Cost-Benefit Analysis of Transportation Investment: A Literature Review

Couture, L-E., S. Saxe and E.J. Miller

iCity: Urban Informatics for Sustainable Metropolitan Growth

A project funded by the Ministry of Research and Innovation of Ontario through the ORF-RE07 Program and by partners IBM Canada, Cellint Traffic Solutions, Waterfront Toronto, the City of Toronto and the Region of Waterloo

Report # 16-02-04-01

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING
Transportation Research Institute

UTTRI

Cost-Benefit Analysis of Transportation Investment: A Literature Review

Louis-Étienne Couture
BASC Candidate, Department of Civil Engineering, University of Toronto

Shoshanna Saxe, PhD
iCity Post-Doctoral Fellow, University of Toronto Transportation Research Institute

and

Eric J. Miller, PhD
Professor, Department of Civil Engineering, University of Toronto
Director, University of Toronto Transportation Research Institute

July, 2016

1 Introduction

Since its development in the mid-19th century, cost-benefit analysis (CBA) has become the predominant tool of analysis to compare investment alternatives (Pearce, 1998). Initially prominent in the assessment of hydrological and military investments, in many European and other high-income countries, CBA has become the tool of choice in evaluating transportation projects. CBA stems for the idea that a project (or policy) is worth pursuing on economic grounds if the overall benefit exceeds the overall costs, even if the people who benefit are different from the people who pay (Pearce, 1998). CBA is particularly used for public projects where the costs are generally born by the taxpayers and the benefits accrue to the members of society

CBA has not been used systematically for transportation projects in Ontario and Canada. The lack of prominence of the CBA process in transportation in Ontario is reflected in the rate at which the standards are updated; while the transportation authorities in the United Kingdom, New Zealand, and the European Commission have issued transport-specific CBA guides as recently as 2014, Transport Canada's latest guide dates from 1994. In the 32 years since Canada's last update, best-practice CBA has broadened to include many new social and environmental impacts, as well more sophisticated evaluations of economic impacts.

This document provides a brief of summary of the recent CBA literature. The first section discusses how CBA is carried out in the analysis of transportation projects. The second section focuses on challenges associated with CBA in the literature. The third section discusses alternatives to CBA. This document is meant to serve as a high level summary. For more detailed research on CBA please refer to the referenced papers.

2 Cost-Benefit Analysis

A cost benefit analysis relies on estimation of the costs of building and operating a proposed project over its useful lifetime as well as the envisioned time-stream of benefits expected to accrue from the project. These time-streams of benefits and costs need to be converted to a common time base due to the time-value of money. That is, a dollar invested today at annual interest rate r is "worth" (1+r) one year from now. In other words, $1 at Year 0 is equivalent to $(1+r) at time Year 1. Future year benefits and costs can both be "discounted" back to their Year 0 equivalent values – called their Net Present Value (NPV) so that they can be compared on an equal footing. That is, if (Browne & Ryan, 2011; Van Wee, 2007):

B_{it} = Total benefits accruing from project i in year t

C_{it} = Total capital plus operating costs incurred by project i in year t

N = Project assessment period (years)

r = Annual interest rate (expressed as a fraction) used to discount future year benefits and costs

Then:

NPB_i = Net present value of benefits over the project lifetime

$$= \sum_{t=0,N} B_{it}/(1+r)^t \quad [1]$$

NPC_i = Net present value of costs over the project lifetime

$$= \sum_{t=0,N} C_{it}/(1+r)^t \quad [2]$$

Then the project is considered economically viable if

NPV_i = Net present value of the project

$$= NPB_i - NPC_i > 0 \quad [3]$$

Or, equivalently:

BCR_i = Benefit-Cost Ratio

$$= NPB_i/NPC_i > 1 \quad [4]$$

Similarly, project j is economically preferred over project i if:

$$NPV_j > NPV_i \quad [5]$$

CBA as a financial decision-making tool is described in many economic textbooks. Analyses differ for the most part in which cost and benefits are taken into account, how they are quantified, the time period considered and the discount factors applied. While the details of CBA often vary significantly from place to place and project to project, the basic principles of CBA remain the same across countries

CBA analysis is promoted as particularly effective in evaluating alternative designs or approaches for the same purpose; CBA allows for comparison of often quite different projects (e.g. rail vs. highway) using standardized procedures. The 'do nothing' scenario must also be considered as an option, and evaluated, as it often establishes the benchmark for minimum NPV.

