Economic appraisal of public transport service enhancements

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Contents

Executive summary

This research project was tasked with developing recommendations on economic appraisal approaches, parameters and parameter values appropriate for application in New Zealand to assess the viability of public transport proposals (in particular service enhancements), and then to assess the effects of applying these recommendations to a sample New Zealand case study.

Economic appraisal approaches and procedures

The first focus area included an international review of economic and project appraisal approaches and procedures, with five broad approaches to project appraisal identified and assessed. A multi-criteria analysis (MCA) framework was found to be most appropriate for overall project appraisal of transport projects in New Zealand. Within this overall framework, social cost-benefit analysis (SCBA), supported by cost-effectiveness analysis (CEA), was found to be the most suited approach to economic appraisal, with CEA being most appropriate for smaller projects focusing on public transport service changes. This is consistent with existing practice in New Zealand and therefore we recommend no substantial changes to the current New Zealand approach to economic appraisal.

Six procedures from Australia, the UK, USA and New Zealand, currently used for SCBA and CEA of transport projects were then reviewed. The review focused on key methodological considerations, public transport user benefit parameters and the application of 'simplified procedures' for economic appraisal. The procedures were all based on SCBA, except in the US, where procedures were primarily based on CEA (within a MCA framework).

The public transport appraisal procedures in the New Zealand *Economic evaluation manual* (EEM) provide monetary values for travel time in different situations, generally similar to the equivalent Australian and UK evaluation manuals, although there are notable omissions relating to rail infrastructure factors and public transport mode-specific preferences. We therefore recommend that parameter values for rail infrastructure features and for mode-specific preferences be incorporated into New Zealand practice and included in the current EEM review/update. Our review, and previous reviews, also identified that practitioners find the EEM difficult to apply; we therefore recommend the EEM be redrafted to improve ease of use.

Appraisal methodology issues

Seven SCBA methodology issues were addressed, principally in the context of the EEM volume 2, and by comparing the New Zealand approach with international practices:

1. We recommend that future appraisal procedures incorporate escalation of unit parameter values over time (to reflect changes in real incomes).
2. Adoption of either equity or behavioural valuations of non-work time was reviewed but no recommendations made (as this is largely a policy decision).
3. We recommend no changes to existing EEM procedures relating to choice of willingness-to-pay or social cost basis in SCBA calculations, although the text and presentation could usefully be enhanced.
4. We recommend no changes to existing EEM procedures relating to choice of market price or factor cost units of account, although the text and presentation could usefully be enhanced.
5. Treatment of key benefit and cost items in deriving SCBA decision criteria (net present value, benefit–cost ratio ((BCR)) etc). We recommend clarification in EEM of the roles for BCR_N and BCR_G for public transport schemes.

6 Discount rate, no recommendations as not specific to public transport (needs to be addressed in a wider context).

7 Analysis period, no recommendations as not specific to public transport (needs to be addressed in a wider context).

Application of procedures

This area concluded with how economic appraisal procedures might best be applied to public transport proposals in New Zealand. We looked at the following three levels of appraisal:

1 'detailed appraisal' based on full SCBA

2 'rapid appraisal' based on SCBA with simplified consideration of externalities

3 'simple appraisal' based on CEA and including operating costs, patronage and revenue impacts.

We recommend the appraisal method for public transport proposals be tailored to ensure an appropriate level of analysis, based on a consideration of the type of proposal, cost and risk profile, and stage of the assessment within the decision-making process. We recommend further research into the selection of an appropriate level of analysis, and to determine the extent to which rapid appraisal procedures might differ for single-stage and multi-stage decision-making processes.

Public transport user benefit parameters

The second focus area considered appropriate public transport user benefit parameter values that might be applied to economic appraisal of public transport proposals in New Zealand. This involved a comprehensive review of evidence on public transport parameter values from market research undertaken since 1990 in Australia (28 studies) and New Zealand (seven studies), covering: values of travel time in a range of situations (access/egress, waiting, in-vehicle including crowding, interchanging), reliability of travel time and vehicle and stop/station quality factors. Comparisons were made with current EEM and *National guidelines for transport system management in Australia* (NGTSM) values, with the evidence analysed to identify appropriate 'default' parameter values and any gaps in the existing research evidence.

Our recommendations are as follows:

- **In-vehicle time, headway (frequency), vehicle quality and stop/station quality features**
  Recommend that any changes to these parameters in EEM be considered once the public transport pricing strategies research project is completed (refer section 5.6).
- **Access/egress (walk) time, travel time reliability and seat availability/crowding**
  Recommend no changes in these parameters in EEM (current parameter values more-or-less consistent with weight of evidence examined).
- **Interchange (wait time and transfer 'penalty')**
  Recommend changes to both these sub-parameters in the EEM. Also note need for additional New Zealand-based market research on this aspect (important in the context of service and modal integration/coordination policies being considered in Auckland, Wellington and other centres).
- **Mode-specific factors**
  Recommend that 1) these be incorporated into the EEM; 2) in the short term, adopt the NGTSM formulations; 3) in the medium term, undertake a more comprehensive review of international evidence and integrate with the findings on quality factors from the public transport pricing strategies project.

Case study

Finally, a case study based on the Wellington public transport spine study short list evaluation was undertaken to illustrate the potential application of recommended improvements to economic appraisal procedures and recommended user benefit parameter values. The case study included a 'rapid appraisal' and 'detailed appraisal', applied using EEM simplified procedures and EEM full procedures respectively. The full procedures case study included a comparison of results using recommended user benefit parameter values.

Based on our 'detailed appraisal' (using EEM full procedures), we conclude that adoption of our preferred set of public transport user benefit parameter values, in place of the current EEM values, is likely to make material differences to 'detailed' economic appraisal results for public transport proposals, in both absolute and relative terms. The case study makes a good case for implementing our recommendations on parameter values.

Based on comparative analysis of our 'rapid appraisal' (using EEM SP10 procedures) and detailed appraisal, we conclude that:

- In this particular case, the public transport user benefit estimates by both methods are reasonably similar in magnitude, and the options are ranked in the same order as in the detailed appraisal.
- While it is not clear whether such a result would be replicated for other schemes (as it is not appropriate to generalise results from a single case study), in general terms this is to be expected. The SP10 public transport user benefit estimates are driven by the number of new passengers, which in turn are driven by the level of benefits to existing passengers (which account for the great majority of public transport benefits in the detailed appraisal).
- In this particular case, the road user benefits estimated through SP10 and using detailed (modelling) procedures are very different; this reflects the particular nature and impacts of the PTSS scheme and seems unlikely to be a general finding.

We recommend a review of the EEM simplified procedures relating to the economic appraisal of public transport proposals (ie SP9 and SP10 of the EEM). Such a review should cover:

- the case for retaining simplified procedures, and a clearer specification of the circumstances in which they are in practice likely to be appropriate (taking account of the combined demand forecasting/economic appraisal task, and the stage in project development)
- if they are to be retained, then consideration of the need for two sets of procedures (as now) or their replacement by a single set (or possibly multiple sets)
- the inclusion of additional and practical advice on demand assessment (either within the context of simplified procedures and/or elsewhere in the manual)
- review and updating of any parameter formulations and values specific to the simplified procedures (eg as in SP10 table 1).

Abstract

This research project was undertaken to provide guidance on appropriate methods and benefits parameters to use in the economic appraisal of public transport proposals (in particular service enhancements) in New Zealand.

The research involved two focus areas and a case study. The first focus area included an international review of economic and project appraisal approaches and procedures, followed by a detailed assessment of selected international appraisal procedures. The second focus area involved a comprehensive review of existing New Zealand and Australian research evidence on public transport user benefit parameter values. Finally, a case study based on the Wellington public transport spine study short list evaluation was undertaken to illustrate the potential application of recommended improvements to economic appraisal procedures and recommended user benefit parameter values.

The research found that social cost benefit analysis and cost effectiveness analysis were the most appropriate methods for economic appraisal of public transport proposals in New Zealand, and that an appropriate level of analysis should be undertaken. Recommended default values for appropriate user benefit parameters were also identified.

1 Introduction

1.1 Project objectives and scope

The overall objective of this research was to provide guidance on appropriate methods and benefit parameters for use in the economic appraisal of public transport proposals (in particular service enhancements) in New Zealand. One potential application of this research project would be as an input into the NZ Transport Agency ('the Transport Agency') review of the *Economic evaluation manual* (EEM) (NZ Transport Agency 2010a; NZ Transport Agency 2010b).

The high-level scope of this research project was as follows:

- Describe economic appraisal methods used to assess the viability of investment in public transport proposals (including service enhancements).
- Describe the associated parameters and parameter values.
- Compare these against current New Zealand methodology.
- Identify a preferred approach, and associated parameters and parameter values that are most relevant to New Zealand.
- Demonstrate the recommended approach in a sample New Zealand case study.
- Recommend possible resulting enhancements to economic appraisal procedures in New Zealand for public transport services.

The research focused on the following two areas, plus a case study:

1. Economic appraisal approaches and procedures: The role of economic appraisal within the wider context of project appraisal was considered, with five broad approaches to project appraisal identified and evaluated. A more detailed assessment of procedures, focusing on key methodological considerations and benefit parameters, was then carried out for a range of procedures currently used in Australia, the UK, USA and New Zealand. Recommendations have been made in this report for improving the application of economic appraisal procedures and practices to public transport proposals in New Zealand, including potential improvements to current Transport Agency procedures.
2. Public transport user benefit parameter values: A comprehensive review of existing New Zealand and Australian research evidence on public transport user benefit parameter values, based on willingness-to-pay market research, was undertaken. This evidence was analysed to identify appropriate 'default' parameter values for use in economic appraisal procedures and to identify any gaps in the existing research evidence. 'Default' parameter values have been recommended and aspects for further research identified.
3. Case study on application of recommendations: The findings from these two research areas were applied to a case study to illustrate the potential application of recommended improvements to economic appraisal procedures in New Zealand; and the impact of adopting research recommendations for user benefit parameters and parameter values.

The consideration of demand parameters (eg elasticities), public transport supply and unit operating cost parameters were outside the scope of this research project, but would need to be considered in any 'real world' application of the recommendations in this report.

The research was undertaken by Ian Wallis Associates Ltd (Ian Wallis and Adam Lawrence) in conjunction with Douglas Economics (Neil Douglas).

1.1.1 Public transport proposals – service enhancements, network reconfigurations and infrastructure developments

The emphasis of this research project was on service enhancements and 'network reconfigurations' which, in New Zealand tend to be more common than infrastructure-based schemes. However, the public user benefit parameters and associated values considered in this research project are generally the same for all public transport proposals, whether service enhancements or infrastructure projects. The term 'public transport proposal' is therefore used throughout this report as a generic term referring to public transport service enhancements, network reconfigurations and infrastructure developments.

1.2 Project context

1.2.1 Economic appraisal of public transport proposals in New Zealand

In New Zealand, economic appraisal procedures are set out in the two-volume *Economic evaluation manual,* first released by the Transport Agency in 2006 (NZ Transport Agency 2010a; NZ Transport Agency 2010b). The first and more substantial volume (EEM volume 1) is primarily for the appraisal of roading projects, while the second volume (EEM volume 2) covers other modes, including public transport, but also depends on sections of volume 1 which focus on road-based appraisal requirements. EEM volume 2 includes simplified procedures in accompanying spreadsheets for appraising changes to new public transport services (SP9) and existing public transport services (SP10).

There have been a number of reviews/recommendations on improvements that could be made to the EEM volume 2 and its public transport procedures in particular (Ashford and Van Geldermalsen 2007; John Bolland Consulting 2006; Wallis 2007; Wignall 2012a). The Transport Agency is currently (June 2013) reviewing the EEM, and as part of the scoping stage of that review, Wignall (2012a) made the following recommendations on matters that should be addressed and that are directly relevant to this research project[1]:

- *Advice on the circumstances (preliminary evaluation, post-implementation review, non-major projects) where the mixed use of simplified procedures and full procedures is appropriate.*
- *Allowance for the comprehensive treatment of PT infrastructure and service improvements when these represent a 'package' of measures, rather than the (typical) current approach of undertaking separate evaluations.*
- *Comprehensively identify the range of potentially allowable benefits and provide advice on methods to quantify these.*
- *Updating of benefit and cost parameter values and indices up to July 2012.*

[1] A number of other recommendations were made; but these were mostly outside the direct scope of this research project.

- *Review the value of time, especially the value of PT travel time for work related travel which international comparisons reveals is currently low in both relative and absolute terms* (Wignall 2012a)

The work undertaken in this project on economic appraisal approaches and procedures dealt with the first two points above, with recommendations relating to potential improvements to EEM guidelines and procedures; particularly on the application of simplified procedures to public transport service enhancements (which often include a component of infrastructure investment). The work on public transport user benefit parameter values dealt with the last three points above, with recommendations on the value of time savings for public transport users in different journey situations, including the user benefit parameters and values appropriate for the appraisal of public transport proposals and service enhancements.

This report's recommendations are also of direct application to regional councils (in particular) and other organisations looking to justify or introduce public transport service enhancements, irrespective of whether or not they are required to follow EEM guidelines.

The EEM provides detailed guidance on the economic appraisal of projects, but economic appraisal is only one component of project appraisal and decision making, as now discussed.

1.2.2 Transport project appraisal and decision making in New Zealand

Project appraisal refers to a systematic process of defining the implications of (mutually exclusive) options for a project, to assist decision makers in deciding whether the project should proceed and which option should be selected: economic appraisal is one component of his process. A review of the various approaches to project appraisal is provided in chapter 2; one such approach being multi-criteria analysis (MCA), which is currently used by the Transport Agency in its funding decisions.

The Transport Agency, as administrator of the National Land Transport Fund, is a key decision-making body for most transport investment in New Zealand and its requirements drive most other decision-making processes[2]. The Transport Agency's decision-making requirements are set out in the *Planning and investment knowledgebase* (NZ Transport Agency 2011). The decision-making framework is essentially a form of MCA with projects assessed as ranking high, medium or low against the following three criteria:

1. Strategic fit – refers to how an identified problem, issue or opportunity aligns with the Transport Agency's strategic investment direction. Strategic fit is assessed against a stated set of strategic priorities or goals, which are derived from the *Government policy statement on land transport funding 2011/2012 – 2021/2022* (GPS) (MoT 2011). The GPS also prescribes the amount of funding available for each project type (or activity class).
2. Effectiveness – refers to the contribution that the proposed solution makes towards solving the identified problem. Guidelines on how this criterion should be applied are contained within the *Planning and investment knowledgebase.*
3. Economic efficiency – refers to the value (benefits) of the proposed solution relative to the resources used (with the rating based on benefit-cost ratio appraisal using the EEM[3]).

[2] For example, most local and regional transport projects (including public transport proposals) receive a funding contribution from the Transport Agency and therefore the Transport Agency's decision-making requirements must be followed.

[3] The benefit-cost ratio is converted into a low (<2), medium (2–4) or high (>4) rating.

The resulting three-letter 'assessment profile' is used to rank projects from 1 to 11 using a rating table specified by the Transport Agency[4]. In practice, the economic efficiency component is the only quantified factor with the other factors being subjective judgements.

1.2.3 New Zealand Treasury Better Business Cases framework

The New Zealand Treasury Better Business Cases (TBBC) framework has been developed to guide and assist government agencies seeking funding for new capital expenditure. It adopts a project appraisal approach based on 'five cases' (NZ Treasury 2012) [5]:

- Strategic case – is the proposal supported by a robust case for change?
- Economic case – does the proposal maximise value for money?
- Commercial case – is the proposal commercially viable?
- Financial case – is the proposal financially viable?
- Management case – is the proposal achievable?

The TBBC framework provides a structure for project appraisal and decision making, as discussed in section 4.2.3.1. The framework includes different 'paths' for projects and programmes and provides for a single-stage or two-stage decision-making process (depending on the scale and risk profile of the project). A key emphasis of the TBBC framework is the 'case for change'; with the strategic case the first of the five cases to be developed. The economic case is then developed, based on social cost-benefit analysis as the preferred method.

The TBBC framework is now being applied in the local government and transport sectors. It was used to prepare the Additional Waitemata Harbour Crossing preliminary business case (Price Waterhouse Coopers and NZIER 2011) and is being used as an organising structure for the *Wellington public transport spine study* (PTSS) (AECOM 2012). The Transport Agency is currently (June 2013) in the process of incorporating aspects of the TBBC framework into its own decision-making processes (National Infrastructure Unit 2012), with new procedures expected to be published prior to the next planning round scheduled for 2015/16 (D List, Transport Agency – *pers comm*, March 2013). This is significant for public transport proposals in New Zealand, as the appraisal and funding approval of these projects is dependent on meeting the Transport Agency's requirements. Further discussion on the Transport Agency's application of the TBBC is provided in appendix A.

This business case approach, particular the staged decision-making process, is being applied to transport projects in other jurisdictions. In the UK, WebTAG2 seeks to combine the UK Treasury framework (which the TBBC is based on) with the current WebTAG guidelines (DfT 2011a). The *National guidelines for transport system management in Australia* (NGTSM) (ATC 2006a) adopted a similar staged or tiered approach to transport appraisal and decision making. Further discussion on both these is provided in appendix A.

[4] Refer www.pikb.co.nz/assessment-framework/prioritisation-of-activities/

[5] The TBBC is based on the UK Treasury framework but takes some elements from the Investment Management Standard produced by the Department of Treasury and Finance in the State of Victoria, Australia (HM Treasury 2012; State of Victoria Department of Treasury and Finance 2004).

1.3 Report structure

The remainder of this report is structured around the two main research areas identified above, together with the case study and application considerations, as follows:

- Economic appraisal approaches and procedures:
  - Chapter 2 considers the role of economic appraisal (for public transport proposals) within the wider context of project appraisal. It provides a summary of various project appraisal approaches and includes an assessment of these against a number of criteria in order to determine the project appraisal approaches most appropriate for use in public transport economic appraisal in the New Zealand context.
  - Chapter 3 reviews economic appraisal procedures appropriate for the project appraisal approaches recommended above. A summary is provided of economic appraisal procedures currently used in Australia, the UK, USA and New Zealand, focusing on key methodological considerations, public transport user benefit parameters and consideration of 'simplified procedures' for economic appraisal.
  - Chapter 4 considers the application of economic appraisal procedures to public transport proposals in New Zealand, focusing on considerations for methodology and level of analysis that is appropriate to the problem being considered, eg considering of simplified procedures for smaller projects such as those involving simpler public transport service changes. Potential improvements to the application of economic appraisal procedures and practices in New Zealand are identified.
- Public transport user benefit parameter values:
  - Chapter 5 sets out the user benefit parameters relevant to the economic appraisal of public transport proposals in New Zealand. For these parameters, it includes a detailed analysis of the available New Zealand and Australian research evidence on appropriate values, recommends 'default' parameter values for use in New Zealand economic appraisal procedures and identifies any gaps in the existing research evidence.
- Case study and application considerations:
  - Chapter 6 uses a case study approach to illustrate the application and implications for New Zealand public transport economic appraisal practices and results of adopting the project's recommendations on appraisal procedures, parameter formulations and parameter values.
- Conclusions and recommendations:
  - Chapter 7 sets out the research conclusions and recommendations.
- Appendices – eight appendices, as listed on the contents page, provide additional details on some of the aspects addressed in the main body of the report, and a glossary.

