which are included in Appendix B, do not include different values for walking or cycling through parks & greenspace, but do differentiate by surfacing type – for cycle only¹⁰⁵.

4.2.2 Other parameters and values relevant to active mode benefits

In addition to the above, ATE and DfT could consider empirical research on:

- the safety in numbers effect – particularly for pedestrians, also for cyclists – see §2.2.1;
- place quality values – see §2.2.3 and §3.4 for suggested variables and valuation methods.

4.2.3 Population segments and disaggregations

As noted throughout this document, segmentation of the sample will be key in all empirical research, in order to inform appropriate segmentation of the values, including, e.g. (where appropriate): trip purpose; mode; age category; sex/gender; household car ownership; past-week walking and cycling; local authority; distance. We would not expect all of these disaggregations to flow through into the appraisal values – for the same reasons that other appraisal values in TAG strike a balance between simplicity and detailed reflection of contextual differences.

The cycle mode should be disaggregated to show e-bikes and unpowered cycles separately, since the effort and safety characteristics may differ.

4.3 Implications for appraisal

4.3.1 Questions for ATE and DfT to consider

Questions to consider include:

- should more attention be given to the values and parameters relating to perceived safety, in order to capture the safety benefits of a wider range of infrastructure and other measures in future (e.g. see the ATE Critical Safety Issues, ATE, 2025)?
- should more attention be given to the values and parameters relating to effort and exercise, and perception, in order to better understand total health benefits and avoid double-counting in future?
- should more attention be given to crossings, junctions and stopping/starting in order to fill known gaps in valuation?
- should – as we have suggested – walking values be subject to an approach more aligned with the current cycling values (in TAG)?

¹⁰⁵. “Paving stones”, i.e. cobbles, “Sidewalk tiles”, “Concrete slabs”, “Asphalt”

4.3.2 Relationship with ATE Infrastructure scheme types

The following table may help to consider which types of intervention will bring which categories of trip utility benefit. This is purely indicative, and relates ATE's Infrastructure scheme taxonomy, which was shown earlier in Table 3, to the main components of the trip utility function in equations (6) onwards.

Some observations based on Table 15 are:

- one of the 11 scheme categories brings in the trip end utilities (for secure parking);
- the other 10 relate in the in-trip utilities, and between them offer potential improvements in all four of the main attributes: journey time; safety; effort; and other comfort/ambience attributes including increased exposure to greenspace/greening and reduced exposure to noise and air pollution;
 - all 10 of these contribute to improved safety for active mode users;
 - the pattern of journey time / safety / effort / other benefits varies across the 10 categories;
- the table highlights some trade-offs, e.g. new cycleways, footways and shared use facilities might reduce or sometimes increase journey times, however improvements in safety, effort and other benefits may outweigh time losses;
- similarly, some new facilities may increase trip distance and hence (potentially) total effort, yet there might be offsetting benefits from the other three categories (and potentially from reduced effort associated with stopping/re-starting for cyclists).

Table 15: ATE Infrastructure Scheme Taxonomy vs user benefit variables in the framework (indicative).

Scheme categorisation	Time saving (↓opportunity cost)	(↓Disutility (safety risk))	(↓Disutility (effort))	(↓Disutility (other))		Trip end benefits
New segregated cycling facility*	+/-	+	.	+	e.g. ↑green, ↓noise exposure	
New junction treatment**	+/-	+	.	.		
New permanent footway	+	+	+	+	e.g. ↑green, ↓noise exposure	
New shared use (walking & cycling) facilities	+/-	+	+/-	+	e.g. ↑green, ↓noise exposure	
Improvements to make an existing walking/ cycle route safer (includes essential maintenance schemes)	.	+	.	.		