The time frame a project is evaluated over is a key choice in the of CBA process. Recommendations for the length of appraisal period are of a minimum of 20-30 years (Van Wee, 2007) while the UK Department for Transport suggests 60 years, other than in the case of a finite project with a lifespan less than that (United Kingdom Department for Transport, 2014). Most CBAs include an assessment of the residual value of the infrastructure at the end of the appraisal period (Olsson, Økland, & Halvorsen, 2012).

For the appraisal period selected, costs and benefits (from here on referred to collectively as 'impacts') are typically expressed in increments or annualized to facilitate conversion to a present value. For almost every project, this includes an estimation of internal impacts including, but not limited to: capital costs of the project over the period of construction, operation and maintenance costs, and the accrued revenue (fares, toll revenue, etc.) expected. Since these impacts are integral to any CBA, many resources exist which describes them and their integration into a CBA. See, amongst others: Litman *Transportation Cost and Benefit Analysis* (2009), Transport Canada (1994), the previously noted UK Department for Transport (2014), and non-transport specific the CBA guides issued by the Treasuries of New Zealand (2015) and Canada (2007).

National authorities also issue suggested discount rates. These are used to express future costs and benefits at the current value of money. The present value of costs (PVC) is then subtracted from the present value of benefits (PVB) to determine the NPV that can be used to compare options, as can the benefit-cost ratio (BCR), which is PVB/PVC.

2.1 Impacts Considered in Transportation CBA

In theory a CBA captures all the costs and benefits of the project it is assessing. In practice, what can be practically predicted and/or assessed and the approach taken to choosing the time line of the analysis limit the scope of CBAs. Table 1, below, compares the impacts considered by four authorities: (1) Metrolinx, the transportation planning agency for the Greater Toronto-Hamilton Areas (GTHA), (2) Canada's National Guidelines, (3) the UK national guideline and (4), the European Commission guide on CBA transport section. The four provide an overview of the variability within CBA. The UK's guide is widely seen as best practice.

CBA processes consistently value travel-time savings and increases in safety. Increasingly, greenhouse gas savings, air quality and noise effects are incorporated in CBAs. However, beyond these, the inclusion of different kinds of benefits, especially social and environmental benefits is inconsistent (Quinet, 2004). The impacts included in the CBA, the time period chosen and the factors used are critical to the outcomes of a CBA. Research has shown that the same projects evaluated using CBA guidelines from different countries can lead to divergent outcomes that would change the evaluation decision from build to no build and vice versa (Gwee, Currie, & Stanley, 2011; Olsson et al., 2012).

Table 1*: Impacts Considered in CBA by Different Agencies*

Impact	Metrolinx	Transport Canada	UK Department for Transport	European Commission
Investment Cost	☐	☐	☐	☐
O & M	☐	☐	☐	☐
Travel Time Savings	☐	☐	☐*	☐
Revenue	☐	☐	☐	☐
Vehicle Costs	☐	☐	☐	☐
Safety	☐	☐	☐	☐
Greenhouse Gases	☐		☐	☐
Local Pollution (incl. Air Quality)	☐	D	☐	☐
Noise	☐	D	☐	☐
Water Environment	D	D	D	
Biodiversity		D	D	
Congestion		D		
Accessibility	☐		D	
Security			D	
Punctuality/Reliability	D		☐	
Service Frequency	D			
Comfort/Quality	D		☐	
Affordability			D	
Option value			☐	
Indirect Tax Revenue			☐	
Property/Land Value	☐	D		
Land Use	☐			
Landscape			☐	
Historic Environment			D	

Note: A '☐' indicates an impact which the report/guideline states should be included in monetized form, while a 'D' indicates an impact whose inclusion in an analysis is only discussed in the report/guideline, but is not monetized.

