Australasian Transport Research Forum 2023 Proceedings
29 November – 1 December, Perth, Australia
Publication website: http://www.atrf.info

Cost benefit analysis of active modes of transport: Review of international guidance

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Abstract

Urban transport systems may support active transport which in turn contributes to population health and environmental sustainability. To assess where the limited resources for transport projects should be allocated, governments developed frameworks for Cost Benefit Analysis (CBA) to guide investment decisions for transport initiatives. However, generally most CBA guidance refers to motorised transport with a more limited amount of guidance for assessing active transport initiatives. This study reports on a synthesis of existing guidance on CBA of active transport initiatives and accompanying tools. The synthesis focused on publicly available guidance in high income countries. The current study is work in progress and reports on general findings and further analysis will be performed to understand methods used to calculate impacts monetized values and compare guidance across countries.

1. Introduction

The transport sector like other government sectors, faces the problem of allocating limited resources and competing interests (e.g. economic growth, reduce climate change, inequality) for public action (Nellthorp, 2018b). To overcome these issues, governments have developed project (policy) frameworks to support decisions based on a logic and systematic approach. These frameworks often start with transport objectives or targets. Specific options in accordance with the objectives or targets are identified and an ex-ante appraisal is conducted to prioritise and select options. Once the decision for a transport project is made it is implemented, and ideally ex-post evaluation and feedback in reference to the original project (or policy objectives) takes place (Nellthorp, 2018b, Australian Transport Assessment and Planning (ATAP), 2018, 2021). An ex-ante appraisal assesses and compares the cost and benefits for possible alternative uses of resources to enable the selection of the most cost-effective options (Dobes et al., 2016).

Economic appraisal in the form of Cost Benefit Analysis is commonly used to guide investment decisions for transport projects and policies (Gössling et al., 2019, Jones et al., 2014, Mackie and Worsley, 2013). CBA, as a tool to support decision-making, has steadily grown in significance and several countries have published guidance manuals for transport CBAs, e.g. the United Kingdom (UK), the United States (US), Sweden, Australia and New Zealand (Mackie and Worsley, 2013, Wangsness et al., 2017). CBA as a method includes the assessment of potential impacts of a project or policy (initiative hereafter) across a specific time horizon, monetary valuation of the intended and unintended impacts, and the appraisal of net benefits and costs to society (Gössling et al., 2019). In the context of government, CBA assesses whether social benefits exceed social costs for the initiative under assessment (Dobes et al., 2016).

For existing CBA frameworks in the transport sector, there is criticism of the strong focus on automobility, although CBA frameworks for rail and aviation also exist (Gössling et al., 2019, Mackie and Worsley, 2013). Gössling et al. (2019) conclude that for transport investment projects in the European Union this focus on cars means that the cost of automobility is systematically underestimated. Thus, in urban transport planning contexts, CBA assessments

should include active transport and be comparative to adequately consider the implications of the prioritisation of a certain transport mode. van Wee and Börjesson (2015) argue that to help efficient allocation of public funding, CBA should be applied routinely to cycling projects.
Several guidelines and tools for conducting economic appraisal of active transport initiatives exist in some countries or states, however, there is a lack of comprehensive understanding or comparison of what these guidance documents and tools recommend. This article aims to address these knowledge gaps and synthetises existing guidance on economic appraisal of active transport initiatives.
Active travel in this paper is understood as transport which is non-motorised and requires physical activity, such as walking or cycling (including electric assisted bicycles), but also scooting or skating. In terms of types of initiatives, some guidance differentiates between infrastructure and behavioural change programs (e.g. active travel to work). This article evaluates guidance for infrastructure only.