2 Review of approaches to project appraisal

2.1 Introduction

This chapter considers the role of economic appraisal (for public transport proposals) within the wider context of project appraisal. A literature review of international approaches to project appraisal, including national and sub-national guidelines for project appraisal and relevant academic literature, was undertaken. The review focused on approaches that could be compared against existing social cost-benefit analysis (SCBA) procedures in New Zealand and that were suitable for *ex-ante* appraisal of public transport proposals.

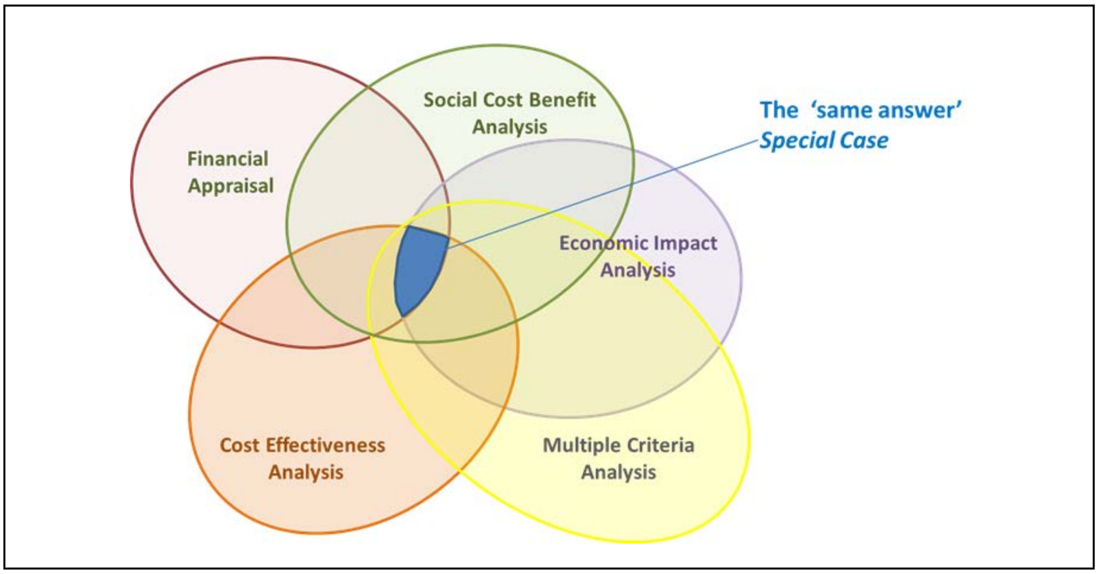
The review also sought out methods for cost-effectiveness analysis (CEA), particularly for consideration as potential 'short-cut' procedures that might be a suitable proxy for a full economic appraisal but are easier and quicker to apply. Potential 'short-cut' procedures were considered as being of particular relevance to minor public transport changes (eg changes to frequency or hours of operators). These considerations are covered later in this report (refer chapter 3).

A summary of the identified project appraisal approaches is provided below, followed by an assessment to determine those approaches most appropriate for use in the economic appraisal of public transport proposals. The last section of this chapter sets out our recommendations on the most appropriate approaches to economic appraisal of public transport proposals in New Zealand.

2.2 Project appraisal approaches

The project identified five broad approaches to project appraisal as shown in figure 2.1. These approaches are not mutually exclusive, for example a financial appraisal may form an input into a CEA or the outputs of a SCBA may be used as one of the criteria in a MCA. There is also a range of tools and methods associated with each of these approaches as set out in appendix B.

Figure 2.1 Project appraisal approaches



2.2.1 Financial appraisal

Financial appraisal compares revenue and financial costs directly attributable to a project – the normal 'business' approach. Key characteristics of financial appraisal include:

- Financial appraisal usually undertaken from the perspective of the transport operator or agency incurring the financial costs and receiving the revenues, rather than a broader social view.
- Financial appraisal requires a 'market' to exist for project inputs and outputs. For public transport services, fares may be set to capture user benefit. In making quality improvements to services, eg more comfortable buses, emphasis is placed on assessing the likely demand response and the ability to capture user benefit through fare rises (or public subsidy).
- Financial appraisal includes funding gap analysis, such as in the EEM (NZ Transport Agency 2010a), which considers incremental impacts on revenue and costs that are incurred/received by the transport operator. Also includes public transport 'farebox' analysis which may differ from funding gap analysis (eg treatment of capital charges) or calculation of 'commerciality ratios' under the new public transport operating model in New Zealand (NZ Transport Agency 2013).

Financial appraisal is often a subset of other appraisal approaches, such as SCBA, where the financial components of the approach can be separately identified and reported.

2.2.2 Cost-effectiveness analysis

Cost-effectiveness analysis compares the costs of alternative projects in contributing towards a particular objective or outcome, eg cost per life saved or cost per passenger-kilometre. In some quarters, CEA is confined to looking at costs of different options in achieving the same (equal/constant) objective or outcome. Cost-effectiveness analysis is:

- Particularly useful when options are similar in nature (ie similar impacts) and where it is not possible or feasible to value certain major benefits in monetary terms (Griffith et al 2012, p15; NSW Treasury 2007, p10).
- Sometimes considered a proxy for a full SCBA, in that all benefits and costs need to be identified. Monetary values should be placed on as many benefits as possible so they can be included with the costs. This inclusion of benefits is a key distinguishing factor between financial appraisal and CEA.
- Currently used mainly in areas such as health and education. It has been less used in the transport sector (The World Bank 2005a). Cost-effectiveness analysis can be used to evaluate multiple objectives or outcomes using a form of MCA known as a weighted CEA (The World Bank 2005b, p6).
- Often expressed in terms of a cost-effectiveness ratio which is obtained by dividing the effectiveness of a measure by its costs but where effectiveness is not necessarily expressed in monetary terms (Griffith et al 2012, p16). This then becomes a value for money measure that can also be used as part of an index to compare the degree to which alternative projects achieve a defined outcome relative to their costs.
- Not appropriate when considering projects that are intended to deliver different objectives or outcomes because there is no common basis for comparison. Cost-effectiveness analysis does not provide any information on the 'worthiness' of different objectives (weighted CEA, which is a form of MCA, can be used to differentiate between objectives).

2.2.3 Social cost-benefit analysis

SCBA measures in monetary terms the value of all benefits and costs of alternative projects in social economic terms and:

- goes further than CEA by allowing comparison of projects with different objectives or outcomes, eg comparing increased frequency against increased coverage of public transport services (provided the costs and benefits can be expressed in monetary terms)
- provides a relative measure of total economic welfare of alternative projects and does not consider distributional impacts on different groups (although it can be formulated to identify benefits to specific grounds and weightings subsequently applied)
- requires benefits and costs to be valued based on market prices. When there is no market to test consumers' willingness-to-pay, values need to be estimated, usually on a willingness-to-pay basis. Benefits that cannot be monetised need to be evaluated and reported separately.
- generally focuses on direct impacts (on users, non-users and externalities).

2.2.4 Economic impact assessment

Economic impact assessment traces the direct and indirect impacts of a project throughout the economy and:

- provides useful information on the distributive impact of projects at the local, regional or national level by tracing impacts through the economy. Choosing the correct level of analysis is important because any benefits/costs outside the scope will not be considered in the analysis
- starts by assessing the direct impact on employment and expenditure of a project, with the investment and money spent by workers then being traced through the economic system, generating further jobs. Initial impacts therefore have multiplier effects, eg an initial dollar spend may generate $1.30 of final economic activity in the study area
- when narrowly focused, typically excludes impacts on the natural environment unless
    - mitigation or prevention costs are included in the project costs, or
    - the project has damaging environmental impacts that reduce economic output (eg reduced crop yield from road dust).

  In such cases, it is usual for a separate environmental impact assessment to be undertaken.
- places reliance on monetary multiplier effects (generally market prices), which are most commonly analysed by way of input–output tables or alternative methods such as computable general equilibrium models. An input–output table shows the fraction of expenditure by one industry going to all others in the local area, region or country
- does not consider alternative uses of resources and has a number of forecasting difficulties that make it impractical for all but the very large-scale transport projects and wide-ranging policies (such as carbon fuel taxes). It is also significantly more costly to conduct in time and resources than a SCBA, unless relevant multiplier tables are already available in which case this form of analysis could be very cost effective.

2.2.5 Multi-criteria analysis

Multi-criteria analysis (MCA) compares options against a range of criteria, with results often presented in terms of a score. Criteria may have different weightings and be rated subjectively or quantitatively, with cost-effectiveness or SCBA often used as some criteria.

MCA:

- is used when there are different impacts (often qualitative) that are not easy to express on a common basis (eg dollars)
- covers a wide variety of techniques that compare options against one or more objective criteria. At one level, MCA is similar to CEA in that a data framework is provided for impacts to be quantified either subjectively (eg points based) or objectively (using appropriate physical or monetary measures)
- enables projects to be assessed against more than one objective. The main departure from other approaches is that money need not be used to cost inputs, outputs or impacts. MCA can instead use any set of weights, however derived, to develop a scoring system to rank project alternatives.
- is particularly useful at project selection in that it can offer a quick and cost effective way of short-listing projects and comparing them against strategic objectives in a structured way.

The main concern about MCA is the development and application of weighting systems. MCA can be criticised in the over-reliance on largely subjective weighting systems made by the analyst or imposed implicitly (eg equal weightings) or explicitly by the decision-maker. MCA also risks double (or more) counting of impacts.

2.3 Assessment of appraisal approaches

The project appraisal approaches identified above have been assessed to determine those most suited for use in the economic appraisal of public transport proposals in New Zealand. But first we need to acknowledge the distinction (or lack thereof) between project appraisal and economic appraisal. In much of the literature these terms are used interchangeably, for example the NSW government guidelines for economic appraisal state that:

> *[t]he purpose of an economic appraisal is not to validate a specific proposal, but to help choose the best means to satisfy a specified objective, and to rank competing proposals when resources are limited.* (NSW Treasury 2007)

This definition, however, can equally apply to project appraisal. Project appraisal essentially refers to a systematic process of analysing and comparing options in order for present sufficient information for decision-makers to make informed decisions. Economic appraisal is essentially a subset of project appraisal and is primarily concerned with weighting up economic costs and benefits to society, which are usually expressed in monetary or equivalent terms.

This assessment of appraisal approaches could be applied to any transport proposal or project, but in this instance has been undertaken particularly in the context of public transport proposals.

2.3.1 Multi-criteria assessment criteria

We have used MCA to compare the suitability of the above project appraisal approaches for use in economic appraisal of public transport proposals in New Zealand. This approach is most useful when comparing options against a number of different criteria. We note that while the subjective nature of MCA weighting systems is a key criticism, the approach does provide a useful framework for our purposes.

We have identified eight criteria for the MCA, as set out in table 2.1. We have made no attempt to derive a weighting system for our criteria, reflecting a view that the criteria are equally important and that decision-makers will have a range of views as to the relative importance of these criteria.

We also note that these criteria are inherently linked. For example, a sound basis for allocation of scarce funds could be considered the most important criterion. However, this may itself require a firm theoretical basis, consistency and commonality between appraisals, inclusion of all impacts relevant to the funding objective in the evaluation, projects to be assessed independently of scale and projects to be able to be assessed as part of a package if and when necessary. Alternatively, other criteria, such as enabling options to be evaluated against all objectives stated in relevant transport plans, might be considered of greater importance.

Table 2.1 Criteria used to assess project appraisal approaches

Criteria	Requirement
1 **Sound** basis for allocation of scarce funds	The appraisal approach should provide a sound basis for comparing the costs of options and projects based on the objectives of the funding agency/organisation. The approach should accommodate the requirements of various decision-makers. For example, transport operators (eg bus and rail operators) may focus on financial objectives, local authorities may consider a broader range of costs and benefits for their communities, and a national agency may consider national objectives in allocating scarce funds.
2 **Consistent** appraisal framework	The appraisal approach should provide a consistent, common framework for the testing of alternatives in an unbiased way. It should also accommodate inherent differences between different types of project (eg roading infrastructure vs public transport services) and potential funding distortions with other sectors of the economy.
3 **Comprehensive** consideration of costs and benefits	The appraisal approach should include all relevant inputs, outputs and impacts within the evaluation framework. In addition, the distribution of impacts should be fully described to show the incidence of inputs, outputs and impacts throughout the community.
4 **Cost-effective** to undertake appraisal and monitor outcomes	The appraisal approach should be cost-effective to undertake, placing no undue bias on options by virtue of data requirements and complicated costly analysis. The appraisal approach should enable both a stand-alone and comparative assessment of results (ie ability to assess both whether the project is better than 'doing nothing' or 'doing minimum' and whether the project is better than undertaking other 'competing' projects.
5 **Scalable** to both small and large-scale projects	The appraisal approach and criteria should be equally applicable to small projects (eg those that will produce marginal changes in service levels) and large projects (eg those that will have substantial effects on service levels).
6 Ability to assess **complementary** projects as part of a package	The appraisal approach should be able to take account of the complementary relationship between projects.
7 **Measurable** results against all project objectives	The appraisal approach should enable comparison of results against all project objectives. A distinction should be made between objectives that must be met and those that are targets to be approached. We note that economic appraisal may not be applicable to some project objectives, in which case these should be clearly identified and considered as part of the overall project appraisal process.
8 Clear **rationale** and firm theoretical framework	The appraisal approach should have a clear rationale for the types of inputs, outputs and impacts included and the relative importance placed on them. The approach should avoid 'double counting' and use parameters and values that have a firm empirical and/or theoretical basis.

2.3.2 Results of multi-criteria assessment

The assessment of project appraisal approaches is set out in table 2.2. A discussion of the results, including the recommended approach for economic appraisal is provided in the following section.

Table 2.2 Summary of MCA assessment of project appraisal approaches

Criteria	Project appraisal approach					Comments
	FA	CEA	SCBA	EIA	MCA	
1 **Sound** basis for allocation of scarce funds	×	✓	✓	×	×	CEA and SCBA both provide a sound basis for ranking different projects to allocate funds. SCBA analysis is considered superior as it can rank projects with quite different outcomes, for example a roading project against a public transport service enhancement using a measure such as benefit-cost ratio. This relies all relevant benefits and costs being identified and accurate monetary values assigned. CEA is in effect a restricted SCBA, usually because of its inability to place reliable values on impacts. CEA indices such as passenger kilometres per dollar subsidy can be used to allocate funding, but are best suited for projects with similar objectives. MCA weightings are not always transferrable between different projects and therefore can be difficult when comparing different types of projects competing for funding.
2 **Consistent** appraisal framework	×	–	✓	–	–	SCBA is the only approach providing a consistent common appraisal framework for testing alternative transport projects in an unbiased way. CEA is not transferable between different types of project, and FA is narrowly focused on financial consideration and therefore cannot provide a consistent common approach for all types of project.
3 **Comprehensive** consideration of costs and benefits	×	×	✓	✓	✓	SCBA, EIA and MCA are all suitable for showing the inputs, outputs and impacts through the community. Although all struggle with environmental and other impacts that are difficult to monetise, EIA is also restricted by the significant amount of data required. SCBA and MCA both perform strongly here, with the weighting system the main area of difference. SCBA's weighting system is based on monetary values, with impacts that cannot be valued excluded. The appraisal procedure may impose values which have been previously researched (eg the value of life, time savings) or it may require values to be locally estimated. MCA can use any weighting system but in almost all instances there is some form of value judgement (even when no weightings are applied). SCBA is considered to be better at assessing the allocative impacts of a scheme rather than the distributional impacts. Equity values are sometimes introduced in SCBA to replace behavioural values. Where the incidence of impacts is important, the evaluation should adopt a disaggregated framework. The disaggregated framework should show the incidence and distribution of impacts and effects including those not valued in monetary terms on the full range of community groups, public and private transport operators and users.
4 **Cost-effective** to undertake appraisal and monitor outcomes	–	✓	–	×	✓	MCA and CEA are the easiest and most cost-effective appraisal approaches to implement. SCBA requires further analysis and consideration of benefits but the information requirements are not as onerous as for EIA. EIAs are rarely undertaken in transport appraisals other than for large roading evaluations and airport or ferry terminal assessments because of their complexity. Input-output models are required when data is either out of date or unavailable. Even if suitable input-output models exist, the impacts of transport projects are often too small to be estimated with any accuracy.

Criteria	Project appraisal approach					Comments
	FA	CEA	SCBA	EIA	MCA	
5 **Scalable** to both small and large scale projects	✓	×	✓	×	✓	FA, SCBA and MCA can be applied to both small and large projects. CEA indices such as passenger kilometres per dollar subsidy are criticised as being scale dependent, eg more appropriate for the evaluation of marginal changes to existing service levels than for the introduction of new services. EIA is not suited to smaller projects as the impacts may be too small to identify within the EIA analysis.
6 Ability to assess **complementary** projects as part of a package	–	–	–	–	✓	Projects may be developed as part of a 'package' to satisfy one or more planning objectives. Irrespective of the evaluation approach adopted, separating out the individual impacts of each package component is difficult at best and meaningless at worst. MCA offers the easiest approach especially if based on judgement although the results may simply describe the preconceived ideas of the analysts and planners. The main problem for package appraisal is that the total impact of the package is likely to differ significantly from the sum of the individual package components. Specification of the 'base case' for each project evaluation then becomes difficult. If funding constraints exist, not all the package projects may be able to be implemented and it may be necessary to re-appraise the entire package.
7 **Measurable** results against all project objectives	×	–	–	×	✓	MCA is the only approach that fully provides for the consideration of non-monetised impacts.
8 Clear **rationale** and firm theoretical framework	✓	×	✓	✓	×	Approaches for SCBA and EIA are well established and based on sound economic theory, with FA also based on a sound theoretical framework. CEA and MCA approaches, however, depend on the objectives being measured and how these are compared and therefore does not have as clear a rationale.

Key: ✓ Likely to more than meet the criteria in most applications; × Unlikely to meet the criteria in most applications; Neutral (may meet or fail criteria dependent on criteria application and specification).

Abbreviations:

FA financial appraisal

CEA cost-effectiveness analysis

SCBA social cost-benefit analysis

EIA economic impact analysis

MCA multi-criteria analysis

2.4 Recommended approach for economic appraisal

The above assessment is relevant when considering the requirements of any transport proposal. In this case it was undertaken for the purpose of assessing the suitability of the various approaches for the economic appraisal of public transport proposals in New Zealand.