2.2 Cost

The quantification of costs associated with a transport project is more straightforward to calculate than the benefits. They consist, in the first instance, of the capital costs and costs associated with operation and maintenance. Inputs to costs general come from easily available data or outputs of standard models (Iacono & Levinson, 2013). However, as many newspaper readers would recognize, transport infrastructure projects, especially large ones, regularly cost more than initially predicted. A famous study of transit project costs found that cost over runs of 50-100% were common (Skamris Holm & Flyvbjerg, 1997). The Toronto York Spadina Subway Extension, currently under construction in Toronto, for example, was originally budgeted at 2.6 billion Canadian dollars and is now expected to cost closer to 3.2 billion, a 23% increase (CBC News, 2016).

As one half of the cost-benefit analysis the regular overruns of cost projects can significantly impact the CBA and NPV calculations. To account for the possibility of cost overruns CBA analysis can include a risk multiplier and an optimism bias factor (Metrolinx, 2015). The use of large risk multipliers, however, is also not without its difficulties in terms of (a) possibly leading to the rejection of worthwhile projects due to excessively conservative cost assumptions; and (b) the possibility that expenditures during implementation will be allowed to rise to the higher assumed costs, when lower cost estimates might act as a constraint on these expenditures (due ot the pressure to "stay within budget").

2.3 Benefits

The benefits calculated for a transportation project can be broken into two categories, (1) the direct or internal benefits associated with the users of the transportation infrastructure and (2) the secondary or external impacts that accrue to non-users. The main direct benefits of transportation projects are typically travel time-savings and increases in safety.

In monetary terms the largest benefit calculated in CBA analysis usually derives from assessed travel time savings. This is the projected total amount of person hours that will no longer need to be used for travel and could be redirected to other activities like work or leisure. The monetary benefit associated with travel time-savings is dependent of the value of time (VOT) for individual people and/or society at large. Extensive literature exists on the theory behind establishing specific VOT values (Börjesson, Fosgerau, & Algers, 2012; Habib & Weiss, 2014; Lam & Small, 2001; Nelson, 1978; Ojeda-Cabral, Batley, & Hess, 2016; Rashedi, Hasnine, Mahmoud, & Habib, 2016; Schuler & Coulter, 1978). VOT will vary with the type of user and the type of travel (Gunn, 2001). To account for individual variation, it is standard practice to use an average VOT for work travel and a separate for non-work travel (United Kingdom Department for Transport, 2014). The VOT used in CBA varies from country to country, with, for instance, the Netherlands assigning a value three time higher than Australia. Generally, VOT ranges from 30 to 50% the average hourly wage rate (Gwee et al., 2011). A growing issue with VOT assessments is the question of how productive time is while traveling. For instance, a passenger on a train could work or read (Laird, Nash, & Mackie, 2014; Olsson et al., 2012). However, when dealing with productivity adjustments in valuing time savings there is a risk of valuing the time of transit and train travellers less than drivers (who must pay attention to the road) which would bias assessments of projects to favour saving drivers time at the expense of users of other modes.

In addition to travel time savings, increases in safety are universally incorporated into CBA. The benefits of increased safety are calculated from the avoided costs of having to deal with an accident (emergency services, repair, disruption) and/or a monetary value assigned to injury and loss of life. Similar to VOT assessment, the value of avoiding injury or death varies from country to country. For example, the US assigns 66 times more value to avoiding a major accident than Singapore (Gwee et al., 2011). Assessed benefit of increased safety is sometime calculated from people's stated willingness to pay to avoid an accident (Jakob, Craig, & Fisher, 2006)..