2. Methods

We searched for publicly available guidance for cost benefit analysis and economic appraisal of active transport initiatives in high income countries (World Bank, 2021). Our focus was on the national and state level. We limited the search to the English, German, Spanish and French languages; based on language capabilities within the research team. We searched for documents in the following countries: Australia, Canada, France, Germany, Ireland, The Netherlands, New Zealand, Spain, Switzerland, the United Kingdom and the United States. Furthermore, we included the European Union into the search. Similar to Wangsness et al. (2017), we focused on synthesising guidance rather than the practice of active transport appraisal. Our selection of countries was based on past reviews of guidance (Wangsness et al., 2017, Gössling et al., 2019, De Gruyter and Currie, 2019) that focused on other evaluation aspects of transport (i.e. wider economic benefits, unit values for inclusions in CBAs and amenity valuation).
We used four different search pathways: we examined past similar reviews regarding which transport guidance they had analysed (Wangsness et al., 2017, Cooley et al., 2016, De Gruyter and Currie, 2019, Douglas and Brooker, 2013, Mackie and Worsley, 2013, Gössling et al., 2019, Kamis, 2014); and we searched through Google, the Transportation Research International Documentation (TRID) database and websites of "Departments of Transport" from July to October 2020 and conducted an updated search in November 2022. For the Google search, we used the Advanced Search Engine and searched for the following words: transport, CBA, externalities, guidelines, guideline, manual, handbook, principles, guidance, transport, "cost benefit analysis", "benefit cost analysis". The search was limited to Adobe Acrobat PDF extension files (.pdf) and from 01/01/2010 to 16/07/2020. For the TRID database we used the Advanced Search Option and used the key words combination: "cost benefit analysis" and "guidelines". To find the websites of 'Departments of Transport' for countries and selected states and regions within countries (Australia, Austria, Canada, Germany, Switzerland, the UK and the US) we also used Google. On the websites we searched for "active transport" and "cost-benefit analysis" in combination with "guidelines". During the analysis and writing period of this review, updated guidance documents were published (e.g. New Zealand, California), hence, the latest available was used.

2.1 Exclusion criteria

We applied a two-step exclusion, first for titles and second for full text. Documents were excluded if their title showed that:

1) It is not a transport appraisal/ cost benefit analysis framework or guideline;

2) It is not from a high-income country; and
3) It is not in English, German, French or Spanish

The documents selected after the first exclusion step were then scanned as to whether they included guidance for the ex-ante appraisal of active transport initiatives.

2.2 Data extraction and synthesis

Included guidance were assessed by two reviewers (AK and BZ-D) and data were extracted (Table 1). Principles of economic evaluation (comparator, baseline year, discount rate), methods for forecasting active travel demand and detail on impact inclusions were extracted based on principles for economic evaluations of transportation in the context of goverment (Nellthorp, 2018a).

In a number of instances, guidance were accompanied by tools to perform CBAs in various formats, including Excel workbooks and online interfaces. When tools were available (e.g. Active Mode Appraisal Toolkit (AMAT) for the UK), and these differ in methods and impacts inclusions from those in guidance, we report on the tools' methods and inclusions. This decision was made on the fact that the tools provided clearer methods than the guidance which facilitated understanding and hence, reporting.

3. Results

3.1 Search results

The search strategy resulted in a total of 1683 (past reviews: 86, google 1450, TRID 127 and DoT websites 20). After the title screening (AK past reviews, TRID and websites and BZ-D Google) and removing duplicates a total of 88 documents (and websites) were read in full for relevance, with a total of nine guidelines left in the final sample for the original search.

3.2 Summary of included guidance

As shown in Table 1, most of the guidance pertains to walking and cycling as active travel modes. However, the Australian and New Zealand guidelines extend this to encompass electric bikes, while the German guidance solely addresses cycling.

All the guidance documents include recommendations for the appraisal period, which spans from 20 to 40 years. The specific period is determined by project nature and the lifespan of the longest-lasting asset. Discount rates also vary across the guidance, ranging from 7% to 1.5% in the UK guidance. These rates are primarily applied to health considerations, reflecting lifespan and quality of life. The significance of discount rates lies in their influence on analysis outcomes, with higher rates penalizing long-term benefits. Health benefits linked to physical activity, air pollution, and noise (as outlined in Table 2) generally materialize over the long term, given their association with chronic conditions that tend to manifest in later years. Consequently, higher interest rates can impose penalties on these health benefits that extend into the distant future.