Scheme categorisation	Time saving (↓opportunity cost)	(↓Disutility (safety risk)	(↓Disutility (effort)	(↓Disutility (other)		Trip end benefits
Area-wide traffic management (including by TROs (both permanent and experimental))	.	+	.	+		
Bus priority measures that also enable active travel (e.g. bus gates)	.	+	.	+		
Provision of secure cycle parking facilities						+
New road crossings	+	+	+	+?		
Restriction or reduction of car parking availability (e.g. controlled parking zones), usually only as a component of other schemes	.	+	.	+		
School Streets	.	+	.	+		

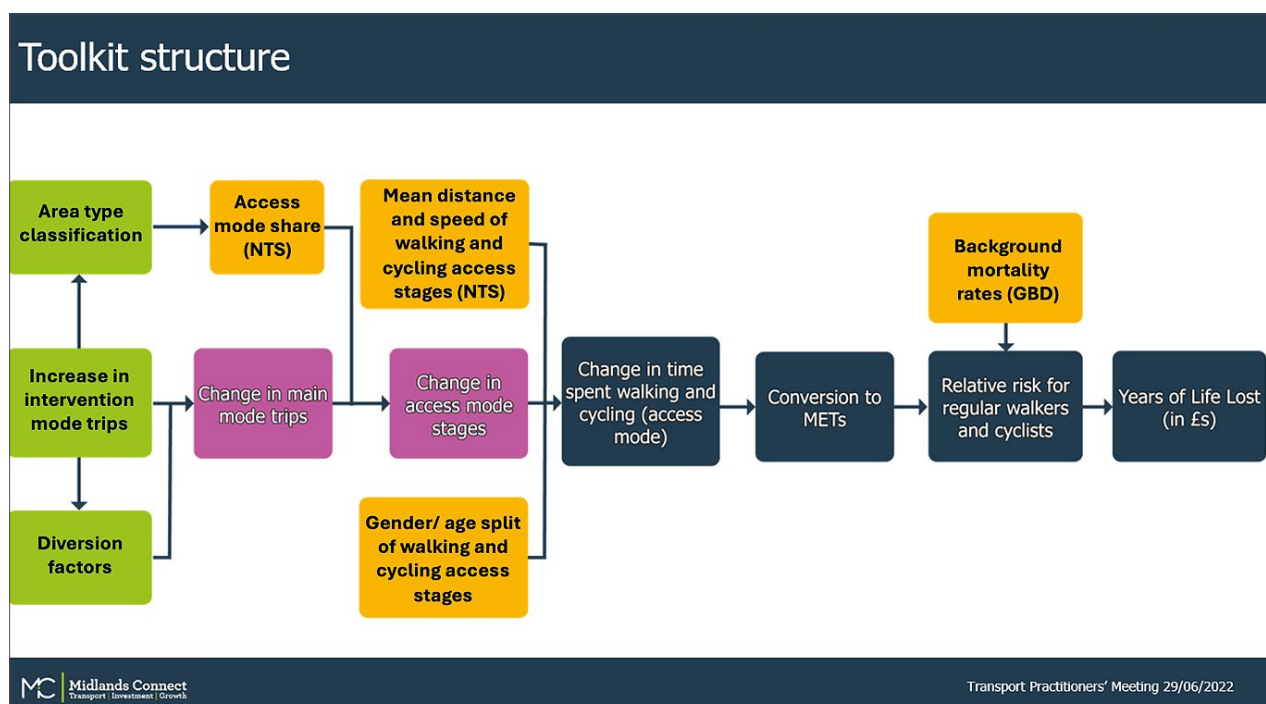
Note: + indicates a potential utility increase, - indicates a potential utility decrease, . indicates potentially no significant effect, ? indicates uncertain.

4.3.3 Multi-stage trips involving active modes

The latest NTS data on multiple-stage trips (from 2023 & 2024 in table NTSQ09073) is much richer than the previous 2014 data, and sheds light on the important role of active modes as an access and egress mode, e.g. 43% of rail trips were accessed/egressed by active modes only in 2024. The benefits associated with increasing use of rail and public transport have been analysed by, for example, Katie Lewis (2024), combining standard AMAT assumptions with some customised analysis of station catchments and access mode shares. Her work shows that even counting access and egress benefits for the walking mode only, this raises the PVB and the BCR for the TransPennine Route Upgrade by over 9%. A previous business case for the MetroWest Phase 2 scheme in Bristol, using more basic assumptions about the walk catchments, showed a figure of 6% (Jacobs, 2019).