In addition to the direct effects of new transportation infrastructure discussed above there are myriad secondary impacts associated with transportation projects. These secondary benefits can include, greenhouse gas reduction, environmental air quality impacts, noise reduction, land use influences, agglomeration benefits. How these are assessed for inclusion in CBA is an evolving process. Different CBAs in different places often include different secondary impacts (Gwee et al., 2011).

The methods for monetizing secondary impacts can be difficult to establish, although many procedures have been put forward. For example, for local air pollution, a physical relation is established between particulates in the air and adverse health effects that are then priced based on the cost of medical services (Quinet, 2004). With noise, a common approach is to use the hedonic price method, or revealed price method that indirectly estimates the cost of noise by comparing the differences in price of noise-related goods (e.g. housing) in areas with different noise levels (Pearce, 1998). For greenhouse gas impacts a monetary value is often calculated from the local cost of GHG emissions and an assumed GHG impacts of each passenger kilometer travelled for different modes (Metrolinx, 2015).

3 The Challenges and Shortcomings of CBA

While the use of CBA is widespread, the literature identifies a number of problems with its use. These include:

1) Difficulty in assessing environmental and social impacts.
2) Difficulty is assessing meso and macro economic impacts.
3) Reliance on models of future travel behaviour.
4) Timing of CBA in the planning process.

3.1 Environmental and Social Impacts

With conventional approaches to CBA there are concerns that the impacts on different users or non-user group are poorly understood and that some impacts are not well quantified (Iacono & Levinson, 2013). Early CBAs largely avoided assessing environmental and social impacts and focused on the direct costs (construction) and savings (travel time) associated with transportation projects (Pearce, 1998). More recently CBA has been expanded to encompass a wider range of impacts. Nonetheless, criticism continues of the use of CBA for monetizing elements such as environmental impacts and social impacts (Beukers, Bertolini, & Te Brömmelstroet, 2012).

In dealing with environmental impacts, CBAs often monetize the value of nature using people's willingness to pay to protect it. This ignores the intrinsic value of nature and the impact of nature on society rather than on an individual. Many also criticize the monetization process saying that it debases the environment (Pearce, 1998).

Further a review of the modelled impacts of external factors (like the environment) finds wide discrepancies in the way they are priced (Quinet, 2004). Quinet finds that standardization of the methods used to include external factors like the environment is needed.

The inclusion of social impacts lags behind environmental impacts. The social equity impacts of transport infrastructure (who the "winners" and "looser" are), however, can be very important to how people view and value a project. One of the challenges in including social impacts in CBA is that they often overlap with economic and environmental impacts. Air quality and emissions effect people and the natural world, the relocation of jobs associated with new infrastructure has economic as well as social value; and in CBA analysis each impact must be included only once to avoid double counting. There is currently minimal established methodology for the monetization of social impacts necessary for CBA. Further, CBA is a blunt tool designed to compared the total benefit against the total cost and is badly structured for assessing the distribution of costs and benefits within society (Geurs, Boon, & Van Wee, 2009).

3.2 Meso- and Macro-Economic Impacts

CBA generally focuses on local impacts, but transportation infrastructure projects, particularly large, expensive projects, also have regional impacts (Iacono & Levinson, 2013). Being a microeconomic tool CBA is not well suited to mega projects which are expected to have transformational and macroeconomic impacts (Mackie, Worsley, & Eliasson, 2014) Since most CBA assumes relatively fixed land use, it is liable to underestimate wider economic benefits. Further, many CBAs struggle to account for agglomeration impacts and associated increases in productivity (Laird et al., 2014).

3.3 Reliance on Models

Economic assessments of transportation infrastructure schemes are very dependent on predictions of ridership and changes in travel behaviour. These are usually based on models, which can generate significant forecast errors, for a variety of reasons (Flyvbjerg, Skamris Holm, & Buhl, 2005; Naess, 2006). Transport modelling and forecasting is a major risk factor in economic assessment of transport infrastructure. Comparing first-year ridership to first-year travel forecasts Flyvbjerg *at al*. found that ex-ante transport infrastructure usage predictions were often wrong. Examples of rail passenger forecasts overestimations range from 66% to 169% (95% confidence interval), with these forecasts often not becoming more accurate over time. Similar to the challenge with inaccuracy in cost forecasting, over-estimation of ridership/road usage can lead to a inaccurate benefit calculation based on assumed – but unrealized - accumulated time savings.

