Údarás Náisiúnta Iompair
National Transport Authority

Modelling Services Framework

Regional Model Development

Appraisal Tools - Health

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1 Introduction

1.1 Background

As part of the Modelling Services Framework, Systra/Jacobs were commissioned by the National Transport Authority (NTA) to develop a system of multi-modal transport models for each regional-city in Ireland. As part of this commission, a scoping process was initiated in September 2014 to define the most appropriate suite of appraisal tools to complement the regional models.

We are developing a number of separate appraisal processes:

- Safety
- Economy
- Reliability
- Environment
- **Health Benefits**
- Accessibility
- Social Inclusion
- Wider Economic Benefits

In addition to the individual notes outlined, a subsequent note will describe how all of the impacts (monetised and non-monetised) may be drawn together within a single appraisal summary process.

1.2 Purpose of this Note

This note considers the approach to the appraisal of Health Benefits. It includes a discussion of the health benefit appraisal process, outlines the required datasets and provides a framework for the implementation of the approach and tools.

2 Overview of the Health Appraisal Process

2.1 Introduction

There is a growing awareness of the need to change our transportation habits by reducing our use of cars and shifting instead to active transport, i.e. walking and cycling. Such change can bring about significant benefits for our health and environment. Most transport investment is assessed for its value for money using methods which compare costs against benefits over the lifetime of a project. Benefits are now increasingly assessed in a wider sense – economic, environmental, social and distributional. As a result, the consideration of health benefits arising from transport is becoming an integral part of the appraisal process adopted to inform transport policy and investment decisions.

Transport related changes to the following factors can have health impacts as set out:

- **Physical activity** – increased levels of activity can positively impact on reducing the risk of death and occurrence diseases such as heart, diabetes and cancer related illnesses;
- **Absenteeism** – this is expected to decrease when more people walk or cycle. Moderate physical activity is seen to lead to a reduction in the number of sick days and hence provides a benefit to the employer. The impact is different to the benefit of better health for the individual. Absenteeism related benefits are therefore taken into account as part of the economic appraisal;
- **Journey quality** – refers to the quality impacts of schemes on journey experience which is calculated on the basis of 'safety-insecurity' and assigning a 'quality value' to each trip made by existing and new users;
- **Safety** – a 'safety in numbers' effect can result from increasing levels of active travel or conversely a decline in safety where change occurs towards these modes and/or routes with higher accident rates. This is addressed in the Safety note; and
- **Environment** – air quality, greenhouse gas and noise impacts resulting from a decline in road traffic and associated congestion. These factors are considered through damage costs which are discussed further in the Environment note.

2.2 Scope of Health Benefits – Physical Activity

2.2.1 Relative Risk of Mortality

This note focuses on the health benefits associated with physical activity derived from a reduction in the relative risk of premature death - the 'Relative Risk of Mortality' is directly linked to the time spent walking and cycling based on the average length, speed and frequency of new trips encouraged by active travel modes. This indicator provides a calculation of the lives saved due to the health benefits of cycling and walking.

2.2.2 Monetising Physical Activity Benefits

The number of potentially prevented deaths is subsequently multiplied by the value of a prevented fatality to provide a monetary benefit. Future benefits include real growth in the value of a prevented fatality in line with forecast GDP/capita. However, in an Irish context and as set out in recommendation ACT1 of the Peer Review undertaken of the draft Department for Transport, Tourism and Sport (DTTAS) appraisal guidance[1], it is considered to be more appropriate that GNP per person is employed rather than GDP per person for adjusting the cost of pedestrian and cycling accidents from one year to another (nominal GNP for years prior to the baseline year and real GNP thereafter). The approach for setting out the calculation in this note will be consistent (or as consistent as possible) with forthcoming appraisal guidance which will be released by the DTTAS.

[1] Peer Review & Forecasting Advice Services Draft Final Report to Department of Transport, Tourism & Sports (SYSTRA & DKM Economic Consultants, 2015)

3 Datasets Required

3.1 Outcome of the Initial Data Review

Appraisal guidance has increasingly looked to include specific guidance for the appraisal of investment in walking and cycling schemes which includes assessment of the health benefits resulting from regular physical activity. The Health Economic Assessment Tool (HEAT) developed by the World Health Organisation (WHO)[2] is frequently cited in literature and appraisal guidance to assess the impact of increased physical activity from regular walking and cycling and is the basis of the approach adopted in the appraisal guidance proposed by DTTAS.