Work by Martin Wedderburn for Midlands Connect has shown how AMAT can be applied to data on the active mode stage of PT trips at an area level, enabling appraisals of rail and bus scheme proposals. The following diagram from Wedderburn (2022) summarises the method. The work is embedded in a Midlands Connect Public Transport Physical Activity Appraisal Toolkit. This seems a natural and very valuable extension of the AMAT methodology.

Figure 5: Midlands Connect Public Transport Physical Activity toolkit method.



4.3.4 Implementation of the framework and the trip utility functions in planning and appraisal

In practice, there are different ways in which this theoretical framework could be deployed. Firstly, like the 'SLOTH' framework by Cawley (2004), it could be used largely as a conceptual model around which to shape the analysis of active mode benefits. For this purpose, the important components are the scope, the concepts and measures, and the relationships between the variables within the analysis. We have focused on setting these out as clearly as we can, highlighting where double-counting may arise.

Secondly, our main focus here is appraisal, so we have given more detail where we could on how the different benefits in the TAG framework relate to each other – through a theoretical lens – and trying to formalise matters as much as possible, including indications of the size of parameters and values where they are available and important. This means bringing out more clearly the links between trip utility and future health benefits, for example, and the role of internal versus external cost items in the appraisal. In this aspect of the work we have made a case for where double-counting is likely, and how to avoid it.

Finally, the structure of trip utility is a key component of this work, and empirical research is planned, so we have tried to bring together the best evidence we can on which variables are significant within trip utility, and how they come together in generalised cost and user benefits. We have given some similar attention to the components of place quality – more empirical research is needed in that field too. These should assist ATE and DfT to move towards a more robust calculation of total benefits and Net Present Value for active mode interventions in future.

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Appendix A – Journey Ambience review evidence

The following content is taken from Nellthorp (2025) and is believed to be up-to-date for present purposes.

Tables A1 and A2 summarise the evidence base on valuation of journey quality/journey ambience factors. The first and second columns describe the components of journey quality for these modes, based on the literature review by Nellthorp et al. (2020/1). 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 A1: *Cycling journey quality factors – valuation evidence.*

General	Cycle Journey Quality Factors	TAG	International Evidence
Speed of progress through network	Frequency of stops	-	Börjesson and Eliasson (2012a).
Safety & Security: danger from traffic	Traffic volume	-	LOS metrics.
	Traffic speed	-	Wardman et al. (2007). LOS metrics.
	Proximity of cyclists to traffic	-	Wardman et al. (2007). LOS metrics.
	Proximity of cyclists to traffic	‘Wider lane’	Wardman et al. (2007). LOS metrics.
	Interaction with on-street parking	-	LOS metrics.
Safety & Security: cycle infrastructure	Traffic-free cycleways	✓	Börjesson and Eliasson (2012a). Wardman et al. (2007). TfL (2019) Ambience Benefit Calculator Hopkinson & Wardman (1996). LOS metrics.
	Advanced stop lines	-	TfL (2019) Ambience Benefit Calculator LOS metrics.
	Right turn facilities	-	LOS metrics.
	Routes to avoid roundabouts	-	TfL (2019) Ambience Benefit Calculator LOS metrics.
	Secure cycle parking	✓	Börjesson and Eliasson (2012a). Wardman et al. (2007). TfL (2019) Ambience Benefit Calculator. LOS metrics.
Comfort	Width of cycle lane for 2 or more cyclists/for 1	-	TfL (2019) Ambience Benefit Calculator LOS metrics.
	Congestion (cycle flow vs capacity)	-	TfL (2019) Ambience Benefit Calculator LOS metrics.
	Effort (exertion)	-	TfL (2019) Ambience Benefit Calculator
	Surface quality	-	TfL (2019) Ambience Benefit Calculator LOS metrics.
Environment	Air pollution and noise exposure – traffic related	-	-
	Other environment factors including urban greening, character, visual amenity and soundscape	-	TfL (2019) Ambience Benefit Calculator ‘aatractiveness’
Information	Signage (a limited effect)	-	TfL (2019) Ambience Benefit Calculator
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: LOS metrics based on the US BLOS (National Research Council, 2016), Denmark (Jensen (2017), and the BCI (Harkey et al., 1998).