3.4 Timing

CBA is positioned as a tool to assist in choosing between different transportation schemes. However, for the best chance at accuracy the CBA needs a detailed and well-developed scheme. Transportation planning and prioritization of transport projects needs to occur much earlier, when only rough ideas and schematic designs are available. CBA often comes too late in the process to really influence choices and planning (Beukers et al., 2012).

4 Alternatives to CBA

The shortcomings of CBA have led many to propose alternatives or improvements to the CBA process. The expansion of CBA to include environmental and social factors works to address some of the imitation of CBAs focused on direct uses and first order impacts. However, there continue to be many aspects of transport projects that are hard to quantify and monetize (for instance place-making, promoting of a certain image) and the single number value provided by the NPV analysis can disguise the uncertainty inherent to ex-ante evaluations (Macharis & Bernardini, 2015; Salling & Banister, 2010).

Many proposals have been made to improve the CBA process. Ianoco and Banister recommend using changes in land value to assess local user benefits on the micro-economic scale rather than calculating times savings multiplied by the value of time (Iacono & Levinson, 2013). Flyvbjerg, et al recommend reference class forecasting where ridership is based on the outcomes of past similar projects rather than models (Flyvbjerg et al., 2005). Below three example variations/alternatives to CBA are discussed. Other evaluation methods not discussed here include social cost benefit analysis, cost-effectiveness analysis, regional economic impact study and environmental impact assessment (Brucker, Macharis, & Verbeke, 2011).

Salling and Banister present an expansion of traditional CBA, which incorporates quantitative risk analysis (QRA), called CBA-DK. Rather than produce one result (that can be sensitivity tested) CBA-DK uses Monte Carlo simulations to analyze the range of likely possibilities for all the factors used in the CBA. This allows for a final result showing the most likely outcome and well as the distribution of other outcomes (i.e. ranges of NPV) based on the range of inputs. Uncertainly in the CBA system comes from two main places (1) uncertainly in the base factors used, such as the dollar value for VoT and (2) the accuracy of the prediction models. CBA-DK shows the range of uncertainty and the most likely predicted outcomes (Salling & Banister, 2010). Although not a full CBA, the ridership and revenue forecasts for the California High Speed Rail Authority 2016 Business Plan employed an extensive Monte Carlo simulation of risk factor impacts on the distribution of possible ridership and revenues for the high-speed rail system under construction in the state (Cambridge Systematics, 2016).

Laird, et al 2014, highlight the apparent incongruity between the estimated impact of transport projects on the economy (the Gross Value Added (GVA)) and the NPV for large transport infrastructure projects in the UK. For High Speed 2 between London and Leeds the GVA is calculated at 15 billion GBP per year while the NPV over 60 years is 63.6 billion GBP, only 4 times the annual GVA. The discrepancy is due to many factors but includes GVA's ability to better capture transformative and land value impacts. Laird, et al suggest that while CBA is still the best way to analyze transport projects GVA has a place in the assessment of mega projects that are expected to have macroeconomic impacts.

Deciding on which transport projects to build is inevitably a complicated process, requiring weighing of many different factors both quantitative and qualitative (environment, social impacts, economic). And there are often many different possible solutions to given transport problem. Multi-Criteria Decision Analysis methods can facilitate choosing between options and maximizing outcomes across metrics. There is a growing shift from CBA to multi-criteria decision analysis (MCDA) in transport project decision-making in an effort to satisfy the desire to include other factors in the analysis apart from the economic elements. This includes social and environmental impacts discusses above but also spatial and political considerations and the interest of different groups and stakeholders (Macharis & Bernardini, 2015).