Our recommended approach for the economic appraisal of public transport proposals is SCBA, supported by CEA. This recommendation applies to all public transport proposals; whether changes to existing routes, network-wide reviews or public transport infrastructure projects.

SCBA provides a value in money terms of all project benefits and costs, to whomever they may accrue, and also meets the requirements of most of the above assessment criteria. SCBA is considered the most suitable approach for economic appraisal generally; it uses a consistent approach that is applicable to all alternatives in an unbiased way, is equally applicable to both small and large projects and provides for the widest assessment of economic impacts.

CEA meets only a few of the criteria but is considered the most appropriate appraisal approach for projects where a full SCBA cannot be justified. CEA identifies the effectiveness of achieving particular objectives relative to costs involved. CEA benefits are not necessarily expressed in monetary terms but can be expressed in terms of a particular objective or outcome (eg cost per passenger). CEA is considered to be of particular relevance in the application of 'simplified procedures' for economic appraisal and is considered especially suited to minor public transport proposals, where there are few externalities and where changes can be compared against existing operations. CEA is also suited to comparing efficiency outcomes such as farebox recovery.

FA and EIA are not recommended. EIA is not recommended because it is not suitable for smaller projects where impacts through the wider economy may be hard to identify and can be costly to develop and implement. FA is not comprehensive enough to be considered, but will usually be required at some point to establish the need for and amount of funding. FA often forms part of a wider appraisal, and is often included as a subset to SCBA where the financial components of analysis can be separately identified and reported.

Economic appraisal is only one part of a wider project appraisal and decision-making process. It is therefore important that the process and requirements (including data requirements) are consistent with the wider decision-making processes in the relevant country. We note that our preferred approach for project appraisal would more generally be a MCA framework supported by SCBA, with SCBA providing the economic appraisal. This would allow all project impacts, including those for which monetary values could not be identified, to be compared alongside each other. This approach would be similar to that used in the UK where the transport appraisal guidelines, WebTAG, require the preparation of an 'appraisal summary table'. The Transport Agency's project appraisal and decision-making procedures summarised in section 1.2 also include a combined MCA/SCBA approach to project appraisal, as does the NGTSM in Australia. The TBBC provides an alternative approach, where 'business cases' are prepared for different components of the project (ie the five case model).

3 Review of economic appraisal procedures

3.1 Introduction

This chapter provides an overview of SCBA and CEA procedures currently used in Australia, the UK, USA and New Zealand for the economic appraisal of public transport proposals. The following six procedures were reviewed:

- New Zealand – NZ Transport Agency (2010a; 2010b) *Economic evaluation manual* (EEM)
- Australia – Australian Transport Council (ATC) (2006e) *National guidelines for transport system management in Australia* (NGTSM)
- Australia – Transport for New South Wales (Australia) (2012) *Principles and guidelines for economic appraisal of transport investment and initiatives – draft* (TfNSW)
- United Kingdom – Department for Transport (2011b) *Transport analysis guidance – WebTAG* (WebTAG)
- United Kingdom – Transport for London (2008) *Business case development manual* (TfL)
- United States – Federal Transit Administration (2013) *Proposed new starts and small starts policy guidance* (USA new starts).

These procedures were selected to reflect current practice and to cover national guidelines from leading countries in the field of transport economic appraisal. These procedures also include a selection of sub-national guidelines relevant to the appraisal of public transport proposals.

We note there are a number of other national and sub-national guidelines that have not been reviewed. Many of these other guidelines are largely comparable to the procedures summarised here, eg guidelines from countries such as Ireland (Department of Transport 2009) or states such as Victoria in Australia (DoT 2010). Some guidelines were not included in the review due to their age, such as Canada's guide to cost-benefit analysis published in 1994 (Transport Canada 1994).

The review focused on key methodological considerations, public transport user benefit parameters and consideration of 'simplified procedures'. It considered all benefit parameters included in the procedures reviewed (refer appendix C) but the primary emphasis was on public transport user benefits.

3.2 Key methodological considerations

A summary of the decision-making criteria included within the six approaches reviewed is provided in table 3.1. The procedures across Australia, New Zealand and the UK are all based on SCBA and are generally comparable, but emphasising different areas[6]. The US procedures focus on CEA within a MCA framework, but are not as advanced as the other procedures reviewed in terms of economic appraisal[7].

[6] All the procedures reviewed also had a multi-criteria analysis element embedded in the decision-making processes, whether this was implicit or explicit (eg by way of an appraisal summary table).

[7] The study team had some difficulty in identifying any relevant federal level guidelines. We note that the Transport Cooperative Research Program in the USA includes a large number of published reports on advanced economic appraisal methodologies, but the extent to which any of these documents form part of official procedures was not clear. They were therefore not included in this review. The complexity of the system in the USA and scope of this project limited further investigation into this area.

Nonetheless, we consider CEA an important component of economic appraisal, particularly for smaller projects and service changes, and is included in a supporting role in some of the other procedures reviewed. Key methodology considerations for SCBA and CEA are each discussed separately below.

Table 3.1 Comparison of economic appraisal procedures – decision criteria and associated considerations

Aspect of methodology		Economic appraisal procedure					
		NZ EEM	**Aust. NGTSM**	**Aust. TfNSW**	**UK WebTAG**	**UK TfL**	**USA new starts**
Approach	SCBA	✓	✓[(a)]	✓	✓	✓	x
	CEA	✓	–	✓	×	×	✓
Decision criteria	Net present value (NPV)	✓	✓	✓	✓	✓	x
	Benefit-cost ratio (BCR)	✓	✓	✓	✓	✓	x
	First year rate of return	✓	✓	✓	x	x	x
	Internal rate of return	×	✓	✓	x	x	x
	Multi-criteria	✓	✓	✓	✓	✓	✓
Period of analysis	Discount rate (%)	8	Varies	7	3.5	3.5	n/a
	Evaluation period (years)	10–30	20–50	20–50	60	3–40	1–20
	Residual values allowed	✓	✓	✓	✓	✓	x

Notes:

Key: ✓ = covered in procedures; × = not covered; – = unclear/inconclusive

(a) The NGTSM includes procedures for an 'adjusted benefit–cost analysis', which is a hybrid of SCBA and MCA that retains the use of dollar values. This adjusted methodology provides a formal way to re-weight or incorporate non-efficiency objectives, eg for safety or environmental outcomes (ATC 2006c).

3.2.1 Social cost-benefit analysis

The review of economic appraisal procedures for SCBA included consideration of key methodological matters. The following issues were considered to be of particular relevance when applying SCBA to public transport projects in New Zealand:

- variation of unit parameter values over time
- adoption of 'equity' or 'perceived' valuations of non-work time
- choice of SCBA calculus – willingness-to-pay or social cost basis
- choice of units of account – market prices or factor costs
- basis for BCR calculus – benefit and cost definitions
- discount rate (brief comments)
- analysis period (brief comments).

These issues have been considered in the context of the EEM procedures for appraisal of public transport projects in New Zealand, as set out in in table 3.2 and appendix D[8]. In relation to these issues, we would

[8] There are numerous other issues that might be addressed but those set out above were considered to be among the most important in the New Zealand context. Further consideration of methodological issues was not part of this research project.

recommend that the EEM volumes 1 and 2 be updated to provide for future year escalation of unit values for time-related parameters in line with forecast changes in real incomes. In relation to the other issues examined, the EEM volume 2 is largely in line with leading international practices, although it is apparent from our review and from previous reviews (eg Ashford and van Geldermalsen 2007) that practitioners find the current EEM volume 2 difficult to apply. We would therefore also recommend that the EEM volume 2 be redrafted.

Table 3.2 Key methodology considerations for SCBA and recommended changes to EEM procedures

Issue	Conclusions and recommendations
Main issues	
Variation of unit parameter values over time	• This issue relates to the variation of unit parameter values over time, and whether they should be escalated to reflect income changes. • Current EEM procedures have constant (real terms) unit benefit parameters over time, for time savings and related parameters. • Prevailing international practice is for time-related unit parameters to be escalated for future years with some measure of real incomes (in some cases with an elasticity factor such that unit values increase at a slower rate than income). • We recommend the EEM be updated to adopt the prevailing international practice in this regard. This is already being adopted in recent urban transport modelling in New Zealand. • Aspects to be considered in more detail include: - the measure of real incomes to be used - the application of the adjustments to working time, non-working time and accident costs - whether in each case the income elasticity factor should be 1.0 or a lesser factor.
Adoption of 'equity' or 'perceived' valuations of non-work time in economic appraisal	• Current EEM procedures stratify unit values of non-work time by mode, trip purpose and person role/situation. However, there is no stratification within the public transport modes (eg bus vs train). • For economic appraisal purposes, a number of other countries adopt a common ('equity') value of non-working time applying across all modes and trip purposes (but maybe allowing for variations in relation to, for example, walking/waiting time and standing in-vehicle time (IVT)). • We make no recommendations on any changes in this regard to New Zealand procedures: essentially the adoption of 'equity' valuations would involve a policy rather than a 'technical' decision. However, if a move towards 'equity' values is contemplated, we recommend careful exploration of all the issues involved as appropriate.
Choice of SCBA calculus – willingness-to-pay or social cost basis	• Current EEM procedures essentially adopt a willingness-to-pay approach. This has the advantage of enabling costs and benefits to be readily disaggregated between the various parties affected, and between 'hard' (financial) and 'soft' (non-financial) components. • This approach is consistent with the approach increasingly adopted in leading international SCBA practices over the last 10 years. • We recommend no changes to the EEM procedures in this regard, although the EEM volume 2 text and presentation could usefully be enhanced.
Choice of units of account – market prices or factor costs	• Current EEM procedures adopt the 'market prices' approach (ie costs include indirect taxes), which is consistent with values resulting from willingness-to-pay research. • This is consistent with leading international practice (in conjunction with use of the willingness-to-pay approach, as above). • We recommend no changes to the EEM procedures in this regard (although some of the text could usefully be enhanced).

Issue	Conclusions and recommendations
Main issues	
Basis for BCR calculus – benefit and cost definitions	• The focus has been on appraisal methods from a national perspective, as per usual practice for SCBA, but comment is made here on methods from a government perspective also, reflecting both financial and economic factors. • Current EEM procedures appear technically sound in relation to three sub-issues examined: - items to be categorised as 'costs' in the BCR denominator - the merits in expressing BCR performance from a national economic perspective (BCR_N) or from a public funding perspective (BCR_G) - the treatment of fare revenues as a component of benefits. • In updating of EEM volume 2, we recommend attention be given to: - the need for BCR_N appraisals for public transport proposals - clarification of the text in a number of respects, including the treatment of fare revenues in benefit assessment.
Other issues (brief consideration)	
Discount rate	• Current EEM procedures specify a discount rate of 8% pa (real terms) over the project appraisal period. This rate was reduced from the previous value of 10% in 2008, following a review by the NZ Treasury. • The current New Zealand rate is towards the high end of discount rates used in economic appraisals of transport projects internationally. The current UK rate is 3.5%. • Parker (2009) undertook a review of the discount rate for the Transport Agency, as part of a research project. He concluded that: '…using a social time preference rate is most appropriate. This might range from 3%–5% real rather than the current 8% real, with 4% being appropriate'. (Parker 2009) • Given that the discount rate issue is not specific to public transport proposals, and given Parker's relatively recent in-depth review, we have not undertaken further work on this aspect.
Analysis period	• This may be considered in parallel with, and related to, the discount rate aspect above. As noted by Parker (2009): 'Given that the analysis period is based upon the discount rate, lowering the discount rate should increase the analysis period.' • The maximum analysis period advised in the EEM procedures is 30 years (having been increased from 25 years in 2008, when the discount rate was reduced). This period is towards the low end of the range found in both UK and Australia. • For public transport proposals, the EEM does not appear to be specific on the period to be adopted. For public transport services, the Transport Agency advises that the normal period to be adopted is 12–15 years (depending on contract length); but for public transport schemes involving substantial capital investment, we assume a 30-year period would normally be adopted.

3.2.2 Cost-effectiveness analysis

CEA is in effect a restricted SCBA, restricted in terms of its ability to place reliable values on many impacts, but is generally easier and cheaper to apply than a full SCBA. CEA is most useful when appraising changes to existing public transport services, where changes can be compared against existing operations and any externalities are generally minimal.

The US Federal Transit Administration (2013) 'new starts and small starts' guidelines were the only CEA procedures reviewed and are discussed further in section 3.4.3. A number of other procedures identified CEA as having a supporting role (eg NZ Transport Agency 2010b; Transport for NSW 2012), the Transport Agency also uses CEA internally when reviewing funding levels for existing systems as part of the National Land Transport Programme (refer section 1.2.2).

We expect that most public transport authorities and major operators use CEA in some form, but this informal use has not been reviewed by this study as such use is generally not well documented.

3.2.3 Comment on financial appraisal

Financial appraisal (FA) will usually be required at some point to establish the need for and amount of funding. FA often forms part of a wider appraisal, and is often included as a subset to SCBA or CEA where the financial components of analysis can be separately identified and reported. FA is also an important component of the new public transport operating model (known as PTOM) in New Zealand, for example in the application of new 'commerciality ratios' and benchmarking, and will be an important consideration in any changes to public transport services.

3.3 Public transport user benefit parameters

The review of economic appraisal procedures internationally included consideration of the public transport user benefit parameters that the procedures covered. These are shown in table 3.3 for New Zealand (EEM) together with five sets of procedures used in other countries. A wider comparison of benefit parameters, including externalities, is provided in appendix C. Our conclusions and recommendations on parameters for inclusion in economic appraisal procedures in New Zealand are discussed in chapter 5.

Most of the procedures reviewed included comprehensive coverage of public transport user benefit parameters within a SCBA framework, with the USA being a notable exception (based on CEA). Monetary values are available for most of these parameters, although interestingly WebTAG does not monetise travel time reliability. In regards to access time, the EEM is unclear as to treatment of walk access, and in all the procedures car and bus access modes have (at best) only passing mention. Public transport mode-specific factors appear to be available only in the Australian NGTSM. Transport for London identified pre-journey/ticketing as a separate parameter, although this appears to risk double counting as it is generally included as part of other quality factors (we therefore do not recommend further investigation of separate values for this parameter). Infrastructure and vehicle quality are covered by all the procedures, although it is unclear whether WebTAG provides any parameters for bus infrastructure/vehicles.

Economic appraisal procedures should include consideration of all relevant benefits (and costs). A summary of all benefits included in the various procedures reviewed is provided in appendix C. Road traffic system (decongestion) benefits are covered by most of the procedures. Of interest, Transport for London does not appear to require consideration of these benefits, except for accident cost savings. Parking cost savings are included in the EEM and WebTAG but not the other procedures. In regards to environmental factors, travel demand management (TDM) factors[9], wider economic benefits and national strategic factors there is a range of treatments with some benefits monetised and others not. We note that any parameters that have not been monetised would need to be reported alongside any SCBA, for example, as part of the 'appraisal summary table' required by the WebTAG guidelines.

[9] TDM is defined in chapter 2.1 of the EEM volume 2 as follows: 'Transport demand management (TDM), includes various strategies that encourage more efficient and sustainable travel and transport behaviour. TDM has the objective of encouraging motor vehicle users to use alternative, more sustainable, means of transport when appropriate, while also reducing total vehicle kilometres travelled. TDM is an increasingly common response to urban traffic congestion and pollution issues, and to reduce general issues associated with vehicle dependency.'

Table 3.3 Comparison of economic appraisal procedures – public transport user benefit parameters

Benefit parameters		**Economic appraisal procedure**					
		NZ EEM	**Aust. NGTSM**	**Aust. TfNSW**	**UK WebTAG**	**UK TfL**	**US 'new starts'**
Value of IVT	IVT (standard values)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	x
Journey time attributes	Access time • walk time (access/egress) • car access • public transport access[a]	 ✓(M)[e] × ×	 ✓(M) × ×	 ✓(M) ✓(M) ✓(M)	 ✓(M) – –	 ✓(M) – –	 x x x
	Headway (service interval)[b]	✓(M)	✓(M)	✓(M)	✓(M)[h]	✓(M)	x
	Seat availability/crowding	✓(M)	✓(M)	✓(M)[g]	✓(M)[h]	✓(M)	x
	Interchange (transfer penalty and wait time)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	x
	Reliability of travel time[c]	✓(M)	✓(M)	✓(M)	✓(N)	✓(M)	x
	Mode-specific factors[d]	×	✓(M)	×	–	–	x
	Pre-journey/ ticketing	x	x	x	x	✓(M)	x
Quality attributes	Vehicle features	✓(M)	✓(M)	✓(M)	✓(M)[i]	✓(M)	x
	Stop/station features	✓(M)[f]	✓(M)	✓(M)	✓(M)[i]	✓(M)	x

Notes:

Key: ✓(M) = monetised parameter; ✓(N) = non-monetised parameter; – = unclear/inconclusive; × = not covered

(a) Public transport access time (eg bus/ferry access to rail) is considered a 'transfer' and covered under 'interchange' in most procedures.

(b) Headway (service interval) is often referred as the expected wait time at a stop or station.

(c) Reliability of travel time includes unexpected wait time at stop or station and unexpected IVT (eg delay due to congestion).

(d) Mode-specific factors are also known as alternative specific constants.

(e) EEM is unclear as to treatment of walk access

(f) EEM provides parameters for bus stop and station features only (ie excludes rail).

(g) TfNSW seat availability/crowding parameters provided for rail only.

(h) WebTAG headway (service interval) and seat availability/crowding parameters provided for rail only.

(i) WebTAG quality attributes are provided for rail, it is unclear if any apply to other modes.

3.4 Consideration of 'simplified procedures' for economic appraisal

The review of economic appraisal procedures included consideration as to whether there was provision for 'simplified procedures': the results are summarised in table 3.4. The recommended application of simplified procedures is discussed in chapter 4. The use of EEM simplified procedures, including conclusions, is also covered in the case study in chapter 6.

The EEM was the only procedure to include specific simplified procedures for public transport project appraisals, although the NGTSM includes a 'rapid appraisal' stage and provision for simplified road user benefit parameters. The US Federal Transit Administration (2013) 'new starts and small starts' procedures might itself be regarded as a simplified procedure, although not considered suitable for New Zealand. These three procedures are discussed in turn below.

Table 3.4 Comparison of economic appraisal procedures – provision for 'simplified procedures'

Consideration		Economic appraisal procedure					
		NZ EEM	Aust. NGTSM	Aust. TfNSW	UK WebTAG	UK TfL	US 'new starts'
Provision for simplified procedures		✓	✓ (c)	×	×	×	✓
Benefit parameters included(a)	Public transport user benefits	✓(M)(b)	×	×	×	×	✓(N)
	Road user benefits	✓(M)	✓(M)(d)	×	×	×	✓(N)

Notes:

Key: ✓(M) = monetised parameter; ✓(N) = non-monetised parameter; × = not covered.