The basis of HEAT is to calculate *'If x people cycle or walk y distance on z days, what is the economic value of the mortality rate improvements?'*. In summary, HEAT:

- Is intended to be part of comprehensive cost–benefit analyses of transport interventions or infrastructure projects;
- Complements existing tools for economic valuations of transport interventions, for example on emissions or congestion;
- Can also be used to assess the current situation or past investment; and
- Is based on best available evidence, with parameters that can be adapted to fit specific situations. Default parameters are valid for the European context.

HEAT can be applied in many situations, for example:

- To plan a new piece of cycling or walking infrastructure: it models the impact of different levels of cycling or walking and attaches a value to the estimated level when the new infrastructure is in place;
- To value the mortality benefits from current levels of cycling or walking, such as benefits from cycling or walking to a specific workplace, across a city or in a country; and
- To provide input into more comprehensive cost–benefit analyses, or prospective health impact assessments: for instance, to estimate the mortality benefits from achieving national targets to increase cycling or walking, or to illustrate potential cost consequences of a decline in current levels of cycling or walking.

Adopting the principles of HEAT, the DfT published *Cycling and Walking: The Economic Case for Action*[3] in March 2015. The 'toolkit' comprises a technical note including an overview of how to demonstrate the economic case for a new cycling and walking proposal accompanied by a spreadsheet based model which provides a basis to replicate calculations for different schemes. The spreadsheet includes four modules, the first two use inputs from modal shift which monetise the health benefits of the number of trips being diverted to cycling and walking separately. The third and fourth modules allow for the assessment of health impacts from cycling and walking in separate sheets and independently from the modal shift impact.

[2] Health Impact Assessment Tool (HEAT) http://heatwalkingcycling.org/index.php?pg=cycling&cs=q6.1&m=pre

[3] Cycling and Walking: The Economic Case for Action https://www.gov.uk/government/publications/cycling-and-walking-the-economic-case-for-action

3.2 Main Source of Relevant Data

It is understood that the DTTAS will shortly be publishing guidance for undertaking the appraisal of transport schemes. The guidance and supporting tools will form the primary data source for the different parameters to input to the health benefit appraisal.

Data inputs can take the form of:

- Data from a single point in time – used when assessing the status quo, such as valuing current levels of walking and cycling in a city or if data on the results of an intervention are only available; and
- Before and after data – used when assessing the impact of an actual intervention or hypothetical scenarios. Pre and post measures will be used to calculate health benefits and associated financial savings.

As the appraisal tool is related to the NTA's multi-modal regional model it has been assumed for the purposes of this note that requirements will primarily draw on outputs from scenario testing. As such, the primary source will be before and after data.

Inputs used by the DfT spreadsheet to calculate the health impact of cycling and walking are summarised in Table 1. This sets out all the parameters for completeness to calculate the economic impact of cycling and walking schemes. Where the source for an input is defined as 'User / Default' this means that default values are already pre-populated in the model but can be modified with study specific values where appropriate and information is available. The parameters and values specific to Ireland are discussed further in Chapter 4.

Table 1: Summary of inputs – health impacts of cycling and walking

Input	Units	Comment	Source
Number of cycling/walking journeys per day as a result of the policy/measure.	Number of journeys	The user needs to input the number of cycling and walking journeys separately. These are the journeys resulting from the policy or measure.	User
Length of cycling/walking journeys.	Km	These inputs are relevant for the policies which will change the length of the cycling or walking trip. For example construction of new cycling route can decrease or increase the overall distance travelled on a bike. Inputs for cycling and walking have to be input separately	User
Cycling/walking speed.	Km/h	Together with journey distance, it is used for estimating cycling/walking time.	User / Default
Decay rate.	%	The rate at which health benefits decay (i.e. after the end of the policy/measure).	User / Default
Year decay start.	Year	Year in which decay starts (i.e. when funding for a cycling scheme ends).	User / Default

Input	Units	Comment	Source
Ramp up of health benefits.	Year	The number of years it takes for the measure/policy to achieve full potential.	User / Default
Number of days in the year that cycling/walking would occur.	Number of days	Number of days per year that the number of journeys per day entered will apply.	User / Default
Share of journeys (both from walking and cycling) that form part of a return trip.	%	This is to identify the number of users affected by the policy.	User / Default
Background annual growth.	%	Expected annual growth in %.	User / Default
Value of life saved.	£ in 2010 prices	The economic value of a saved life.	WHO European Region Average
Mean proportion of population aged 15-64 who die each year from all causes.	Percentage	This is the total proportion of people who die from all causes in England and Wales.	WHO European Detailed Mortality Database for age group averages, or can be user defined to the locale of the scheme.
Reduced relative risk index for cycling and walking.	Index	The value used for cycling is from a Copenhagen study which puts a cap on the index at 0.28. This is associated with 36 min cycling per day. In the case of walking the index is 0.22, associated with 21.5 min walking per day.	Copenhagen Centre for Prospective Population studies[4]
Average cycling trip duration.	Minutes	This input provides an average duration travelled per cyclist per trip.	National Travel Survey Table NTS0314 - Sheet NTS0314_Eng
Average walking trip duration.	Minutes	This input provides an average duration travelled per walking trip.	National Travel Survey Table NTS0314 - Sheet NTS0314_Eng