5 In Summary

Cost Benefit Analysis remains the most common approach to quantitative evaluation of the net impacts of a transportation project. It has, however, a number of shortcomings. These include the difficulty in monetizing non-monetary impacts such as impacts to health and the environment. As an ex-ante evaluation tool CBA by definition is carried out under uncertainty. It is reliant on models and predictions, and is very dependant on the factors and inputs chosen. There is a conflict between the design level needed to carry out a detailed CBA and the use of CBA in the comparison of alternatives that needs to happen early in the planning and decision-making process. A number of alternatives have been proposed to improve on standard CBA. These include CBA-DK that highlights the uncertainty inherent to the analysis and MCDA, which allows for assessment of qualitative as well as quantitative impacts.

6 References

Beukers, E., Bertolini, L., & Te Brömmelstroet, M. (2012). Why Cost Benefit Analysis is perceived as a problematic tool for assessment of transport plans: A process perspective. *Transportation Research Part A: Policy and Practice*, *46*(1), 68–78. doi:10.1016/j.tra.2011.09.004

Börjesson, M., Fosgerau, M., & Algers, S. (2012). Catching the tail: Empirical identification of the distribution of the value of travel time. *Transportation Research Part A: Policy and Practice*, *46*(2), 378–391. doi:10.1016/j.tra.2011.10.006

Browne, D., & Ryan, L. (2011). Comparative analysis of evaluation techniques for transport policies. *Environmental Impact Assessment Review*, *31*(3), 226–233. doi:10.1016/j.eiar.2010.11.001

Brucker, K. De, Macharis, C., & Verbeke, A. (2011). Multi-criteria analysis in transport project evaluation : an institutional approach. *European Transport - Trasporti Europei*, *47*, 3–24.

Cambridge Systematics Inc. (2016). 2016 California High-Speed Rail Business Plan Ridership and Revenue Risk Analysis, Technical Report. http://www.hsr.ca.gov/docs/about/ridership/DR1_2016_CAHSRA_Business_Plan_Risk_Analysis_Documentation.pdf

CBC News. (2016). Toronto-York Spadina subway extension $400M over budget - Toronto - CBC News. *http://www.cbc.ca*. Retrieved May 30, 2016, from http://www.cbc.ca/news/canada/toronto/spadina-subway-cost-1.3404472

Flyvbjerg, B., Skamris Holm, M. K., & Buhl, S. L. (2005). How (In)accurate Are Demand Forecasts in Public Works Projects?: The Case of Transportation. *Journal of the American Planning Association*, *71*(2), 131–146. doi:10.1080/01944360508976688

Geurs, K. T., Boon, W., & Van Wee, B. (2009). Social Impacts of Transport: Literature

Review and the State of the Practice of Transport Appraisal in the Netherlands and the United Kingdom. *Transport Reviews*, *29*(1), 69–90. doi:10.1080/01441640802130490

Gunn, H. (2001). Spatial and temporal transferability of relationships between travel demand, trip cost and travel time. *Transportation Research Part E: Logistics and Transportation Review*, *37*(2-3), 163–189. doi:10.1016/S1366-5545(00)00023-5

Gwee, E., Currie, G., & Stanley, J. (2011). International Variation in Cost-Benefit Analysis of Urban Rail Projects. *Transportation Research Record: Journal of the Transportation Research Board*, *2261*(-1), 73–85. doi:10.3141/2261-09

Habib, K. N., & Weiss, A. (2014). Evolution of latent modal captivity and mode choice patterns for commuting trips: A longitudinal analysis using repeated cross-sectional datasets. *Transportation Research Part A: Policy and Practice*, *66*(1), 39–51. doi:10.1016/j.tra.2014.04.013

Iacono, M., & Levinson, D. (2013). Methods for Estimating the Economic Impact of Transportation Improvements: An Interpretive Review, 1–31. doi:10.4337/9780857937261.00023