(a) The review of procedures included consideration as to whether any specific 'public transport user benefits' and/or 'road user benefits' were identified for inclusion in 'simplified procedures'.

(b) EEM provides for 'public transport user benefits' when appraising existing public transport services but not when appraising new services.

(c) Aust. NGTSM includes 'rapid appraisal' and 'detailed appraisal' in the decision-making process.

(d) Aust. NGTSM includes procedures for calculation of decongestion benefits.

3.4.1 NGTSM 'rapid appraisal'

The 'rapid appraisal' methodology is contained within the NGTSM and is intended to provide a means of gauging whether or not an initiative is likely to pass a detailed appraisal (also refer section 4.2.3.2 for further discussion on NGTSM appraisal). This is different from the EEM 'simplified procedures' (below), which provide an alternative assessment framework for certain types of project. In regards to rapid appraisal, the NGTSM states that:

> *A rapid BCA allows consideration of monetised benefits and costs. In a rapid appraisal, non-monetised benefits and costs also need to be explored at an indicative level. The AST [Appraisal Summary Table] can be used to summarise both monetised and non-monetised impacts.*
>
> *The methodology used for rapid BCA is the same as for the detailed BCA outlined in Part 2 of this volume. However, the estimates for a rapid BCA are less precise and the benefits and costs that are small, or difficult to estimate, can be omitted altogether.*
>
> *The majority of initiatives submitted for rapid appraisal are likely to be at an early stage of development, with limited planning and limited available data. An estimate of investment costs is essential. Based on the experience of Australian jurisdictions, the expected margin for error in rapid BCAs for investment costs is ±40 per cent.* (ATC 2006c)

The NGTSM requires costs and benefits to be estimated using default parameter values (eg for externalities). Where this cannot be done within the limits of a rapid appraisal a qualitative description of impacts is required, with quantitative measure in physical units where possible. However, benefit (and cost) items that are difficult to estimate can be omitted altogether at the rapid appraisal stage.

3.4.2 EEM 'simplified procedures'

The EEM volume 2 includes sets of simplified procedures for new passenger transport services (SP9) and changes to existing passenger transport services (SP10), as well as for the economic appraisal of various types of non-public transport proposal. The key features of SP9 and SP10 are set out in appendix C. Points relating to the application of these procedures include:

- The EEM states SP9 may be used for the evaluation of all new public transport services, and SP10 for improvements to all existing public transport services. The EEM does not set out any clear distinction between these two types of schemes.
- The EEM material places no restrictions on the use of the simplified procedures in terms of the size and nature of the scheme or the stage in the development/appraisal process involved. However, it does note a number of simplifying assumptions made in the procedures – which would discourage their use if the assumptions are not largely met. These include, for both sets of procedures, their intended use for schemes that predominantly benefit peak-period travellers.
- The guidance given on the use of SP10 appears to be generally comprehensive; while that for SP9 is less so, as it is unclear how the guidance would be applied in practice (refer appendix G).

Further discussion of issues arising in the application of EEM 'simplified procedures' (SP10 in particular) is provided in chapter 6 and appendix G.

3.4.3 Federal Transit Administration 'new starts and small starts'

The Federal Transit Administration (2013) 'new starts and small starts' is a simplified procedure for economic appraisal, in that it does not include all benefits and costs. A summary of the requirements for the evaluation and rating of major new transit investments seeking federal funding contributions under the discretionary 'new starts' and 'small starts' programmes is provided in table 3.5.

The procedures focus on CEA within a MCA framework, but are not as advanced as the other procedures reviewed in terms of economic appraisal. For example, the application of measures is inconsistent, with some measures expressed relative to project costs (cost effectiveness, environmental benefits) while others are expressed in 'total' terms. The logic for this is unclear and it does not seem appropriate to treat environmental benefits differently in this regard from mobility, economic development and land use effects. Also, the lack of a measure for congestion relief is rather surprising. In regards to the MCA element of the procedure, the approach of giving all measures equal weight, and, it appears, equal weight to various sub-measures within the main six measures, is clearly simplistic.

Table 3.5 Federal Transit Administration (2013) project justification criteria and measures for 'new start and small starts' projects (US Code, title 49, section 5309)

Criterion[(a)]	Measure summary[(b)]	Research team comments
Mobility improvements	Total number of linked trips using the proposed project (with trips by transit-dependent persons given desirable weighting)	Number of trips relates to all trips using the project, not just incremental trips resulting from the project.
Economic development effects	Extent to which a proposed project is likely to enhance additional, transit-supportive developments in the future, based on a qualitative examination of the existing local plans and policies to support economic development proximate to the project.	Involves a complex and subjective rating system under six categories and various sub-categories.
Environmental benefits	Based on the dollar value of the anticipated direct and indirect benefits to human health, safety, energy and the air quality environment divided by the annualised cost (capital expenditure + operating expenditure) of the project.	Assessment based on complex set of factors applied to change in vehicle miles travelled.

Criterion[(a)]	**Measure summary**[(b)]	**Research team comments**
Cost effectiveness	Annualised (capital expenditure + operational expenditure costs) per trip using the project.	Number of trips relates to all trips using the project, not just incremental trips resulting from the project. Costs are incremental annualised costs associated with project (relative to 'do minimum').
Land use	'. . . include an examination of existing corridor and station area development; existing corridor and station area development character; existing corridor and station area pedestrian facilities, including access for persons with disabilities; existing corridor and station area parking supply; and existing 'legally binding affordability restricted' housing in the corridor and station areas.'	Intention to 'base the rating primarily on quantitative measures', but inevitably a considerable degree of subjectivity.
Congestion relief	Not yet developed.	All projects to be given equal weighting, pending development of a measure for congestion relief.

Notes:

[(a)] These six criteria are set out by law. In addition, a seventh criterion relates to potential projects having an acceptable degree of local financial commitment.

[(b)] All six criteria to be given equal weight. In application, the score against each measure is converted to a rating (five-point scale H, MH, M, ML, L).

4 Considerations for application of economic appraisal procedures in New Zealand

4.1 Introduction

This chapter considers the application of economic appraisal procedures to public transport proposals in New Zealand, focusing on methodology and the appropriate level of analysis for the problem under consideration, eg simplified procedures for smaller projects such as those involving simpler public transport service changes. Potential improvements to the application of economic appraisal procedures and practices in New Zealand are identified.

The economic appraisal of public transport proposals (and other projects) must be considered within a wider decision-making framework. This research project assessed economic appraisal approaches and procedures for application to public transport proposals and the circumstances in which theses might be applied.

We have therefore focused on one application consideration, albeit an important one, which is the determination of an appropriate level of analysis for public transport proposals in New Zealand.[10.] This chapter discussed the appropriate level of analysis, before recommending three levels of analysis for economic appraisal and the basis for selection.

4.2 Consideration of appropriate level of analysis

The consideration of an appropriate level of analysis is about making sure that the analysis is appropriate to the relevant decision-making requirements. The NZ Treasury (2005) *Cost benefit analysis primer* states that:

> *The extent or depth of the analysis should be tailored to the relative size, impacts, and risks of the proposal. Not all proposals will require full cost benefit analysis or involve all the detailed elements…*

Determining an appropriate level of analysis is essentially about making sure the level of analysis applied to project appraisal is commensurate with the change or problem being considered. Three factors that the research team considered as being of particular relevance in determining the appropriate level of analysis were:

- type of proposal
- cost and risk profile
- stage of assessment

These are discussed below. We note that the TBBC approach provides a good framework for the consideration of many of these matters.

[10] We note that this research project was not tasked with developing or recommending full procedures (ie specific methods for completing an economic appraisal) but some guidance on selecting an appropriate appraisal method has been provided.

4.2.1 Type of proposal

The type of proposal is relevant in determining the appropriate level of analysis. This is similar to the cost and risk consideration below, but focuses more on the different characteristics of various projects. The consideration of the type of proposal is also different from the cost and risk of the project in that the 'thresholds' for acceptable costs and risks will most likely vary depending on the type of proposal.

The need to consider the type of proposal in determining the appropriate level of analysis is already reflected in the EEM, with the inclusion of 'simplified procedures' for the appraisal of new public transport services (SP9) and changes to existing public transport services (SP10) (NZ Transport Agency 2010b). These simplified procedures reflect that the nature of changes resulting from public transport service reviews often involve no significant infrastructure investment. In many cases service changes are focused on incremental changes to service levels required to meet customer demand, which often involves a trade-off of benefits between different groups of people (eg moving a service from one area to another)[11]. It is difficult to justify a full economic appraisal for these types of projects and in many cases a simplified appraisal focusing on operating costs and patronage/revenue impacts may be all that is required.

On the other hand, other types of public transport project do require a greater level of appraisal. These would include major new public transport investments such as the Northern Busway in Auckland (Wignall 2012b) and policy decisions with significant system-wide implications such as significant fare restructuring. In some cases, a simplified approach where the significant impacts are estimated broadly can be justified, but this would depend in large part on the cost and risk profile of the proposal, as discussed below.

4.2.2 Cost and risk profile

The cost and risk profile of a proposal is an important factor in determining the appropriate level of analysis. This section provides two examples of how this is applied, being the TBBC 'scalability matrix' for determining the required level of analysis and decision-making process, and the project type thresholds applied by the Depart of Transport in Ireland (2009).

The cost and risk profile will have a bearing on the appropriate level of analysis required, although we note the level of analysis required for a certain level of cost/risk also depends on the type of proposal (discussed above) and the requirements of the decision-making body. For public transport proposals the costs involved are predominantly for recurrent operations and for vehicles (which may be readily redeployed) rather than for infrastructure (generally sunk costs). This different mix of cost types (compared with road infrastructure projects) should be taken into account when assessing the cost and risk profile of each proposal (as well as its effective life for economic appraisal purposes).

Specific consideration of the level of cost/risk or 'thresholds' to determine an appropriate level of analysis was outside the scope of this research project.

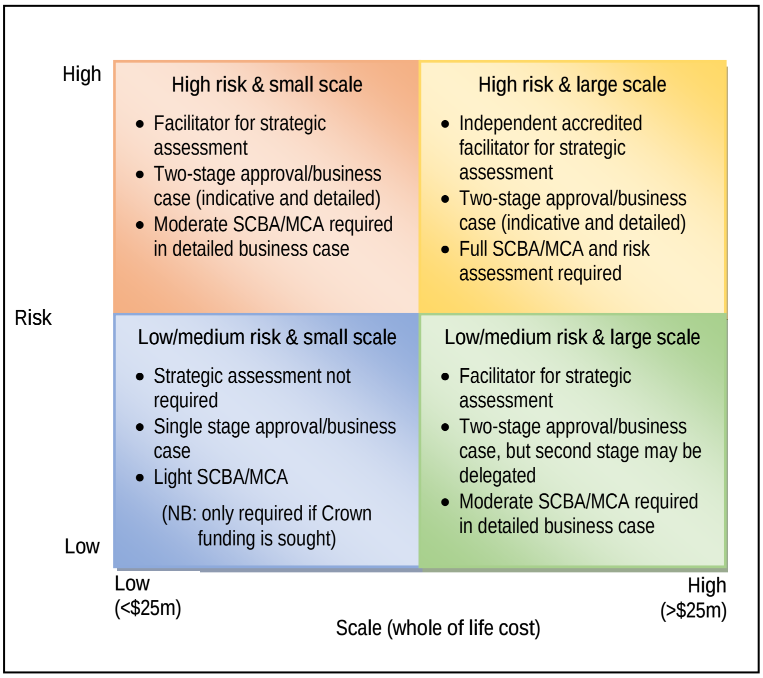
4.2.2.1 Example 'scalability matrix' used for the TBBC in New Zealand

The TBBC framework is a requirement for New Zealand government agencies seeking Cabinet approval for funding of more than $25 million but is also required for high-risk projects requiring lesser funding. Figure 4.1 sets out the TBBC 'scalability matrix' which is used to determine the level of detail required in the economic appraisal and whether a single-stage or two-stage business case is required (NZ Treasury 2012).

[11] In New Zealand, the focus in recent years has been on funding public transport service improvements through efficiency gains.

We note that the risk/cost scales in the 'scalability matrix' relate to the need for Cabinet approval but this approach could be adopted for consideration of other cost/risk scales. This may be of particular relevance to the selection of an appropriate level of analysis for public transport proposals, as discussed in section 4.4, where a suitably scaled risk/cost matrix could help to decide between detailed and rapid appraisal (primarily). We note that the type of proposal would probably be more important in determining whether the recommended simple appraisal approach might be used (eg for service changes only).

Figure 4.1 TBBC 'scalability matrix' is used to match development effort to risk, cost and type of decision. Figure adapted from NZ Treasury (2012)



4.2.2.2 Example 'thresholds' used by the Department of Transport in Ireland

The Department of Transport in Ireland provides an example of 'thresholds' used to determine the appropriate methodology (Department of Transport 2009)[12]. The guidelines state that:

> *...[the] project appraisal processes should be commensurate with the costs of projects and the degree of complexity of the issues involved. The thresholds and methodologies set out are as follows.*
>
> - *A simple assessment should be carried out for minor projects with an estimated cost below €0.5 million, such as projects involving minor refurbishment works, fit outs etc.*
> - *Projects costing between €0.5 million and €5 million should be subject to a single appraisal incorporating elements of a preliminary and detailed appraisal.*
> - *A Multi-Criteria Analysis (MCA) should be carried out at minimum for projects between €5 million and €30 million.*
> - *Projects over €30 million should have a Cost Benefit Analysis (CBA) carried out.*

[12] The Ireland procedures were not reviewed in chapter 3 as they are largely similar to the UK procedures.

The value of these thresholds is not material for our purposes, but indicates an approach where thresholds can be set to help guide the appropriate level of analysis. This is not too dissimilar to the approach used by the Transport Agency (refer section 1.2.2).

4.2.3 Stage of assessment

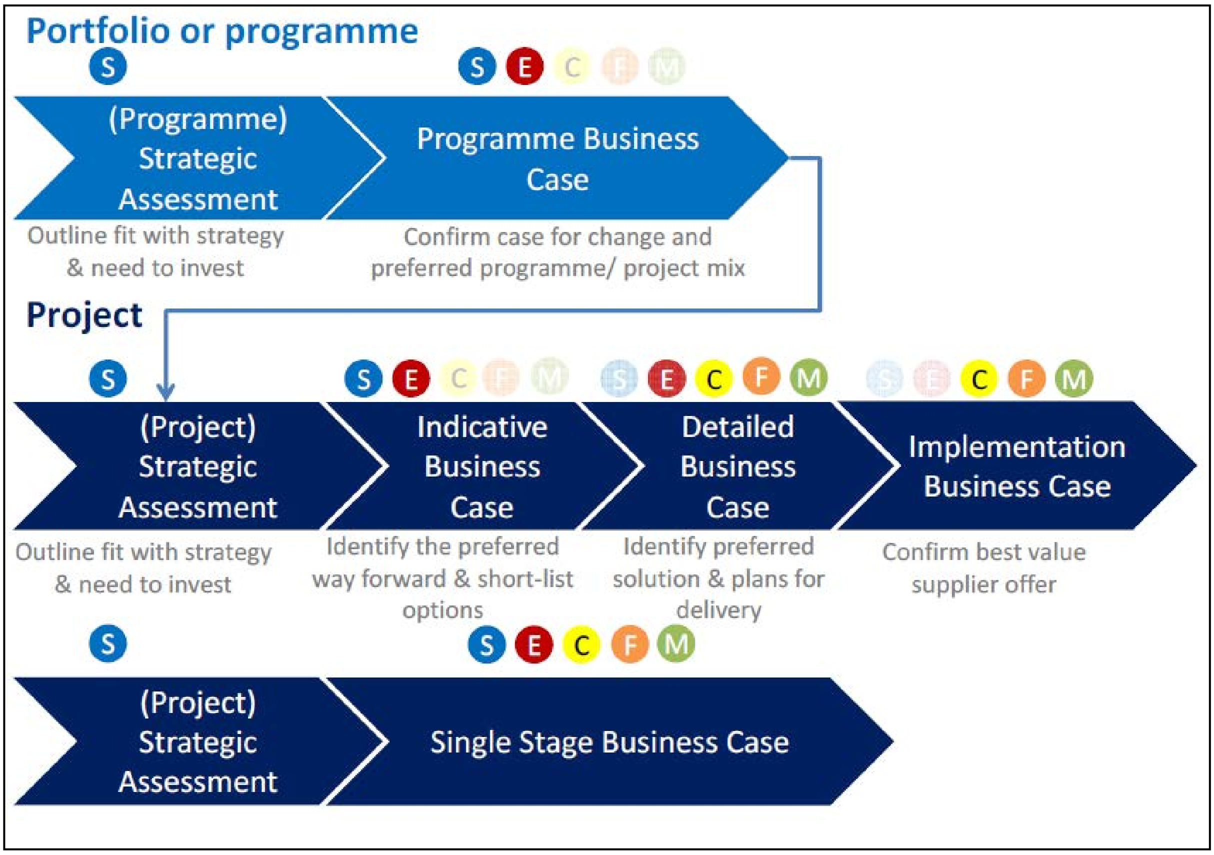
The stage of assessment within the decision-making process is an important consideration in determining the level of analysis required. This is a largely a decision-making consideration, rather than an economic appraisal, but it is important in determining the appropriate level of analysis.

A common approach to ensuring an appropriate level of analysis is by staging the level of detail required, eg a preliminary business case then a detailed business case. The TBBC framework in New Zealand and the NGTSM in Australia provide good examples of how the stage of assessment determines the level of analysis required (as outlined below). In staging the levels of analysis it is important that each stage of analysis adds value to the decision required: for smaller projects (in particular) it is likely to be more cost effective to do an assessment once rather than in stages.

4.2.3.1 Example process used for the TBBC in New Zealand

An overview of the TBBC staged decision-making process is provided in figure 4.2. This shows that as the business case is developed it progresses through various levels of assessment. The circles indicated by an 'E' show where economic appraisal is required, whether through a two-stage (ie indicative business case to detailed business base) or single-stage (single-stage business case) decision-making process (we note that the 'scalability matrix' discussed above is used to determine the required path).