3.3 User Input Data Requirements

The following user data are needed (pre and post scheme implementation) as inputs as part of the calculations relating to physical activity:

- **Trips** – no. cycling and walking journeys per day[5];

[4] Andersen LB et al. All-cause mortality associated with physical activity during leisure time, work, sports and cycling to work. Arch Intern Med. 2000;160:1621–8

- **Distance** – average length of walking and cycling journey. Used to calculate the average journey time together with average cycling/walking speed; and
- **Speed** – average walking and cycling speed. Together with the average length of journey this is used to calculate the average journey time. If either length or speed is left blank for a specific year, default journey times will be applied.

3.4 Fixed Input Data Requirements

There are also fixed inputs required. These include:

- **Mortality rate** – the annual rate of the population (typically aged 15 – 64 years) that dies each year (deaths per 100,000 people per year in the respective age group). The local mortality rate can be derived from published data for people of working age or a European average can be used or a national rate from the WHO European Detailed Mortality Database[6];
- **Value of a Statistical Life (VSL)** – the economic value of a life saved based on the willingness to pay of a middle-aged person to avoid a sudden death. The standard value of a statistical life used in the country of study should be entered where available or alternatively values derived from WHO based on a European average applied;
- **Reduced Relative Risk Index** – the relative risk of premature death; and
- **Average cycling and walking trip duration** – default values are used in case the user does not specify average distance and speed.

3.5 Control Factors

There are also a number of control factors and inputs that affect different steps of the calculations. They are pre-populated with default inputs for use where the user does not have specific values, but can be modified in order to suit the user needs. The parameters include:

- **Decay rate** – the rate at which health benefits decay (i.e. after the end of the policy/measure). The default value is zero, assuming the improvement is permanent (e.g. infrastructure) or the end of the policy is beyond the appraisal period;
- **Year decay start** – year in which decay starts (i.e. when funding for a cycling scheme ends). Default value is the end year of appraisal, making decay ineffective;
- **Ramp up of health benefits** – the number of years it takes for the measure/policy to achieve full potential. Default value is 5 years (Source: WebTAG toolkit);
- **Number of days in the year that cycling/walking would occur[7]** – number of days per year that the number of journeys per day entered will apply. This is different for cycling and walking. Default number of cycling days is 260 weekdays per year. Default number of walking days is 365 days a year;
- **Share of journeys (both from walking and cycling) that form part of a return trip** – this is to identify the number of users affected by the policy. The model is originally designed for commuters that usually cycle or walk both ways. If the user inputs regarding number of

[5] It is likely this will be restricted to an average weekday from the regional model. There are no weekend day trips for the regional model. The user of the appraisal tool will need to consider how to address weekend benefits.

[6] http://data.euro.who.int/dmdb/. For local assessments, this value can be updated with the local statistics.

[7] There is no active travel data from the NTA regional models for weekends. It is likely the appraisal will only refer to weekday travel.

trips, distance and speed refer to individual (one way) journeys, this should be set to zero. Default value is 90% (in Web-TAG toolkit); and

- **Background annual growth** – expected annual growth in %. This input is used in case the user assumes that value of life will grow over time. Default value is zero i.e. value of life remains constant.

3.6 Data Assumptions

Until the DTTAS appraisal guidance is published and formally adopted, it is proposed to work with the following assumptions as defined in HEAT:

- The build-up of benefits will be accrued over a five year period;
- There is a linear relationship between risk of death and cycling/walking duration (assuming a constant average speed), i.e. each dose of cycling/walking leads to the same absolute risk reduction;
- No thresholds have to be reached to achieve health benefits; and
- Men and women have approximately the same level of relative risk reduction.

4 Implementation of the Health Appraisal Process

4.1 Overview

The following steps were specified in the Task Order for the Health Benefits appraisal and are discussed in turn below:

- Create process;
- Test process;
- Sign off;
- Documentation;
- Training;
- Ongoing support;
- Potential enhancements;
- Additional research; and
- Integrate/polish.