Table 1: Economic parameters

Original search/update (Dec/2022)	Active travel	Appraisal period, base case, discount rate	Forecast active travel
New South Wales, Australia (Transport for New South Wales, 2019)/ Transport for New South Wales (2022a), Transport	W & C	AP: 30 years BC*:* Do minimum DR*:* -7% -3%, 4%, 5% and 10% for sensitivity	Models do not need to be complex for smaller projects and may be based on base travel data and assumptions on changes in population and trips incidence. No specific modelling for walking and/or cycling.

Original search/update (Dec/2022)	Active travel	Appraisal period, base case, discount rate	Forecast active travel
for New South Wales (2022b)			
Queensland, Australia (CDM Research, 2016)/ (Department of Transport and Main Roads, 2022)	W & C	AP: -30 years -include construction periods BC: Not specified DR: -7% -4% and 10% for sensitivity	Strategic transport models are unlikely to generate reliable estimate for active transport demand. A pragmatic approach is recommended inferring from observed demand of existing, comparable projects. Automatic counts are recommended to collect data on existing projects for future use in similar project when conducting ex-post evaluation.
Australia (Australian Transport Assessment and Planning Steering Committe, 2016)/ (Australian Transport Assessment and Planning Steering Committee, 2023)	W, C & EB	AP: -expected life of asset -includes construction period BC: Do minimum DR: nominated by funding body.	Recommendations based on the project scale. 1) Small initiatives with limited impact (e.g. path widening): comparative study[1] 2) Medium size initiative (sizeable extensions to a cycle network): sketch planning method or a discrete choice model; 3) Large initiative (e.g. bridge over a river connecting with large residential or working populations): fully-specified four step network based model.
Ireland (Transport Infrastructure Ireland, 2021)/ (Transport Infrastructure Ireland, 2021)	W & C	AP: 30 years -shorter period allowed: life of assets BC: Do-minimum DR: 4% (years 1-30, declining value after)	Low, central and high scenarios to be included given uncertainty in walking and cycling demand. Recommendations for demand scenarios: 1) Use existing count data; 2) Case studies and benchmarking; 3) Census data for work and education trips; 4) Population catchments and standard trip rates.
New Zealand, Simplified and Full methods (Waka Kohati NZ Transport Agency, 2021)/(NZ Transport Agency, 2023)	W, C & EB	AP: 40 years BC: Do-minimum DR: 4 %	For cycling only. Buffer methodology recommended when traffic counts are not available or not reliable to derive cycle demand. Calculates the population within catchments surrounding the facility. It then applies a probability factor to estimate the number of new cyclists who will use the facility by considering their distance from the facility and the current mode share of commuting cyclists. A likelihood multiplier is used as an adjustment for the likelihood of new cyclists using the facility in each buffer.
UK (Department for Transport, 2020)/ (Department for Transport, 2022b, Department for Transport, 2022a)	W & C	AP: 20 years or less BC: without-scheme DR: 1.5% health (QALY) -3.5% (years 1-30, declining value after)	Recommended approaches are: 1) Comparative studies; 2) Estimating from Disaggregate Mode Choice Models; and 3) Sketch Plan methods. [1] Decay impacts are not applicable, children should be explicitly considered, analysis of catchments should considered for sizeable walking and cycling projects, it may be appropriate to explicitly consider for journey end activity, and different types of user may need to be accounted for as some people may be more sensitive to time than others.
California (California Department Of Transportation, 2019)/ (California Department of Transportation, 2022)	W & C	AP: 20 years BC: no-build DR: 4%-7% (depends on funding body)	No methods recommended, but users of the tool need to determine the number of current and induced trips and other trips characteristics (e.g. non-roundtrip probability, purpose, distance).
Cost-benefit-analysis: Assessment of the efficiency of cycling measures – Guidelines (PTV Group and Röhling, 2008)	C	AP: based on operating life of infrastructure BC: do-minimum DR: 3%	It is recommended to do counts within the area to understand the current modal split, and ideally do a count later for monitoring. More research needs to be done on forecasting/modelling methods.
Cycle highways – Guidelines for	C	AP: based on operating life of infrastructure	Recommends use of existing macroscopic traffic models or an approximate method based on the of the