Figure 4.2 Overview of the TBBC process. The coloured letters indicate the relative effort required on each of the 'five cases' – strategic, economic, commercial, financial, management (NZ Treasury 2012)

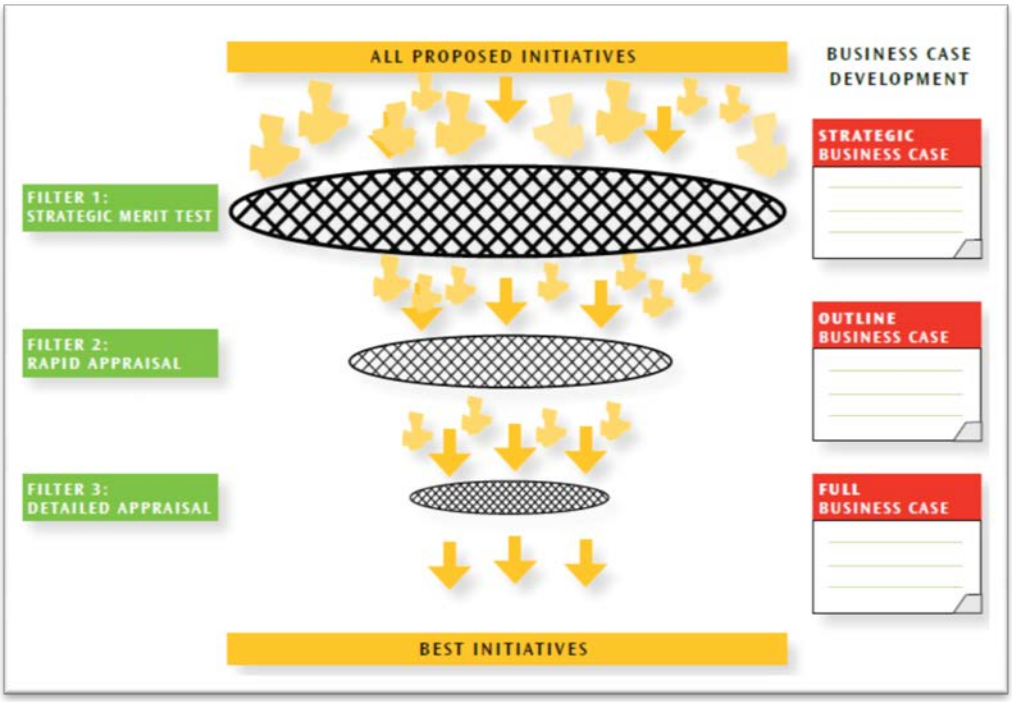


4.2.3.2 Example appraisal process used for the NGTSM in Australia

In Australia, the NGTSM sets out a three-stage appraisal process. This process is used to 'filter' out options that do not stack up as the business case is developed, as shown in figure 4.3 (ATC 2006d). A project is required to go through all three 'filters' with the required level of analysis increasing from a strategy merit test, through a rapid appraisal to a detailed appraisal. The rapid appraisal process is discussed in section 3.4.1 above).

This filtering approach is similar to the TBBC business case process, and is useful for larger projects where a detailed appraisal of all options may be very time-consuming and costly, but it may be less efficient for smaller projects where a single appraisal may suffice.

Figure 4.3 NGTSM three-stage appraisal process (ATC 2006a, p54)



4.3 Recommended levels of analysis for economic appraisal

Ensuring an appropriate level of analysis is an important consideration in the application of economic appraisal procedures to public transport proposals in New Zealand. As set out above, the type of proposal, its cost and risk profile, and its stage of assessment (within the decision-making process) are important considerations in ensuring an appropriate level of analysis.

The research team identified three levels of analysis that might be used in the economic appraisal of various public transport proposals:

- 'Detailed appraisal' – using full SCBA procedures incorporating all relevant parameters
- 'Rapid appraisal' – using SCBA procedures focusing on costs (operating and capital) and user benefit estimates and applying simplified estimates for decongestion benefits and other relevant externalities

- 'Simple appraisal' – primarily using CEA and focusing on operating costs, demand (patronage) and fare revenue impacts, with no consideration of decongestion benefits or other externalities. May also use SCBA procedures, similar to rapid appraisal.

In all these cases, the appraisal should also be supported by a FA to determine the financial impacts of the various project options, in additional to the overall 'social' impacts. A summary of the three levels of analysis and appraisal approaches is provided in table 4.1. The table includes a description of the likely project characteristics and examples of projects that might be subject to each level of analysis. Further discussion on each of these three levels of analysis is provided below.

Table 4.1 Approaches to economic appraisal and characteristics of public transport proposals

Appraisal approach/ characteristic	**Level of analysis[a]**		
	Detailed appraisal	**Rapid appraisal**	**Simple appraisal**
Recommended appraisal approach	• Social cost-benefit analysis, with detailed consideration of all relevant externalities. • A supporting FA should also be undertaken.	• Social cost-benefit analysis, focusing on operating costs and user benefits. • A supporting FA should also be undertaken. A supporting CEA may also be used. • Decongestion impacts and other externalities may be estimated using simplified procedures.	• Cost-effectiveness analysis and FA, focusing on operating costs, patronage and revenue impacts. • Optionally, rapid appraisal analysis may be used with user benefits estimated using simplified procedures. • Decongestion impacts and other externalities not generally considered.
Type of proposal	• Proposals with significant externalities and significant impacts on public transport and roading networks. • Major new public transport investments. • Policy decisions and proposals with significant system-wide implications.	• Proposals with some externalities and/or impacts on public transport and roading networks. • New public transport routes and route extensions into new areas. • Public transport corridor and area-wide reviews. • Significant changes to public transport route structure and service levels.	• Proposals with few externalities and minimal impact on public transport and roading networks. • Changes within existing public transport services. • Relative minor changes that can be easily benchmarked against existing services. • Changes to frequency and hours of operation of public transport routes.
Cost and risk profile	• Proposals likely to be both high cost and high risk. • Potential that significant new capital investment or significant new operating expenditure may be required.	• Proposals likely to have a moderate cost, but may include projects with either a high cost or high risk profile (if both high then detailed appraisal may be more appropriate). • Some new capital investment and new operating expenditure may be required.	• Proposals likely to be low cost and low risk. • Minimal new capital or operating expenditure required.

Appraisal approach/ characteristic	Level of analysis[a]		
	Detailed appraisal	**Rapid appraisal**	**Simple appraisal**
Stage of assessment	• Final/detailed assessment stage when a multi-stage decision-making process is followed. • Single stage decision-making processes and preliminary assessment stages, depending on type of proposal and cost/risk profile (refer above).	• Preliminary or intermediary assessment stages when a multi-stage decision-making process is followed. • Single stage decision-making processes, depending on type of proposal and cost/risk profile (refer above).	• Proposals requiring a single stage decision-making process, depending on type of proposal and cost/risk profile (refer above). • Preliminary assessment stages when a multi-stage decision-making process is followed, depending on type of proposal and cost/risk profile (refer above).
Example public transport proposals and projects	• Auckland North Shore Busway • Purchase of rail rolling stock • Fare structure reviews • PTSS (AECOM 2012) – refer case study.	• Area reviews. • New routes.	• Change in service span (hours of operation) or frequency. • Adjustments to public transport routes.

Notes:

[a] The terms 'detailed appraisal' and 'rapid appraisal' are used by the NGTSM but are not intended necessarily to be applied in sequential order (although they might, for example, as part of two-stage TBBC decision-making process).

4.3.1 Detailed appraisal

Detailed appraisal essentially refers to the application of full SCBA procedures including detailed consideration of all relevant externalities. This level of analysis is the most rigorous and would generally need to be supported by detailed transport modelling. It is equivalent to the existing full EEM procedures (refer case study in chapter 6).

Detailed appraisal is most appropriate for larger scale and more risky projects that involve substantial new public transport investments. It would also be carried out for any project where there is sufficient information/data readily available to do so, as a full SCBA would generally provide a more complete picture of the economic impacts than a rapid or simple appraisal.

Detailed appraisal would most appropriately be used at the 'full business case' stage of a process under the NGTSM in Australia or the 'detailed business case' stage of a process under the TBBC framework in New Zealand.

4.3.2 Rapid appraisal

Rapid appraisal is also based on SCBA procedures, but would focus more on costs (operating and capital) and direct user benefits so as to reduce the amount of effort in carrying out the appraisal. Rapid appraisal would typically use simplified procedures to estimate decongestion impacts and other relevant externalities.

Rapid appraisal would be not too dissimilar from the NGTSM 'rapid appraisal' approach set out in section 3.4.1, although in many instances would probably be the only analysis applied, ie it would not necessarily lead to a detailed appraisal as per current NGTSM procedures. Rapid appraisal would be most suited to public transport service changes (eg resulting from area-wide service reviews), which may involve some modest new capital expenditure, but not on the same scale as for detailed appraisal. Rapid appraisal may be suited to public transport network reconfigurations and public transport fare reviews, but if geographic-based demand estimation is required a detailed appraisal (involving network modelling) may be appropriate.

As discussed above, the EEM volume 2 includes simplified procedures for certain public transport service changes and new public transport services. Rapid appraisal would be applicable for these types of projects and many public transport service changes. However, for projects involving substantial network changes, detailed network demand modelling would generally be required in order to estimate demand changes (refer discussion in chapter 6), so in such cases the amount of work required is still commensurate with that required for a detailed appraisal. Rapid appraisal is intended to be easier to apply than detailed appraisal.

Rapid appraisal would most appropriately be used at the 'outline business case' stage of a process under the NGTSM in Australia or the 'indicative business case' stage of a process under the TBBC framework in New Zealand. Rapid appraisal may also be used for a 'single stage' business case under the TBBC or where a business case is not required, depending on the type of project or proposal. In multi-stage decision-making processes, rapid appraisal is used to help 'filter' options and would lead to further detailed appraisal, but where used in single-stage decision-making processes it would be the only economic appraisal undertaken. We recommend that further research be undertaken to determine the extent to which rapid appraisal procedures might differ for single-stage and multi-stage decision-making processes.

4.3.3 Simple appraisal

Simple appraisal has been introduced to recognise that some changes to public transport services (eg to operating hours and service frequency) do not require a more detailed analysis, particularly where there are minimal impacts outside those to users and the operator (plus any public funding). Also it recognises that such changes typically involve minimal (or zero) capital costs and only modest changes in operating costs, and are readily reversible (any sunk costs being small). A key distinction from detailed and rapid appraisal is that simple appraisal does not need to consider decongestion impacts or other externalities.

Simple appraisal would be based on CEA, focusing on operating costs, demand (patronage) and fare revenue impacts. It would be most suited to relatively minor changes to existing public transport services such as changes to the frequency and hours of operation of routes, but also minor changes to routes and in some cases new services (likely to be in areas adjacent to areas already served, for example the extension of bus services into a new subdivision).

Simple appraisal is not the same as 'simplified procedures' already used in Australia and New Zealand (refer section 3.4) in that those procedures still rely on the consideration of a simplified set of parameters within a SCBA framework. Simple appraisal relies on a CEA, where the impacts of the proposal are usually measured in terms of their cost effectiveness (against financial and other specified objectives). It does not take account of externalities.

As discussed in section 3.2.2, we are aware that most public transport organisations use CEA in some form but this is generally not well documented. The NGTSM (Urban transport, volume 4) includes a 'generalised cost' formulation representing the perceived user costs of public transport travel (refer section 5.2), how these are affected by changes in services and the resultant patronage and revenue impacts – this could form the basis for simple appraisal (ATC 2006e).

The application of this 'generalised cost' formation can be seen in the New Zealand Bus Policy Model, which was developed as part of an earlier research project (Wallis and Schneiders 2012). The model contained within that research provides an example of the type of methodology/tool that is suitable for the level of analysis envisaged for 'simple appraisal'.

The Bus Policy Model is designed as a scenario analysis tool, used to assess the impacts on the bus system and its performance of changes to the bus system itself (eg to services, fares or unit costs) and/or changes in external factors affecting the demand for bus travel (eg changes in fuel prices, impacts of population and urban development changes). It starts from a database of current bus operations, costs, patronage and fare revenues, disaggregated by route/route group, day of week (weekday, Saturday, Sunday) and time of day (peak, interpeak, evening).

The model incorporates a 'generalised cost' formulation, similar to that in the Australian NGTSM, and can be used to derive a set of CEA performance ratios (eg change in patronage per dollar change in operating costs) and can similarly provide FA results (eg farebox revenue/cost, change in funding requirements, etc). The model could also readily be further developed to derive user benefits and hence provide simplified SBCA outputs (ie user benefits/incremental operating costs). While it currently excludes any road traffic and environmental externalities, these could readily be derived by applying current EEM simplified procedures (SP9/SP10).

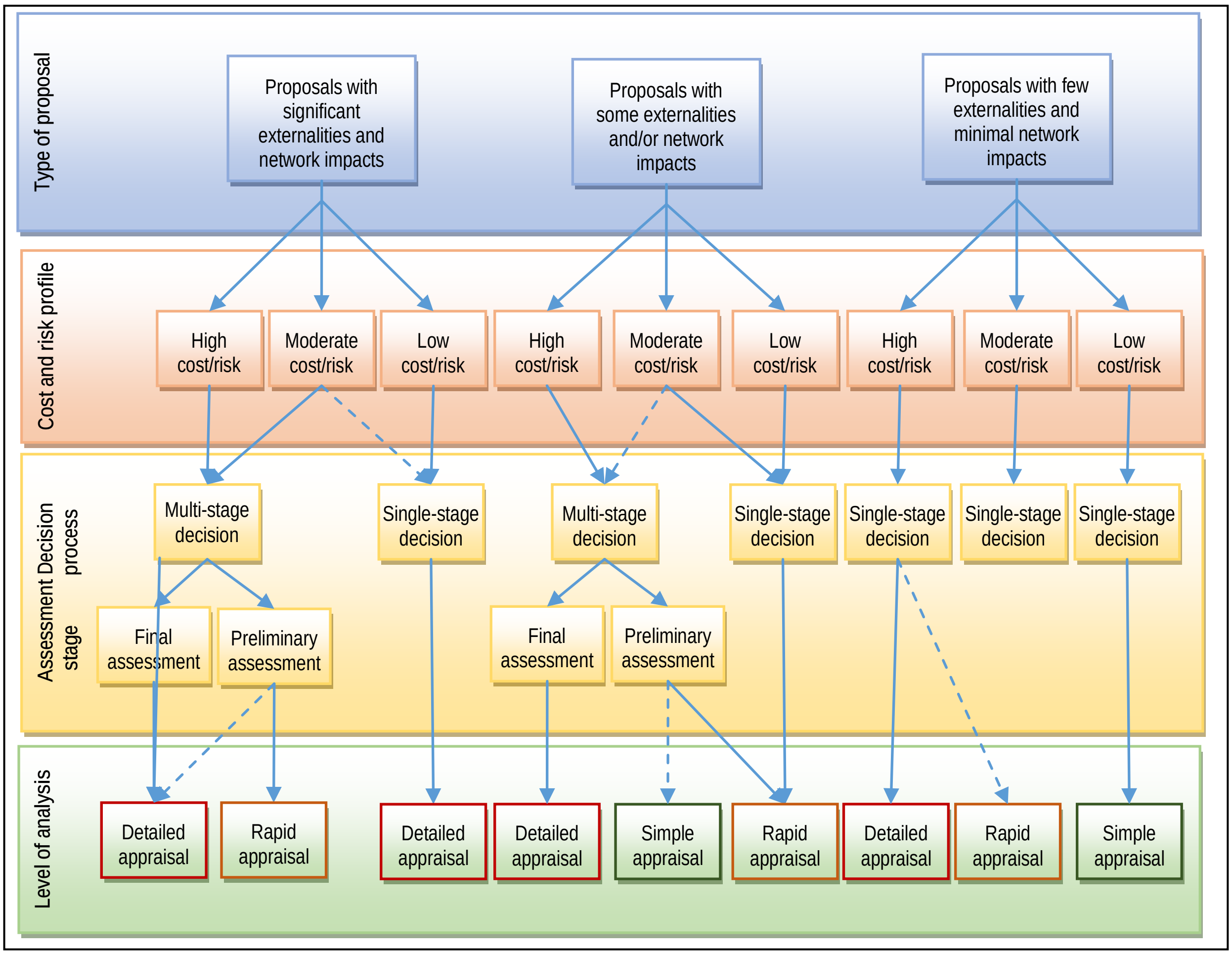
4.4 Selecting an appropriate level of analysis for economic appraisal

The above levels of analysis for economic appraisal (detailed, rapid, simple) have been identified following our review of existing appraisal procedures and a consideration of the project type, cost and risk and stage in determining an appropriate level of analysis. A key consideration in selecting the appropriate level is to ensure that the amount of effort on economic appraisal is commensurate with the expected impacts.

This research project was not tasked with determining the decision-making process or specifying the level of analysis that would be applied to specific projects, but we have set out in figure 4.4 a possible process that could be followed to determine whether a detailed appraisal, rapid appraisal and/or simple appraisal should be undertaken.

In terms of the wider decision-making process, we note that both the NGTSM in Australia and the TBBC framework in New Zealand set out a staged decision-making/analysis process. Consideration must be given to other cases where a two stage approach could be an efficient use of appraisal resources, particular for smaller projects.

Figure 4.4 Possible process to determine applicable level of analysis



5 Review of public transport user benefit parameter values

5.1 Introduction

This chapter outlines and provides the results of the project's review of existing research evidence on unit values for benefit parameters relevant to the economic appraisal of public transport proposals in New Zealand. The review focused on public transport user benefits and on evidence from New Zealand and Australia. The primary purpose was, based on the available research evidence, to identify 'default' parameter values appropriate for application in the appraisal of New Zealand public transport proposals. A secondary purpose was to identify any gaps in the existing research evidence for which further research should be given priority.

In the following sections, we:

- outline the scope of the review work, including the parameters selected for investigation and the rationale for their selection (section 5.2)
- provide an overview of the nature and extent of the research evidence available (section 5.3)
- set out our analyses of this research evidence and draw conclusions on 'default' values for New Zealand applications for each selected parameter (sections 5.4 to 5.6)
- summarise our conclusions from the review, and our recommendations on parameter values for New Zealand (section 5.7).

5.2 Scoping of parameter value investigations

The overall objective of this research project was to provide guidance on appropriate methods and benefits parameters for use in the economic appraisal of public transport proposals in a New Zealand context.

Our review of appraisal approaches in chapter 2 identified SCBA, supported by CEA (for smaller/simpler projects), as the preferred approach to economic appraisal. It was therefore appropriate that our research on parameters and parameter values should be considered within a SCBA methodology. Our international review of economic appraisal procedures then identified a wide range of benefit parameters potentially relevant to the economic appraisal of public transport proposals (refer chapter 3).

The benefit parameters of potential relevance to the economic appraisal of public transport proposals can be considered in the categories shown in table 5.1. For the reasons given in table 5.1, the major focus of the project's parameter values research was on public transport user benefits. While experience is that these usually account for the majority of benefits from most public transport proposals, other benefit categories, especially road system user benefits, also commonly account for a substantial proportion of total benefits. In some cases 'externality' benefits and what we have termed 'other economic' benefits may also be significant; however, the methods and evidence base relating to the valuation of benefits under these two categories are much less well developed than those for public transport user benefits.