4.2 Creating the Process

As noted, the WHO has produced HEAT to assess the economic health impact resulting from changes in physical activity related to cycling and walking trips. The DfT has subsequently developed a spreadsheet based tool to calculate the economic benefits of cycling and walking schemes, including physical activity-related benefits. It is intended this spreadsheet will form the basis of the approach adopted, subject to discussions and agreement from the NTA. The spreadsheet provides more visibility and flexibility for testing the sensitivity of different input parameters compared to the functionality of the web based HEAT tool.

4.2.1 Walking and Cycling Matrices

In the NTA regional models walking and cycling are considered as two separate modes in all model steps. Separate demand, assignment and cost matrices are therefore available for each mode. Walk costs are based on a walk time of 4.8km/h with no link type distinction. Cycle costs are based on different speeds depending on link type e.g. on-road; off-road etc.

Model outputs include actual and perceived cycle times. The latter includes a ‘speed up’ factor applied to reflect the impact of journey quality on perceived journey times. As health benefits are directly linked to the time spent walking and cycling actual time will be used for the purposes of this appraisal.

4.2.2 Application of UK DfT Tool

The application of the DfT tool will be supported by inputs from the emerging DTTAS appraisal guidance, specifically details relating to the calculation of the Relative Risk for cyclists and walkers in Ireland. Table 2 shows the calculation of the reduction of relative risk for walkers and cyclists in Ireland. The average active time per day across individuals making return and single leg trips is based on an assumption that 80% of commuting trips form part of a return journey. The calculated reductions in relative risk of death and the number of new walkers and cyclists are used to calculate a figure for the potential number of lives saved based on average mortality rates. An average mortality rate of 0.0019[8] is used, the mean proportion of the population aged 15 – 64 who die each year. The number of potentially prevented deaths is then multiplied by the value of a prevented fatality used in accident analysis (see Safety note) to provide a monetary value.

For Ireland the relative risks are calculated by interpolating between 0 and the maximum reductions of 0.28 and 0.22 for cyclists and walkers respectively. This is on the basis of the average active time per week (CSO Census POWSCAR, 2011); for example, for cyclists: 41.8mins (average active time per day)*5/ 100mins * 0.1 = 0.21. This is higher than the reference population, but lower than the maximum cap.

Table 2: Relative Risk for Cyclists and Walkers in Ireland[9]

Mode	Cyclists		Walkers	
	Return	Single	Return	Single
Average Active time per workday (mins)[10]	44	22	36	18
Proportion of individuals	0.9	0.1	0.9	0.1
Average Active time per workday (mins)	41.8		38	
Reduction in relative risk	0.21		0.11	

In summary, the physical activity monetary benefits are calculated as follows:

- The change in all-cause mortality rates as a result in the change in activity;
- The calculated reduction in relative risk of death and the number of new walkers and cyclists are used to calculate the potential number of lives saved based on average mortality rates (evidence suggests this proportion is 0.0019 of people aged 15 – 64 years in Ireland);
- The number of prevented deaths is multiplied by the value of a prevented fatality (€2,258,250 in 2011 prices)[11] to give a monetary benefit for each year. A peer review of the DTTAS CAF noted that the value stated appears to relate to the cost of a fatal motor accident which includes a range of non-casualty costs as well as casualty costs in respect of more than one casualty. It was suggested the Irish Value of Statistical Life in respect of one individual should be used in preference (or alternatively Web-TAG presents the equivalent value for the UK in 2010 prices);
- Calculations are repeated for both cyclists and walkers for each year of the appraisal period, including real growth in value; and
- Each annual value is summed to and discounted to give a total net present benefit.

[8] DTTAS Common Appraisal Framework Peer Review RfP (2015) – Appendix 5 (In 2011 5,895 deaths occurred in the 15 – 64 year old population and there was 3.73m people in the 15 – 64 year old population).

[9] DTTAS Common Appraisal Framework Peer Review RfP (2015) – Appendix 5

[10] DTTAS Common Appraisal Framework Peer Review RfP (2015) – Appendix 5 (Data from POWSCAR 2011 (CSO) commute times for walkers and cyclists main mode up to maximum of 45 mins cycle and 1 hour walk (new users assumed unlikely to make long commuting journeys by active modes).

[11] DTTAS Common Appraisal Framework Peer Review RfP (2015) – Appendix 5 & Peer Review & Forecasting Services Report to DTTAS (SYTSRA & DKM, April 2015)

The Department for Transport's (DfT's) Web-TAG guidance notes that the HEAT methodology estimates the benefit to the population using active modes for any level of activity, not just those achieving a specific threshold. There are these considerations for new and existing users:

- For any new walk and cycle trips (shifting from mechanised modes) there will be some health benefits to each individual;
- For existing walk and cycle trips, health benefits may change where the duration of travel may change (e.g. removal of severance on a specific route to decrease journey times).