Original search/update (Dec/2022)	Active travel	Appraisal period, base case, discount rate	Forecast active travel
potentials analysis and cost-benefit-analysis (PTV Transport Consult GmbH, 2019)		BC: do-minimum DR: 1.7%	traffic volume in the study area to derive the corresponding relocation potential.

W: walking; C: Cycling; EB: Electric bike: AP: Appraisal period; BC: Base case; DR: Discount rate

Table 2 demonstrates inconsistencies in inclusions across guidance, ranging from up to ten impacts in some guidance to half that in others. The foremost three inclusions encompass physical activity (n=9), road injuries (n=8), and air pollution (n=6), along with emissions (n=6). For physical activity impacts, the direct link lies in health benefits spanning reduced mortality, morbidity, healthcare cost savings, and absenteeism reduction.

In terms of road injury impacts, quantification in guidance pertains to changes in fatalities, injuries, and property damage. Air pollution impacts encompass health and production, considering shifts resulting from reduced kilometers traveled. Health effects were measured through reductions in carbon monoxide, oxides of nitrogen, particulate matter, and total hydrocarbon, while property and material damage considered nitric oxide. Greenhouse gas emissions reduction, tied to curtailing private car travel, was expressed in terms of carbon dioxide reduction.

Table 2: Impacts inclusions

	Physical activity	Road safety	Journey quality	Maintenance	Decongestion	Vehicle operating costs	Indirect tax	Noise	Air quality	Emissions	Travel time	Parking/PT fares	Others
NSW, Australia	✓	✓		✓	✓	✓		✓	✓	✓			✓
QLD, Australia	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	
Australia	✓	✓		✓	✓	✓					✓	✓	
Ireland	✓	✓	✓		✓	✓		✓	✓	✓	✓		✓
New Zealand[1]	✓	✓	✓								✓		
United Kingdom	✓	✓	✓	✓	✓		✓	✓	✓	✓			✓
California	✓	✓	✓							✓	✓		
Germany (PTV Group; TCI Röhling (2008)	✓	✓				✓			✓	✓			
Germany (PTV Transport Consult GmbH (2019)	✓			✓		✓		✓	✓	✓	✓		✓
Total	9	8	4	5	5	6	1	5	6	6	6	2	4

[1] Impact included in the simplified procedure.

4. Recommendations for theory and practice

Current methods for forecasting active transport demand exhibit weaknesses, primarily relying on ad-hoc approaches rather than advanced modelling techniques. This forecasting process encounters challenges due to distinctions in small zones and determinants of walking and cycling compared to private car travel and public transport. Hence, the research community should prioritise the development of advanced forecast methods for active transport. Suitable methods include agent-based modelling combined with activity-based models and integrated with a representation of road network attributes relevant to active travel (e.g., bike lanes, speed limits, pedestrian crossings). These models can aid governments in accurately accounting for active modes of transport. Moreover, incorporating impacts related to physical activity relies on outdated methods. Updating these impacts with the latest evidence and state-of-the-art techniques is essential.

Guidelines could be enhanced by leveraging publicly available evidence on methods and data. Tools like the Integrated Transport and Health Impact Modelling Tool (ITHIM) (Centre for Diet and Activity Research, 2015) and THAT-Melbourne (Zapata-Diomedi et al., 2021) offer peer-reviewed methods for physical activity, air pollution, and road injuries. However, there's an opportunity to extend these tools to address a broader range of social impacts from active transportation initiatives. Lastly, transparency could be fostered through the publication of conducted CBAs, as proposed by (Dobes et al., 2016).

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