Table 5.1 Benefit parameters associated with public transport proposals

Category	Examples	Treatment for project parameter research
Public transport user benefits	• In-vehicle time • Other time-related attributes • Reliability • Quality attributes	• Major focus of parameter value research
Road system user benefits	• 'Decongestion' (road user travel time, operating costs) • Crash costs • Parking costs	• Not covered in parameter values research – more appropriately addressed in context of parameters for roading proposals (road user benefits are incorporated in case study assessments – refer chapter 6)
Externality benefits	• Global emissions • Local environmental impacts	• Not covered – more appropriately addressed elsewhere (only limited evidence on monetary valuations for many of these benefits)
Other economic benefits	• Option values • Agglomeration impacts	• Outside scope of project
Non-economic (flow-on') benefits	• Land value impacts • GDP impacts	• Outside scope of project

The parameter value research methodology involved a review of evidence available from New Zealand and Australian research and then to carry out a wider international review but only if there was a lack of local evidence. In the event, for most of the public user benefit parameters included in the project research, a reasonable body of research evidence was identified from Australian (particularly) and New Zealand studies; therefore the parameter values research was limited to these two countries. In the case of public transport quality factors, we also compiled evidence from a number of other countries[13].

One reason for focusing our research efforts on the Australian and New Zealand evidence is that the Australian evidence is more readily transferable to the New Zealand context than is evidence for other countries. This transferability reflects the general similarities between the two countries in factors such as urban density, car ownership levels, motoring and public transport usage costs, and transport service policies[14].

For these reasons, our research has focused on public transport user benefit parameters, with values based on New Zealand and Australian research evidence. The following parameters were covered in this research:

- value of in-vehicle time:
  - standard values
- journey time attributes:
  - walk time (access/egress)
  - headway (service interval) – affecting perceived waiting time

[13] For this purpose, we made use of the recent review of public transport quality factors undertaken for the separate Pricing strategies for public transport research project.

[14] All the research of which we are aware in the urban transport policy field indicates that behavioural responses to changes in service levels, quality aspects, fares etc are similar in the two countries (although we note that values of time savings differ, closely reflecting income levels).

- seat availability/crowding – affecting perceived valuation of in-vehicle time
- interchange (transfer penalty and wait time)
- reliability of travel time

- quality attributes, covering:
    - stop/station quality features
    - vehicle quality features
    - mode-specific factors (in general terms).

As shown in figure 5.1, these benefit parameters correspond to the various components of a public transport journey (from origin to destination). The perceived user 'generalised cost' of a public transport journey is effectively the sum of the time involved in each journey component, weighted according to the relevant parameter value of time (which is expressed as a factor on standard values of in-vehicle time). In the context of economic appraisal of public transport schemes, this generalised cost is a key driver of:

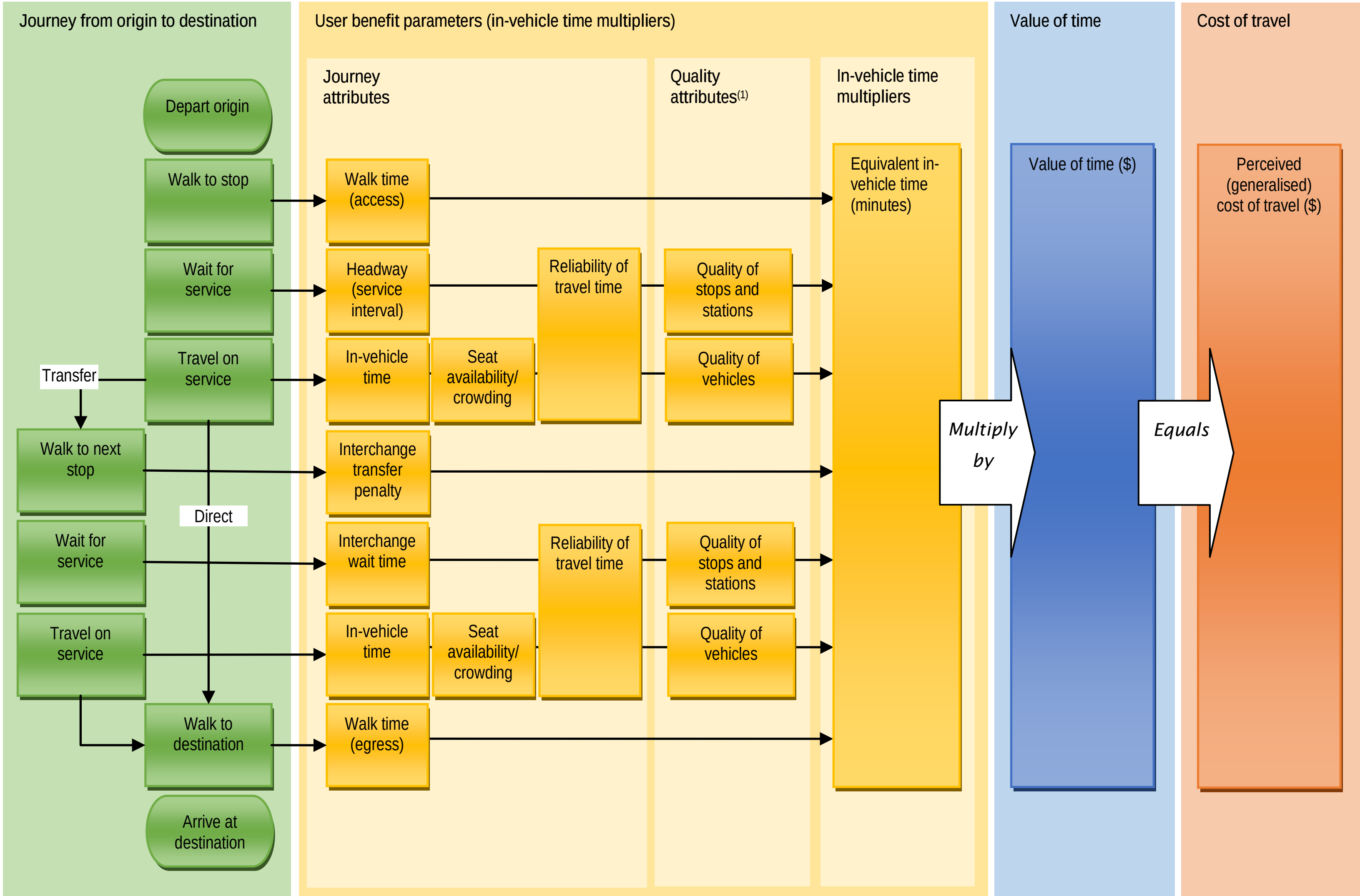
1 User benefits, which represent the change in user costs between a scheme option and a 'base case'

2 Changes in demand (patronage) resulting from the scheme – which may be related to the generalised cost change through elasticity factors of using another type of demand model.

The public transport user benefit parameters selected for the research are essentially consistent with those parameters used in the economic appraisal (SCBA) of public transport proposals in key countries internationally (refer table 3.3). They also largely reflect the public transport user benefits parameters included in the EEM, although there are some areas of difference[15].

[15] The EEM does not include mode-specific factors, although it does include valuations for a range of stop/station and vehicle quality factors.

Figure 5.1 Public transport journey components and user benefit parameter valuation



(1) Mode specific factors (MSF) may be used to reflect overall modal quality factors where more disaggregated quality information is not available.

5.3 Overview of user benefit parameter research (New Zealand and Australia)

A total of 35 studies (28 Australia, seven New Zealand) were reviewed relating to the valuation of in-vehicle time and the various journey time attributes. The studies cover, bus, rail, light rail, busway (transitway) and ferry. Some studies only interviewed public transport users but some included car, walk/cycle and other non-users. The studies covered the period 1990 to 2013, with most of them taking place between 1995 and 2005.

Most of the Australian studies took place in Sydney with the remainder in Brisbane, Canberra and Melbourne, and were a part of demand forecasting work. Other studies were undertaken as part of building demand models, estimating parameters for economic valuations or developing business strategies.

All but two studies were based on stated preference (SP) methods. The remaining two studies were based on an analysis of travel choices or revealed preference (RP) data to estimate a travel model for Sydney using the household travel survey data. In all cases, the benefit parameter values estimated reflect user willingness-to-pay valuations. These values are strongly influenced by the incomes of those surveyed: care is thus needed in comparing research results from different situations (eg countries, years, survey locations).

The SP surveys usually presented respondents with a series of journey choices which were either between public transport modes (eg bus vs bus or bus vs rail) or between public transport and car (or in a few cases public transport vs walk/cycle). Those studies which presented ‘same mode’ choices (eg bus vs bus) produced more reliable relative valuations than those involving ‘different mode’ choices (eg car vs bus)[16].

In drawing conclusions (eg on mean parameter values) from the range of studies relating to such attributes, decisions were required on whether all the relevant study results should be given equal weight, or whether some method of relative weighting should be used. It was decided to weight each study on the basis of the relative spread of its distribution of values, as reflected in its relevant ‘t’ statistic: this t-value represents the ratio of the mean estimate to the standard error[17].

This weighting method gives greater weight to those studies with a narrow spread of results (ie higher t-values), on the assumption that these results will be of higher quality. In practice, while there is likely to be a tendency for this to be the case, many other factors can influence the quality of study results; however, short of an in-depth independent appraisal of each study, there appears to be no better way of assessing relative study quality[18].

[16] Respondents in same mode stated preference surveys were more likely to trade off the times and costs, varying their response across the choice situations, whereas in between mode stated preference surveys, respondents were more likely to stick to their current mode.

[17] Most studies only reported the t-value of the individual parameter estimates rather than the value for the relative valuation (the ratio of the estimates). Where possible, the t-value for the relative value was calculated (assuming zero covariance between the estimators). Where it was not possible to calculate, a value of 1.6 was assumed. To produce the weighting index, the t values were allocated to three categories and given a score of 1 for t-values between 0 and 2, 2 for t-values between 2 and 4 and 3 for t-values exceeding 4, An average weight was then calculated with the individual study categorised t values compared relative to this. This maintained the number of observations.

[18] In practice, such an independent appraisal would not be possible for some of the studies involved, as the detailed study documentation is no longer available.

The following sections (5.4 to 5.6) provide a summary of the review results by attribute, for each attribute giving (weighted) mean values and inter-quartile ranges from the studies analysed, including separate values for New Zealand and Australia where justified by the evidence. The EEM (New Zealand) and NGTSM (Australian) values are also given for comparison. Further detail is provided in appendix E.

5.4 Assessment of parameter value evidence: (standard) in-vehicle time

The value of (standard) in-vehicle time parameter represents the value of in-vehicle time in standard conditions, ie for seated passengers, with the service running to schedule (ie excluding any delays). Conventionally, it is taken as the base value of time, to which time spent in all other situations (eg walking, waiting or standing on board) is related. In situations where more than one public transport mode is being considered (eg the relative merits of bus vs rail service), this standard value is normally taken as relating to the value of in-bus time, and in-vehicle time values for the other modes are expressed relative to this.

Research evidence on in-vehicle time valuations is usually segmented by journey purpose and/or time of travel (eg peak, off-peak). Consistent with this, our assessment segmented the evidence between peak (predominantly commuter purpose) and off-peak periods. Valuations for business (non-work) travel were not addressed.

Consistent evidence internationally is that values of time are strongly related to wage rates or some other measure of personal or household incomes (eg GDP per capita). Given this, it was seen as essential to analyse the research data separately for the New Zealand and Australian studies.

Table 5.2 presents a summary of results for the studies analysed: four studies (with seven values) were identified for New Zealand and 24 studies (74 values) for Australia. The results are given in the currency of each country[19].

Table 5.2 Summary of research evidence on in-vehicle time – standard values

Market segment	Measurement unit	EEM values (NZ$ 2012)	NGTSM values (A$2012)	Values ($2012) Mean (inter-quartile range)			No of studies (values)	
				NZ	Aust.	All	NZ	Aust.
All (non-work)	$/hour			$6.80 (5.30–8.30)	$12.20 (9.40–15.00)	–	4(7)	24(74)
Peak		$7.41[(a)]	$13.15	$7.30 (5.70–9.00)	$13.40 (11.40–15.40)	–		
Off-peak		$4.81[(b)]	$11.20	$6.20 (4.80–7.60)	$11.00 (8.30–13.70)	–		

Notes:

[(a)] Value applies to commuting.

[(b)] Value applies to ‘other’ (non-work) travel purposes.

[19] All in-vehicle time values were converted from original study results to $2012, using changes in GDP/capita. For comparison purposes, EEM values were increased by GST factor 1.15 to give market prices. NGTSM values were factored to 2012 prices by 1.1065 (GDP/capita change 2006–2012, money terms) and 1.10 (GST, to give market prices). Values are in the currency of the study country.

Comments on values:

- Values relate to seated bus passengers, at typical levels of crowding.
- All estimates are in market prices (including indirect taxation component).
- All but two studies were SP. Exceptions were two Sydney cross-sectional mode choice estimates that used Household Travel Survey data with the estimates subject to ‘caveats’ in the reports
- Evidence suggests that values have increased over time, relative to GDP/capita. However most studies were undertaken between 1995 and 2005 (with noteworthy variation).
- Values of time for Australia (mainly New South Wales) and New Zealand were similar proportions of the GDP per capita in each country.
- Average value-of-time approximately 42% of GDP/capita per hour for New Zealand and Australia; higher for peak (45%) and lower for off-peak (38%).
- The New Zealand mean value was similar to EEM for peak, and circa 30% higher for off-peak.
- No statistically significant difference for rail/bus. Some observations included car respondents.

Conclusions and recommendations:

- Peak/commuting. The New Zealand mean value (four studies) is almost identical to the EEM value (allowing for indirect taxation): no case for change.
- Off-peak/other purposes. The New Zealand mean value (four studies) is much higher (29%) than the EEM value. Also off-peak: peak ratio in EEM much lower (65%) than corresponding ratios in NGTSM (85%) and mean values from Australian studies (82%). Indicates good case to increase EEM off-peak/other value to circa 85% of peak/commute value (circa $6.20 including GST, NZ$ 2012).
- The Transport Agency research project on pricing strategies for public transport project will derive estimates for this parameter, based on SP-based market research involving relatively large samples of New Zealand bus and train users. Given that these results will soon be available, we recommend that the case for any changes to the EEM parameters covered in that project be considered at that time. This consideration should address the structure of any new values (eg peak vs off-peak or commuter vs other purpose; rail vs bus).

5.5 Assessment of parameter value evidence: journey time attributes

The following sub-sections present the research evidence relating to the five journey time attributes, as listed in section 5.2 (‘quality’ and modal attributes are covered subsequently). Values for each of these attributes are closely related to the standard value of in-vehicle time, and hence our results for these attributes are presented as factors relative to the standard values (eg people typically value saving one minute walking at 1.40 times their value for saving one minute sitting on the bus, so the walk time parameter value is expressed as a factor 1.40).

For these journey time attributes, the international evidence indicates that the various value factors are largely consistent from one country to another, and particularly between Australia and New Zealand (for comparable conditions, market segments etc). Given this, and given the generally few New Zealand studies available, for analysis purposes we have pooled the data from the two countries.

5.5.1 Walk time (access/egress)

The walk time (access/egress) parameter relates to the valuation of time spent walking to/from public transport services relative to the standard value of in-vehicle time. The research evidence is summarised in table 5.3. The current EEM does not include a parameter value specifically for this attribute, but we understand that the value given in EEM for pedestrian and cyclist travel is intended also to be used for access to/egress from public transport. We also note that EEM does not give specific values for other public transport access/egress modes, so again we would assume that the most relevant EEM values for public transport appraisal purposes would be those for using these modes generally (eg bus or car values).

Table 5.3 Summary of research evidence on walk time (access/egress) values

Market segment	Measurement unit	EEM values	NGTSM values	Values ($2012) Mean (inter-quartile range)			No of studies (values)	
				NZ	Aust.	All	NZ	Aust.
All (non-work)	VoT factor relative to (standard) IVT values	1.4	1.4	-	-	1.30 (1.04–1.42)	3(3)	18(45)

Comments on values:

- A total of 48 values, but only three New Zealand values. Average valuation of 1.30 for combined New Zealand and Australian studies is lower than 'traditional' assumption of valuing walk time at twice public transport in-vehicle time[20]. There is no significant difference in peak vs off-peak values.
- There is no value given in the EEM for walk access to public transport. The EEM value here is the value for pedestrians, relative to seated public transport passengers.

Conclusions and recommendations:

- Study values (mean 1.30, inter-quartile range 1.04–1.42) are very similar to the findings from Australian studies (mean 1.36, median 1.30, 95% range 1.15–1.56) referenced in the NGTSM (table A.3). Both the EEM and NGTSM adopt a value of 1.4.
- The research evidence would suggest that the EEM factor should be reduced from 1.4 to 1.3. However, such a change is marginal and would make very little difference to appraisal results for the great majority of public transport proposals. There is no strong case for change.

5.5.2 Headway (service interval)

The headway (service interval) parameter measures the number of minutes between departures: the higher the frequency, the lower the service interval. For frequent services, where passengers are more likely to turn up at random at bus stops, the average waiting time will be half the service interval. For less frequent services, passengers will time their arrival at the bus stop/train station and the cost of the timetable will be the inconvenience in not being able to travel exactly when desired. The research evidence is summarised in table 5.4.

[20] This traditional assumption dates back to the 1970s. Most of the more recent studies have found lower factors.

Table 5.4 Summary of research evidence on headway (service interval) values

Market segment	Measurement unit	EEM values	NGTSM values	Values ($2012) Mean (inter-quartile range)			No of studies (values)	
				NZ	Aust.	All	NZ	Aust.
All	Value for unit headway change relative to (standard) IVT values	0.36[(a)]	0.46[(b)]	0.48 (0.33–0.64)	0.66 (0.48–0.79)	0.64 (0.46–0.78)	5(8)	22(63)

Notes:

(a) NGTSM uses a curvilinear function with results generally similar in form to the EEM tabulation.

(b) EEM value represents headway change 20 minutes to 15 minutes from table 7.2 ((5.1-4.2)/5x2).

Comments on values:

- Most studies assessed service intervals are in a range of between every 10 minutes to every 40 minutes. The weight of evidence indicates that the service interval valuation increases with frequency, reflecting a greater importance of waiting time. This pattern of variation is reflected in the EEM function.
- EEM values are given in table 7.2 of EEM volume 2. Our interpretation of this table is that a 0.36 value (ie 0.36 in-vehicle minutes valuation for a 1.0 minute headway change) is implied for a headway change from 20 minutes to 15 minutes or vice versa (this value would differ for other headways). We note there is some lack of clarity as to the interpretation of this table and the accompanying text.