Web-TAG recommends that the impact of a proposed scheme on journey distances and also on cycling speeds should be assessed if it is considered that this will be affected significantly. From this, an average journey time may be estimated for new users. Section 11.3.8 of the Design Manual for Roads and Bridges (DMRB) contains further detail on the inference of changes to trip length resulting from a scheme.

Further discussion will be undertaken with NTA around the need and any subsequent approach required to take account of the elasticity of cycling and walking demand. This is particularly relevant where schemes may reduce distance and therefore time spent walking/cycling. It is therefore important to understand in this circumstance if the shortening of a trip creates a benefit or dis-benefit in terms of physical activity i.e. is the shorter distance off-set by an increase in the number of trips made.

4.3 Testing the Process and Sign Off

HEAT provides an estimate of the order of magnitude of the expected effect of an intervention, rather than as precise estimates. It is designed for assessments at the population level (not for individual activity) and for regular habitual activity by adults only. It is not suitable for populations with high average levels of walking or cycling (such as postal delivery workers or bicycle couriers). Caution also has to be applied when using HEAT in very sedentary population groups.

To achieve a better sense for the possible range of the results, the model can be re-run entering slightly different values for variables where you have provided a "best guess", such as entering high and low estimates for such variables.

Steps in testing and signing off the processes will involve:

- Peer review of input parameters;
- Detailed (independent) checking of the data inputs;
- Run spreadsheet for a sample scheme and sense check results; and
- Sensitivity testing around different parameter inputs for the sample scheme to provide a view of the scale of potential impact.

4.4 Documentation, Training and Support

Documentation will include user note(s) for each process and evidence of testing.

A training programme will be agreed with NTA. Training topics could include:

- Principles of health appraisal;
- Overview of processes;
- Step-by-step training in running and checking processes; and
- Worked exercises in assessing appraisal outputs.

It may be most appropriate to develop training courses for two types of user:

- Users who will make use of the summary outputs;
- Users who will be involved in the providing the data required from the model and involved in the more detailed interrogation of the outputs.

4.5 Potential Enhancements and Research

Appraisal of transport related health benefits and their monetisation is an evolving area. HEAT provides a means to assess benefits referencing to impacts on all-mortality (reflecting the number of preventable deaths as a result of increased physical activity). Areas of potential development and refinement the NTA may wish to consider and incorporate into their own bespoke tool surround the current scope and parameter definitions applied by HEAT, including:

- It applies only to working age adults carrying out exercise at average intensity and therefore not applicable to the population with high physical activity levels. It does not take into consideration differences in the intensity of cycling/walking or the possibility that less well-trained individuals may benefit more from the same amount of activity and therefore potentially underestimate the effect in very sedentary population groups;
- Assumes direct linear relationship between cycling and risk of all-cause mortality (but a more complex non-linear relationship can be applied);
- Does not take account of men and women separately (but it could if different relative risks were introduced);
- Does not take account of the different relative risks for different age groups (but uses a relative risk which is adjusted for age). The age group usually evaluated are adults;
- Does not take account of morbidity and is therefore likely to produce more conservative estimates as it does not account for disease-related benefits;
- Assumes a standard cycling speed (but can be adjusted to allow for different speeds); and
- Assumes that the relative risks found in one study population can be applied to different populations and settings.

4.6 Summary

This note has considered the approach to calculate the health benefits associated with physical activity and specifically the reduced risk of mortality based on the time spent walking and cycling.

The WHO developed the Health and Economic Appraisal Tool (HEAT) to calculate the health benefits associated with changes in physical activity resulting from differences in walking and cycling. The tool is available as an online platform. Adopting the principles of HEAT, the UK DfT has developed an Active Travel Appraisal toolkit to calculate the economic benefits of walking and cycling. This includes a physical activity module which is based on the principles of HEAT. The spreadsheet based model provides more flexibility for the sensitivity testing of different input parameters compared to the web based HEAT tool.

It is proposed to use the DfT tool as the basis for calculating the health benefits related to changes in physical activity. In applying the tool within the NTA regional model context, the following factors have been identified for further consideration by the NTA and discussion:

- Treatment of weekend walking and cycling trips which are not included in the regional model;
- Values for parameters specific to Ireland, in particular the basis of the value of statistical life;

- Elasticity of cycling and walking demand, particularly where a scheme may shortening journeys and in turn the time spent undertaking physical activity;
- Position on the treatment of other health benefits, such as those relating to accidents, in other appraisal notes; and
- Limitations of the HEAT based approach and potential/desire for any refinements prior to application of the DfT tool.