Jakob, A., Craig, J. L., & Fisher, G. (2006). Transport cost analysis: a case study of the total costs of private and public transport in Auckland. *Environmental Science & Policy*, *9*(1), 55–66. doi:10.1016/j.envsci.2005.09.001

Laird, J., Nash, C., & Mackie, P. (2014). Transformational transport infrastructure: cost-benefit analysis challenges. *Town Planning Review*, *85*(6), 709–730. doi:10.3828/tpr.2014.43

Lam, T. C., & Small, K. A. (2001). The value of time and reliability: Measurement from a value pricing experiment. *Transportation Research Part E: Logistics and Transportation Review*, *37*(2-3), 231–251. doi:10.1016/S1366-5545(00)00016-8

Macharis, C., & Bernardini, A. (2015). Reviewing the use of multi-criteria decision analysis for the evaluation of transport projects: Time for a multi-actor approach. *Transport Policy*, *37*, 177–186. doi:10.1016/j.tranpol.2014.11.002

Mackie, P., Worsley, T., & Eliasson, J. (2014). Transport appraisal revisited. *Research* *in Transportation Economics*, *47*(1), 3–18. doi:10.1016/j.retrec.2014.09.013

Metrolinx. (2015). *Business Case Development Handbook, Tier 3 Guidance: Technical notes and methods*. Toronto, Ontario, Canada.

Naess, P. (2006). Cost-Benefit Analyses of Transportation Investments. *Journal of Critical Realism*, *5*(1), 32–60.

Nelson, J. P. (1978). Accessibility and the Value of Time in Commuting. *Southern Economic Journal*, *45*(1), 298–300.

Ojeda-Cabral, M., Batley, R., & Hess, S. (2016). The value of travel time: random utility versus random valuation. *Transportmetrica A: Transport Science*, *12*(3), 230–248. doi:10.1080/23249935.2015.1125398

Olsson, N. O. E., Økland, A., & Halvorsen, S. B. (2012). Consequences of differences in cost-benefit methodology in railway infrastructure appraisal-A comparison between selected countries. *Transport Policy*, *22*, 29–35. doi:10.1016/j.tranpol.2012.03.005

Pearce, D. (1998). Cost – Benefit Analysis and Environmental Policy. *Oxford Review of Economic Policy*, *14*(4), 84–100. doi:10.1093/oxrep/14.4.84

Quinet, E. (2004). A meta-analysis of Western European external costs estimates. *Transportation Research Part D: Transport and Environment*, *9*(6), 465–476. doi:10.1016/j.trd.2004.08.003

Rashedi, Z., Hasnine, S., Mahmoud, M., & Habib, K. N. (2016). Exploiting the Elicited Confidence Ratings of SP Surveys for Better Estimates of Choice Model Parameters: Case of Commuting Mode Choices in a Multimodal Transportation System. In *Transportation Research Board Annual Meeting*.

Salling, K., & Banister, D. (2010). Feasibility risk assessment of transport infrastructure projects: the CBA-DK decision support model. *European Journal of Transport and Infrastructure Research*, *10*(1), 103–120. Retrieved from http://www.ejtir.tbm.tudelft.nl/issues/2010_01/pdf/2010_01_08.pdf

Schuler, R. E., & Coulter, J. W. (1978). The effect of socio-economic factors on the value of time in commuting to work. *Transportation*, *7*(4), 381–401. doi:10.1007/BF00168038

Skamris Holm, M. K., & Flyvbjerg, B. (1997). Inaccuracy of traffic forecasts and cost estimates on large transport projects. *Transport Policy*, *4*(3), 141–146. doi:10.1016/S0967-070X(97)00007-3

United Kingdom Department for Transport. (2014). *TAG Unit A1.1: Cost-Benefit Analysis*. London.

Van Wee, B. (2007). Rail Infrastructure: Challenges for Cost–Benefit Analysis and Other ex ante Evaluations. *Transportation Planning and Technology*, *30*(1), 31–48. doi:10.1080/03081060701207995