Conclusions and recommendations:

- Both NGTSM and EEM (based on NGTSM) involve a look-up table/curvilinear function, with the service interval factor reducing as headway increases: the 0.36 factor shown for the EEM represents typical headways of 15–20 minutes.
- Studies analysed (27, Australia/New Zealand) give a mean service interval factor of 0.64 (inter-quartile range 0.46–0.78). While this is considerably higher than the NGTSM and EEM values, this may be because it covers higher frequency services (on average).
- The Transport Agency research project on pricing strategies for public transport will derive estimates for this parameter, based on SP market research involving relatively large samples of New Zealand bus and train users. Given that these results will soon be available, we recommend that the case for any changes to EEM parameters covered in that project be considered at that time. This consideration should address the structure of any new values (eg peak vs off-peak; rail vs bus; variation with service frequency).

5.5.3 Seat availability/crowding

The seat availability/crowding parameter expresses the value of any increase in in-vehicle time valuations in various non-standard conditions over that for standard (uncrowded seating) conditions. Thus, if standing passengers value time savings at 50% higher than in uncrowded seating conditions, the crowding parameter value would be expressed as 0.5. Various non-standard conditions were covered in the different studies analysed, including crowded seating, uncrowded standing and crush standing. While it would be expected passengers would have higher unit values when standing for longer periods (eg 20 minutes rather than 10 minutes), the research on this point is surprisingly limited, so separate values have not been assessed here. The research evidence is summarised in table 5.5.

Table 5.5 Summary of research evidence on seat availability/crowding values

Market segment	Measurement unit	EEM values	NGTSM values	Values ($2012) Mean (inter-quartile range)			No. of studies (values)	
				NZ	Aust.	All	NZ	Aust.
Standing crush	VoT additional time factor relative to (standard) IVT values	n/a	1.0	-	1.00 (0.86–1.25)	1.00 (0.86–1.25)	0	3
Standing		0.4	0.4	0.49	0.62	0.58 (0.39–0.78)	4	6
Crowded seating		n/a	0.1	-	0.23 (0.21–0.28)	0.23 (0.21–0.28)	0	2

Comments on values:

- Additional time factor for passengers in crowded seating, standing and crush standing situations. Only standing estimates produced for New Zealand. For Australia, evidence indicates that standing values increase as length of stand increases and level of crowding increases.
- EEM gives a single value on this aspect, for standing bus/rail passengers relative to seated passengers: the additional factor used is 0.4.

Conclusions and recommendations:

- Very few Australian/New Zealand studies cover seat availability/crowding valuations, and hence confidence in the resulting mean values is relatively low.
- EEM currently has a single 'standing' value (no separate values for 'crowded seating' or 'crush' conditions).
- We recommend against any change to EEM values on the basis of the studies examined.
- Further research would appear warranted on this aspect, with a view to developing a more graduated scale of values, varying with the crowding levels (refer NGTSM). We note that market research on this aspect is currently being undertaken in Sydney.

5.5.4 Interchange

Changing buses and trains typically involves a walk between the two services, and a wait for the second service (as well as possibly an additional fare). Additional to the time involved, passengers typically perceive a transfer penalty, reflecting the added journey 'hassle' and extra uncertainty and anxiety about potentially missed connections. Thus the user cost of a transfer may be divided into three components: the walk time, the wait time for the next service, and the additional transfer penalty. Many studies on transfers do not clearly distinguish between these three transfer components, so our assessment has tried to disentangle them where possible, focusing mainly on the wait time and transfer penalty components (it could be assumed that the walk time valuations are similar to those for walk time as an access/egress mode covered in section 5.5.1).

Transfer penalties are generally expressed in terms of their perceived cost in equivalent minutes of standard in-vehicle time, while wait times are expressed as a factor of in-vehicle time. The two components are discussed separately below.

While we identified 18 studies (with 64 transfer penalty estimates), only one of these was New Zealand-based, indicating a dearth of New Zealand evidence on this important aspect.

The studies reviewed indicated perceived differences in transfer penalties between:

- Same mode transfers and different mode transfers, with the latter having higher penalties than the former. It is not clear whether this effect is intrinsic to the modes, to the quality of the transfer environment, or to the frequency of the services involved (the latter should be addressed separately).
- Transfers at peak and off-peak periods, with the latter having higher penalties than the former. Again it is unclear whether these differences are related to the frequency of the services involved (which should be addressed separately).or the (un)familiarity of passengers with the transfer arrangements.

Evaluation of transfers is an aspect that warrants further research.

5.5.4.1 Transfer penalty

The research evidence on transfer penalties is summarised in table 5.6.

Table 5.6 Summary of research evidence on interchange transfer penalty values

Market segment	Measurement unit	EEM values	NGTSM values	Values ($2012) Mean (inter-quartile range)			No. of studies (values)	
				NZ	Aust.	All	NZ	Aust.
Peak same mode	Value in (standard) IVT minutes	5	5–7	–	–	4 (0–9)	1(1)	17(63)
Peak other mode		5	7–10	–	–	9 (4–15)		
Off peak same mode		5	5–7	–	–	12.5 (10–15)		
Off peak other mode		5	7–10	–	–	17 (14–21)		

Comments on values:

- Values relate to pure penalty excluding any walk or wait time. Most studies estimated gross penalties that included a transfer time. A pure penalty was estimated by netting out the weighted wait time. Off-peak penalty higher than peak, reflecting lower frequency and consequent greater cost of missed connection (and possibly a component of wait time), lesser familiarity with transfer, and greater likelihood of luggage and/or reduced mobility.

Conclusions and recommendations:

- There is a dearth of New Zealand studies on transfers (transfer penalty, walk time, wait time), hence our appraisal relies largely on Australian studies.
- These studies give a considerable range of values for transfer penalties, with the primary distinction being between peak vs off-peak periods (penalty considerably higher in off-peak) and a secondary distinction between same mode transfers (eg cross-platform) and other mode transfers (typically involve significant walking, exposure to weather, etc).
- The same mode vs other mode difference (mean five minutes in-vehicle time) seems very plausible. (The current EEM assumption of five minutes in all cases seems less plausible.)
- We are less confident regarding the apparent peak vs off-peak differences; we suspect this is partly a service frequency (headway) effect, which should be covered under transfer wait time.
- In regard to the EEM transfer penalty value, we recommend:
  - differentiating between same mode and other mode transfers

- pending further New Zealand-based market research, adopting values of four in-vehicle minutes for same mode transfers, eight in-vehicle minutes for other mode transfers
- further New Zealand market research (SP-based) should be undertaken on this topic, including into valuation differences between same and other mode transfers, and between peak and off-peak periods
- if appropriate information is available, this should be accompanied by revealed preference-based market research (eg using transport model calibration and survey data).

5.5.4.2 Wait time (interchange)

The research evidence on transfer wait time valuations is summarised in table 5.7.

Table 5.7 Summary of research evidence on interchange wait time values

Market segment	Measurement unit	EEM values	NGTSM values	Values ($ 2012) Mean (inter-quartile range)			No of studies (values)	
				NZ	Aust.	All	NZ	Aust.
All	Value of wait time at transfer relative to IVT	2.0	1.20			1.25 (1.05–1.44)	1(1)	6(15)

Comments on values:

- Value of time spent waiting at transfer (uncrowded conditions). Lower value than conventionally assumed for waiting time reflecting nature of studies. One study distinguished between amounts of time spent on platform versus in access/entrance way, with access/entrance time valued at 1.5x more than platform time under medium crowding conditions.

Conclusions and recommendations:

- EEM currently adopts factor 2.0 for both walk time and wait time on transfers without specific guidance on how the wait time is to be calculated. There is little basis for this factor (it was the 'traditional' factor adopted some years ago in UK studies for both walking and waiting generally).
- The studies examined indicate a typical wait time factor of around 1.25.
- While the research evidence is not compelling, we recommend that EEM be changed as follows:
    - Transfer walk time: adopt factor 1.4, as for walk access/egress time generally.
    - Transfer wait time – default: adopt 1.25 * wait time, where wait time = 0.5 * headway.
    - Wait time – timed transfers: adopt 1.25 * scheduled transfer time (eg range 3–5 minutes).

5.5.5 Reliability of travel time

Surveys of customer opinion have consistently shown that service reliability (relative to the timetable) is a critical factor in service quality.

Service reliability covers two components: the reliability of services in arrival/departure time at the bus stop or train station and the reliability in the travel time spent on the bus or train. Together they account for the reliability at the destination.

Ten studies were reviewed that estimated values for reliability; four were New Zealand studies and six were Australian. One New Zealand study by Vincent (2008) was undertaken specifically to value reliability. The other studies included reliability among a list of attributes.

Apart from the Vincent (2008) study, it was often not clear whether lateness was measured at the departure stop/station or the destination stop/station.[21] Bus passengers tend to think in terms of bus stop arrival times whereas rail passengers are more concerned with arrival time at the destination station.

All the studies measured reliability in terms of 'average minutes lateness', which can be calculated as the percentage of services late multiplied by the number of minutes late. For example, if 20% of buses are five minutes late, average lateness would be one minute (0.2 x 5). If 15% of buses are five minutes late and 5% 10 minutes late, average lateness would be 1.25 minutes (0.15 x 5 + 0.05 x 10).

Average lateness is then expressed in equivalent minutes of standard in-vehicle time, with a typical average minutes lateness factor of 3.0, ie in the above example 1.25 minutes average lateness would be perceived as equivalent to 3.75 minutes additional in-vehicle time[22].

The research evidence on the valuation of (un)reliability, expressed in terms of standard in-vehicle time values, is summarised in table 5.8.

Table 5.8 Summary of research evidence on reliability of travel time values

Market segment	Measurement unit	EEM values	NGTSM values	Values ($2012) Mean (inter-quartile range)			No of studies (values)	
				NZ	Aust.	All	NZ	Aust.
All	Average lateness (minutes) relative to (standard) IVT values	3.9	3.0	2.7 (1.6–3.4)	3.6 (2.1–5.4)	3.2 (1.9–4.5)	4(4)	6(6)

Comments on values:

- Represent value of minute of average lateness at destination.
- EEM value given as mean of lateness at departure stop (5.0) and lateness en route (2.8).
- NGTSM notes that could apply value 6.0 for unexpected wait at departure stop, 1.5 for unexpected in-vehicle time.

Conclusions and recommendations:

- The New Zealand study on which the current EEM values are based appears to be one of most rigorous of its kind.
- The studies examined gave an average value (average mean lateness at destination) not very different from the mean of the EEM values.
- Based on the evidence available, we recommend against any change to the current EEM values.

[21] Vincent (2008) undertook analyses of departure and arrival time reliability but only arrival time reliability has been included in the review analysis.

[22] The average minutes lateness approach applies only to timetable services (ie those that operate to a set timetable). For services that are defined in terms of frequencies (eg every 6–7 minutes), a different approach to valuing reliability is required, typically based on 'excess waiting times'.

5.6 Assessment of parameter value evidence: quality and mode-specific attributes

5.6.1 Overview

This section addresses perceived values for two groups of public transport journey parameters, which are often considered separately in demand modelling/economic appraisal studies, but are to a large extent different perspectives on the same journey aspects:

- Quality attributes – these primarily cover infrastructure (stops/stations etc) quality features and vehicle quality features, but also include other aspects (such as passenger information) that do not readily fit into either of these categories.
- Mode-specific attributes – cover perceived attributes which are commonly associated with different public transport modes, additional to the (time-related) attributes addressed in earlier sections of this chapter.

These parameter groups together cover all significant (to users) journey attributes that were not covered earlier. They may be regarded as 'soft' attributes, and not readily expressed in numerical or financial terms.

It will be recognised that there is considerable overlap between the two groups of parameters. For example, ride quality may be considered a quality attribute, independent of the mode involved; or it may be treated as a modal quality, being generally different for rail services than for bus services (which usually operate in general traffic, but could operate on a high-quality reserved right-of-way). Another example would be station/stop facilities, such as shelters, passenger information, toilets; these may be regarded as attributes of rail services, but there is no reason why such facilities could not be provided for bus services.

The mode-specific attribute approach is generally taken by demand modellers, who look to generalised modal factors to explain typical differences in user behaviour between (eg) rail and bus modes. On the other hand, the quality attributes approach is generally taken by market researchers and others interested in establishing how the product could be made more attractive to existing and potential users, through enhancing its specific features.

The following sub-sections review research which has been undertaken using each of the approaches, first focusing on quality attributes, then on the mode-specific approach. In developing recommendations on relevant parameter values from the research evidence, the findings from the two approaches would need to be brought together and integrated, to ensure comprehensive coverage without double-counting.

5.6.2 Review of quality attributes

A separate Transport Agency research project on pricing strategies for public transport is expected to provide primary research evidence on appropriate parameter values for vehicle and station/stop quality attributes; it will also derive valuations for in-vehicle time and service intervals (Douglas Economics 2012b). This research project includes market research (using relatively large samples) of public transport users in Auckland, Wellington and Christchurch and will provide up-to-date and local New Zealand evidence on appropriate parameter values. A brief summary of the pricing strategies review of international research evidence on public transport 'quality' attributes is provided below. We have not carried out any further review of evidence on public transport 'quality' attributes, nor made any recommendations in this area.

The pricing strategies research project includes a review of international research covering 13 studies over the last two decades from New Zealand, Australia, the UK, USA and Norway. The aspects of quality reviewed were categorised into eight groups, as listed in table 5.9.

Table 5.9 Quality attributes reviewed

#	Attribute
1	Bus and train 'vehicle' quality package
2	Bus stop and rail station qualitiy package
3	Vehicle design appearance, ambience and facilities
4	Stop design appearance, ambience and facilities
5	Information
6	Personal safety, security
7	Maintenance, cleanliness, graffiti removal
8	Staff availability, appearance, friendliness and performance

Three studies covered both bus and rail services, five covered bus only and five covered rail only. Two New Zealand studies were included: a 1991 SP survey of bus and rail quality undertaken in Wellington and a 2002–2005 survey of Wellington rail station quality. Five Australian studies, three UK studies, one US study and one Norwegian study were also included.

Most of the studies estimated values using only used SP, as opposed to RP based on actual patronage response. The Wellington rail study used a priority evaluator approach, which presented a shopping list of service improvements for the respondents to choose from. By including a fare reduction or a travel time saving in the list, the valuation of the quality attributes can be established.

The reported valuations for most of the studies were converted into:

- equivalent minutes of on-board bus/train time (in-vehicle time)
- the percentage of the average fare paid. Where only fare or in-vehicle time-values were provided, an 'external' value of time was used.

All the studies presented average valuations. Six studies segmented the results by either trip length or time period (or both) but seven studies only provided average valuations. Some studies explored the effect of user and trip profile on the valuations, but none reported valuations by market segment.

Further details of the research are given in appendix E (section E7).

5.6.3 Mode-specific factors

As noted above, mode-specific factors (MSF), sometimes known as alternative specific constants (ASC), account for residual qualitative differences in modes as perceived by users after travel times, frequencies and fares have been taken into account.

In the NGTSM, the MSFs are split into a constant and an in-vehicle time factor. The first component accounts for differences in 'accessing (and egressing) the system' and 'boarding (and alighting)' the vehicle. This reflects the quality of stop/station facilities and aspects of boarding the system (such as negotiating steps and payment). The in-vehicle time factor accounts for differences in the quality of in-vehicle travel (such as comfort and air conditioning) and is distance/time related.

The NGTSM adopted a 'rule of a half' to split the reported values into the constant and in-vehicle time factor. Half the MSF was assumed to relate to the constant (ie account for stop/boarding) and half was assumed to be related to travel time and reflect differences in vehicle quality.

In this review, a total of 13 Australasian studies were found to provide MSF information (a summary of each study is provided in appendix F). Only four studies 'compartmentalised' the MSF into a constant and a time factor. The remaining nine studies presented only a constant MSF. However the review did make an attempt to allocate the MSF split by analysing the size of the MSF by trip length.

Eleven of the studies used SP market research, with most undertaken as part of producing patronage forecasts for new transport services. As such, the values are based more on respondent perceptions of likely future services than on attitudes to existing services. It would be expected that MSFs based on actual experience should provide valuations that are more reliable and less prone to policy response bias.

The remaining two studies used revealed preference data. For these studies, the MSF was a direct result of comparing observed and predicted patronage against modelled travel times and costs. Consequently, the MSF may be more an artefact of the modelling process than a reflection of true qualitative differences between modes.

In total, 40 MSFs were reported covering five different mode comparisons: bus-rail (21 observations); bus–light rail (10 observations); bus-transitway (five observations); rail-transitway (one observation) and bus-ferry (three observations). Table 5.10 provides a summary of findings for each of these comparisons.

Table 5.10 Summary of research evidence on mode-specific factors

Market segment	Measurement unit	EEM values	NGTSM values	Values ($2012) Mean (inter-quartile range)			No. of studies (values)	
				NZ	Aust.	All	NZ	Aust.
Busway/ BRT	Equivalent IVT (on-street bus) minutes	–	4–5[(a)]			5 (4–6)	–	2 (5)
Heavy rail		–	3–7[(a)]			12 (0–15)	2 (2)	9 (21)
Light rail		–	5[(a)]			16 (1–19)	–	4 (10)
Ferry		–	–			21 (7–25)	–	1 (3)
Heavy and light rail		–	7–10			Peak 0.26xT (0.07–0.45) Off peak 0.64xT (0.45–0.71)	2 (2)	13 (29)

Notes:

[(a)] NGTSM values applied to a 20-minute trip. Figures represent perceived benefits (in-bus minutes) relative to a bus on-street trip of same duration.

Comments on values:

- Values represent remaining modal effects after all other factors have been accounted for.
- Very limited New Zealand evidence on this topic (two SP studies, early 1990s). Also very limited choice situations available (suitable for RP studies).
- All total values (including fixed and time-related components). Rail and light rail mode-specific factors increase with length of trip. Heavy rail more likely to be existing services and based on direct experience, whereas light rail was most often a 'new' service as part of a demand forecasting study.

- Caution not to double-count between mode-specific factors values and modal differences in in-vehicle time and/or quality factors.
- Rail and light rail MSFs were combined and regressed on trip length. For peak, bus mode-specific factors (relative to heavy and light rail) increased at 0.26xtime; off-peak 0.64xtime. For a 20-minute trip, bus peak mode-specific factor was worth five minutes and bus off-peak MSF 13 minutes.