Table A2: Walking journey quality factors – valuation evidence.

General	Walk Journey Quality Factor – Crossing Roads	HE/TAG	TfL (2019)	PLOS UK	PLOS DK
Speed	Crossing times	HE Severance toolkit	✓	✓	✓
Safety & Security: danger from traffic	Traffic volume	HE Severance toolkit	~	✓	✓
	Traffic speed	HE Severance toolkit	✓	✓	✓
	% HGVs	HE Severance toolkit	-	-	-
Safety & Security: pedestrian infrastructure	Pedestrian-controlled signalised crossings (e.g. Pelican)	HE Severance toolkit	✓	✓	✓
	Zebra-type crossings	HE Severance toolkit	-	-	✓
	Other crossing facilities	HE Severance toolkit	✓	✓	✓

Notes: TAG refers to TAG Unit 1.4 Journey Quality section and Data Book values; TfL (2019) refers to AmbienceBenefit 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).

General	Walk Journey Quality Factor – movement along roads	HE/TAG	TfL (2019)	PLOS UK	PLOS DK
Safety & Security: danger from traffic	Traffic volume	-	~	✓	✓
	Traffic speed	-	✓	✓	✓
	% HGVs	-	-	-	-
	Proximity to traffic	-	✓	✓	✓
Safety & Security	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		~	~	-	-
Health		✓ in Physical Activity valuation		-	-

Notes: TAG refers to TAG Unit 1.4 Journey Quality section and Data Book values; TfL (2019) refers to AmbienceBenefit 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 A3 and A4 focus on identifying a more complete set of journey ambience factors for future valuation research, based on the work by Nellthorp et al. (2020/1) 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 A3: Journey Quality Factors for Walking, by source.

Journey Quality Factor		Synthesis (Nellthorp et al, 2021)	Current valuation method: ABC/PEAT	Current valuation method: 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 (5)	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 (PM10 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. Cross 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.

Table A4: Journey Quality Factors for Cycling, by source.

Journey Quality Factor		Synthesis (Nellthorp et al, 2021)	Current valuation method: ABC/ PEAT	Current valuation method: AMAT	Design guidance
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. Sides 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.

Appendix B – Dutch CBA multipliers for journey quality

Cycling path configuration				Walking path configuration			
Description			Multiplier	Description			Multiplier
1	Car road – bikes allowed (30 km/h)		1.085	Walking on road with cars and bikes (30 km/h)		1.397	
2	Car road – bikes allowed (50 km/h)		1.233	Walking on road with cars and bikes (50 km/h)		1.598	
3	Bike street – cars allowed, bikes have priority (30 km/h)		0.956	Sidewalk directly next to road with cars and bikes (30 km/h)		1.100	
4	Bike lane in the road (30 km/h)		0.993	Sidewalk directly next to road with cars and bikes (50 km/h)		1.192	
5	Bike lane in the road (50 km/h)		1.034	Sidewalk at 2 metres from road with cars and bikes (30 km/h)		1.005	
6	Bike lane next to the road (50 km/h)		0.963	Sidewalk at 2 metres from road with cars and bikes (50 km/h)		1.034	
7	Bike lane next to the road (80 km/h)		1.122	Shared bike/pedestrian path (no car traffic)		0.818	
8	Bike path (no other road around)		0.862	Pedestrian path (no car traffic)		0.832	
Type of pavement				Walking path width			
Description			Multiplier	Description			Multiplier
1	Paving stones	1.183	Narrow path (less than 1 m) with obstacles (parked bikes, flower beds etc.)	1.072			
2	Sidewalk tiles	1.169	Narrow path (less than 1m) without obstacles	1.008			
3	Concrete slabs	1.085	Normal path (1 – 2m wide)	0.997			
4	Asphalt	0.971	Wide path (more than 2m wide, boulevard-like)	0.952			

Source: Kouwenhoven et al. (2023).