Conclusions and recommendations:

- No figures currently included in EEM, although these are an important feature in appraisal of some major public transport proposals, eg PTSS (AECOM 2012).
- If the EEM is to include values in the short term, we recommend the NGTSM values be used as the starting point: these values distinguish between a fixed modal component (per boarding) and a variable component (per in-vehicle minute) based on an assumed 50:50 split.
- Analysis of the surveys being undertaken as part of the Transport Agency's research project on pricing strategies for public transport may enable derivation of any modal (bus vs rail) differences in in-vehicle time. Decisions will be needed as to whether these differences are to be reflected in mode-specific factor values, or in in-vehicle time values. We note that a market research study being undertaken in Sydney on bus, (heavy) rail and light rail will establish modal constants and in-vehicle time multipliers: the results from that research should be reviewed, along with the pricing strategies work, when considering recommended values.
- If the EEM is to include improved mode-specific factor values, we recommend a more comprehensive appraisal of evidence, such as:
  - a review of international RP and SP evidence
  - detailed appraisal of the pricing strategies for public transport research project evidence, to distinguish modal factors from in-vehicle time and quality differences by mode.

5.7 Recommendations on public transport user benefit parameter values

Based on our assessment of public transport parameter value research evidence (from New Zealand and Australia) in this chapter, table 5.10 presents our summary of recommendations on values for each user benefit parameter covered.

The recommendations may be divided into four categories, as follows:

1 In-vehicle time, headway (frequency), vehicle quality and stop/station quality features.

   a Recommend that any changes to these parameters in EEM be considered once the public transport pricing strategies research project is completed

2 Access/egress (walk) time, travel time reliability and seat availability/crowding.

   a Recommend no changes in these parameters in EEM (current parameter values more-or-less consistent with weight of evidence examined).

3 Interchange (wait time and transfer 'penalty').

   a Recommend changes to both these sub-parameters in the EEM. Also note need for additional New Zealand-based market research on this aspect (important in the context of service and modal integration/coordination policies being considered in Auckland, Wellington and other centres).

4 Mode specific factors.

a Recommend that:

i these be incorporated into the EEM

ii in the short term, adopt the NGTSM formulations

iii in the medium term, undertake a more comprehensive review of international evidence and integrate with the findings on quality factors from the public transport pricing strategies research project.

We discuss the implications of these recommendations for the EEM simplified procedures (SP9/SP10) in appendix G.

Table 5.11 Summary of recommendations – parameter values

Attributes	Recommendations	Comments
In-vehicle time		
In-vehicle time (standard values)	• Consider when results from pricing strategies research become available.	• Review to date indicates case for significant (c 30%) increase in off-peak/other purposes value. • Will need to address structure of values (eg rail vs bus).
Journey time attributes		
Walk time (access/egress)	• No strong case for change based on evidence available.	• Research evidence gives a mean factor of 1.3, as compared with current EEM value of 1.4.
Headway (service interval)	• Consider when results from pricing strategies research become available.	• Will need to address structure of values (eg variation with headway, peak vs off-peak, rail vs bus).
Seat availability/ crowding	• No strong case for change based on evidence available • Would warrant further New Zealand-based market research.	• May be case for more graduated scale of values, varying with loading levels (similar to NGTSM structure).
Interchange:		
1 Transfer penalty	• Revise current values (5 minutes IVT for all transfers) along the following lines: - Differentiate between same mode and other mode transfers. - Adopt interim values of 4 in-vehicle minutes for same mode transfers, 8 in-vehicle minutes for other mode transfers. • Undertake further New Zealand-based market research, including into valuation differences same mode vs other mode, and peak vs off-peak.	• Very limited previous New Zealand research on topic and other (Australian) studies give a considerable range in values. • Aspect becoming of greater importance, given plans to redesign bus networks (Auckland, Wellington, Christchurch and other centres), to increase the role for rail (Auckland, Wellington) and to consider new modes (eg PTSS (AECOM 2012)).
2 Wait time	• Revise current value (2 * wait time) as follows: - Default case – unscheduled transfers: 1.25 * wait time, where wait time = 0.5 * headway. - Timed transfers: 1.25 * scheduled transfer time (typically 3–5 minutes).	• Distinction between timed (planned) and unscheduled transfers is important.

Attributes	Recommendations	Comments
Reliability of travel time	• No case for change to current values	• Current values based on robust New Zealand study (Vincent 2008) and generally consistent with other evidence.
Quality and modal attributes		
1 Vehicle features	• Consider when results from pricing strategies for public transport research project becomes available.	• To consider these results along with findings from international review (part of pricing strategies project, summarised in appendix E (section E7)
2 Stop and station features	• Consider when results from pricing strategies for public transport research project becomes available.	• To consider these results along with findings from international review (part of pricing strategies project, summarised in appendix E (section E7)
Mode-specific factors	• If values are required for application in the shorter term, suggest use of the NGTSM values as a starting point.	• For the medium term, recommend that a more comprehensive/updated appraisal of international evidence be undertaken, and that this includes the results (comparing bus and rail modes) from the current pricing strategies research project.

6 Application of recommended procedures and parameter values – case study

6.1 Introduction

This research project was tasked with developing recommendations on economic appraisal approaches, parameters and parameter values appropriate for application in New Zealand to assess the viability of public transport proposals (in particular service enhancements), and then to assess the effects of applying these recommendations to a sample New Zealand case study.

It was envisaged that, if a suitable case study could be selected, the case study work could be useful to the overall project in two main respects. It could be used to illustrate:

- the effects of any recommended changes in relevant parameters and in unit parameter values for a sample public transport proposal economic appraisal on:
  - absolute levels of benefits and hence economic (BCR) performance
  - relative levels of benefits/BCR between different options relating to that proposal
  - the application of alternative 'levels of analysis' (refer chapter 4, table 4.1 in particular) to a single sample public transport proposal – including shedding light on the relative results obtained, the relative simplicity/complexity of the alternative methods and particular issues arising in their application[23].

A number of alternative public transport proposals (or proposal types) were considered. The PTSS offered a number of advantages over other case study candidates, including:

- It is a 'real world' proposal rather than an example 'invented' for case study purposes.
- It is current and topical, with the economic appraisal work being completed at about the time that the case study needed to be undertaken.
- The appraisal involves several substantially different options, involving different public transport modes and network restructuring plans, to address the same problem.
- The appraisal involves detailed transport modelling work, which provided a basis for assessment of benefits using the full EEM evaluation procedures. It thus provided the opportunity to cover the two main aspects noted above (ie the impacts of parameter value changes on proposal benefits in both absolute and relative terms; and comparisons of evaluation methods involving different 'levels of analysis').
- The case study findings might also provide additional insights on option performance that could be useful to the PTSS deliberations.

The remainder of this chapter therefore describes the PTSS case study, demonstrating the potential application of recommended parameter values (from chapter 5) as well as levels of analysis (from chapter 4). It covers:

- an overview of the PTSS case study (section 6.2)

[23] As far as we were able to ascertain, this application of alternative 'levels of analysis' to the same public transport proposal has not previously been undertaken in New Zealand.

- detailed appraisal of the PTSS options, in terms of the impacts of adopting this project's recommended parameter values in place of current EEM values (section 6.3)
- rapid appraisal of the PTSS options, through applying the EEM 'simplified procedures' (SP10) in place of the detailed EEM procedures (section 6.4)
- brief comments on the application of the simple appraisal level of analysis for proposals such as the PTSS options (section 6.5)
- a summary of conclusions and recommendations from the case study work (section 6.6).

6.2 Overview of case study

6.2.1 The PTSS proposals and economic appraisal scope

The PTSS is essentially a pre-feasibility assessment of options for improving public transport services through Wellington central business district (CBD): its methodology was to progressively refine and 'sieve' options through a three-stage process, ie long list, medium list and short list. The economic appraisal of the short-list options involved comparing the following three options against a 'do minimum' base (reference) case:

- enhanced bus priority (bus priority option)
- bus rapid transit (BRT option)
- light rail (LRT option).

The PTSS economic appraisal involved detailed modelling of demand and user benefit impacts, using the Wellington Public Transport Model. Modelling was undertaken separately for AM peak and weekday inter-peak periods for three representative years (2021, 2031 and 2041). The modelling results were then applied to assess economic benefits on two bases:

1. Applying 'behavioural' benefit parameter values, as used in the model formulation and operation
2. Applying EEM unit benefit values to the model outputs, in terms of 'generalised' time savings for each component of passenger journeys.

For each basis, annual benefits and the present value of benefits (discounted over a 30-year evaluation period) were derived, broken down between two main benefit components[24]:

1. Benefits to public transport users (estimated directly as above)
2. Benefits to road system/users (estimated through additional traffic modelling work).

For our case study analyses (described below), we took as our starting point the PTSS estimates of user benefits (public transport users and road users) for year 2031, based on EEM benefit parameters and their unit values (adjusted to 2012 prices).

6.2.2 The case study scope and approach

The PTSS level of analysis was considered in terms of the three levels of analysis identified in chapter 4 (detailed, rapid and simple) as follows:

[24] In addition, a third component, comprising 'agglomeration' benefits, was estimated, in direct proportion to the main two components. Its consideration was outside the scope of this case study.

- Type of proposal – the PTSS involved a number of externalities and significant network impacts.
- Cost and risk profile – the PTSS involved consideration of high-cost options and due to its scale and network impacts could also be considered high risk.
- Stage of assessment – the PTSS followed a multi-stage decision-making process, with the short-list appraisal being the final assessment stage (leading to the selection of a preferred option, which would then be subject to further development and appraisal).

The PTSS would therefore most suit a detailed appraisal level of analysis, as per the process set out in figure 4.4. Earlier stages of assessment might have been suited to rapid appraisal, or if considered to be only a moderate cost/risk, a single-stage decision-making process might have been followed (still with detailed appraisal). Should the PTSS have had lesser network impacts and moderate cost/risk, a single-stage decision-making process with rapid appraisal might have sufficed, and was tested in this case study.

In the light of these considerations, the case study involved two main appraisals, both starting from the PTSS economic appraisal outlined above:

1. 'Detailed appraisal' – using full EEM procedures to assess the effects of replacing current EEM parameter values with the preferred parameter values from chapter 5[25]
2. 'Rapid appraisal' – using EEM simplified procedures (SP10 – existing passenger transport services) as an alternative to the detailed appraisal procedures (using EEM parameter values in both cases). This assessed the implications of applying alternative levels of analysis (as noted in section 6.1).

In the following sections, we describe the case study work on detailed appraisal (section 6.3) and rapid appraisal (section 6.4). We have not attempted to apply the 'simple appraisal' level of analysis in the case study (refer section 6.5), as this level of analysis is not suited to, or appropriate for, such a relatively high-cost/high-risk project.

6.3 Detailed appraisal – implications of recommended parameter values for the EEM

6.3.1 Details of parameter values tested

This 'sensitivity test' assessed the effects on public transport user benefit estimates of replacing the EEM unit parameter values (as used in the PTSS appraisal) with the recommended/preferred values from this project's research (refer chapter 5). Table 6.1 sets out the two sets of parameter values for the parameters where these differ.[26]

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[25] For those parameters for which no recommendations on appropriate values had been made (while awaiting the impending completion of the pricing public transport strategies research project), we used the 'preferred' parameter values that we would have recommended based on this project's parameter value research.

[26] In regard to the base (in-vehicle) value of time, we adopted the EEM average (peak/off-peak) value for public transport (seated) passengers of $5.31/hour ($2012). However, the PTSS appraisal actually adopted a value of about $10.50/hour, based on a weighted average of EEM values for car drivers and car passengers, by trip purposes. In our view, this approach was not appropriate for the PTSS project, based on EEM guidelines, and therefore the lower EEM (public transport) values were applied in the case study for the EEM methodology.

Table 6.1 Parameter value comparisons – EEM vs preferred/recommended values (detailed appraisal)

Parameter	Unit values		Notes
	EEM	Preferred	
Base (in-vehicle) value of time ($ 2012)	$5.31/hour[(a)]	$7.79/hour[(b)]	
Walk (access/egress) time	1.4 x IVT	1.3 x IVT	
Wait time	0.36 x headway	0.64 x headway	
Transfer penalty	5 in-vehicle minutes	4/8 in-vehicle minutes[(c)]	For this case study, we applied the EEM value as average, as model outputs do not distinguish penalties for same vs other mode transfers.
Modal factors – IVT	Same all modes (IVT factor 1.0)	Differ by mode (BRT 0.90, LRT 0.85)	For the case study assessment, we adopted the modelled (perceived) factors of 0.94 for BRT and 0.88 for LRT in place of the preferred factors here (as it is not possible to factor the EEM figures from the model outputs available).

Notes:

(a) Relates to seated public transport passengers, derived as follows:

- EEM volume 1, table A4.1 values: commuter $4.70, other non-work $3.05, average (unweighted) $3.875 (2002 prices).
- Inflation factor 2002 to July 2012 = 1.37 (EEM volume 1, A12.3).
- Hence value = $5.31 @ July 2012 prices.

(b) Derived as follows:

- New Zealand-based market values derived (from SP research) in this project (table 5.2): peak $7.30, off-peak $6.20, average (unweighted) $6.75 (2012$).
- Deduct indirect taxation (GST) gives 6.75/1.15 = $5.87 (2012 $)
- Escalate to 2031 (19 years), to allow for 1.5% pa increase in GDP/capita (as used in Wellington Public Transport Model): factor (1.015) = 1.327.
- Result is 2031 value = $7.79/hour.

(c) Preferred values 4 IV mins for same mode transfers, 8 IV mins for other mode transfers.

6.3.2 Application and comments

The PTSS provided spreadsheet tabulations of public transport user benefits (peak, inter-peak and annual totals) by benefit component (walk time, wait time, transfers, etc) for each option for year 2031[27], expressed in equivalent in-vehicle minutes. We then factored each benefit component according to a ratio of: ‘preferred parameter value’ to ‘EEM parameter value’ (from table 6.1). The resultant benefit estimates (preferred and EEM), expressed in equivalent in-vehicle minutes, were then multiplied by the relevant in-vehicle time values (from table 6.1) to derive the benefits in dollar terms.

A summary of the results is given in table 6.2. Key features of these results are as follows:

[27] Year 2031 was chosen as a typical year within the PTSS evaluation period, for which model runs were undertaken.

- In terms of generalised time (equivalent in-vehicle minutes), the combined effects of the above sensitivity changes varies considerably between the options, depending on their mix of changes in walking time, waiting time and transfers. The combined effects vary between an increase in generalised time savings of some 4% (BRT option) and a reduction of around 9% (LRT option).
- In terms of total public transport user benefits (allowing for the different unit values of time), the combined effects of the recommended parameter changes are to increase the benefits for all three options – by between 53% (BRT option) and 34% (LRT option). The ranking of the three options, in terms of total benefits, is unchanged.
- On an incremental basis, the results are more mixed. Relative to the lowest cost (bus priority) option, the incremental user benefits for the BRT option increase by 54%, while those for the LRT option increase by only 15%. However, the incremental benefits of the BRT option over the LRT option increase by 85%.

These case study analyses showed that the effects on benefits, expressed in total generalised time savings, of adopting our preferred parameter formulations and values in place of EEM values were mixed, varying between modest increases (BRT +4%) and modest decreases (LRT -9%). When these total generalised time savings were multiplied by the relevant values of (in-vehicle) time, use of our preferred parameter values resulted in higher public transport user benefits than with EEM parameter values, for the three options: the increases ranged from 34% to 53% across the options. When comparing benefits between options (incremental analysis), the increases in the values ranged more widely, between 15% and 85%. We note that, in this case, the increase in the base value of time in our preferred values set (about 47%) produced greater changes in the benefit results than the net effect of the various adjustments affecting the benefits in terms of in-vehicle minutes.

Table 6.2 Summary of evaluation results – public transport user benefit parameters (EEM vs preferred)[(a)]

Option	Benefits – GC[(b)] mins (000pa)			Ave values of IVT ($/hr)			Benefits – $Mpa		
	EEM	Preferred	% incr	EEM	Preferred	% incr	EEM	Preferred	% incr
Priority	22,725	23,412	3,0%	5.31	7.79	46.7%	2.01	3.04	51.1%
LRT	44,333	40,386	-8.9%	5.31	7.79	46.7%	3.92	5.24	33.6%
BRT	70,751	73,721	4.2%	5.31	7.79	46.7%	6.26	9.57	52.9%
LRT – priority	21,608	16,974	-21.4%				1.91	2.20	15.2%
BRT – LRT	26,418	33,335	26.2%				2.34	4.33	85.1%
BRT – priority	48,026	50,309	4.8%				4.25	6.53	53.7%

Note:

[(a)] All figures cover both existing and new users, including fare correction for new users (but not vehicle operating cost correction).

[(b)] GC = generalised cost

6.3.3 Conclusion on effects of applying recommended parameter values

We would be cautious about generalising from these case study results. However, we would expect that:

- In general, benefits would increase somewhat if our preferred values were adopted: the higher values of in-vehicle time would be a major contributor to this (particularly over the medium/longer term).
- Schemes that involve increasing service frequencies would be particularly advantaged. Our preferred headway parameter (applying to service frequencies) is approaching 80% higher than that incorporated in the EEM.

- For the PTSS options appraised, the largest component of the increase in benefits (in absolute terms) relates to the in-vehicle time savings.

We conclude that adoption of our preferred set of public transport user benefit parameter values (from chapter 5), in place of the EEM values, is likely to make material differences to 'detailed' economic appraisal results for public transport proposals, in both absolute and relative terms, including:

- generally resulting in increased benefits
- benefiting some types of proposals more than others
- potentially, in some cases, affecting the ranking of (mutually exclusive) options, in terms of their relative benefits, incremental benefits and hence benefit/cost ratios.

6.4 Rapid appraisal – comparison of EEM simplified procedures (SP10) with detailed appraisal results

6.4.1 Details of scope and methodology

This part of the case study task involved comparisons between the PTSS 'detailed appraisal' methods and results (using full EEM procedures) and the methods and results from using 'rapid appraisal' procedures (the EEM simplified procedures SP10), starting from the same base data in each case.

The purposes of these comparisons were to examine (on a case study basis):

- the 'accuracy' of the SP10 procedures as a means of assessing economic benefits as compared with the full EEM procedures
- issues arising in the application of rapid appraisal procedures, such as SP10.

The starting point for this assessment was the PTSS demand modelling and detailed economic appraisal of the PTSS options and specifically the 2031 estimates for user benefits (used in full procedures) and patronage changes (used in SP10).

The EEM volume 2 states that SP10 '…provides a simplified method for appraising the costs and benefits of activities to improve an existing passenger transport service through the provision of capital infrastructure and/or service improvements'. The procedure provides estimates of scheme benefits in four categories (refer appendix G, section G1 for further details):

1 Road traffic user benefits (RUB)

2 Public transport user benefits (PTUB) – time and costs

3 Public transport user benefits (PTUB) – reliability

4 Public transport user benefits (PTUB) – quality factors.

The PTSS did not assess public transport reliability benefits. In regard to public transport quality factors, these were included within its time and costs category, although not in a detailed manner. The PTSS covered quality differences between public transport modes (bus priority vs BRT vs LRT) at a generalised level, through the values placed on in-vehicle time and boarding time for each mode. Thus our comparative assessment of SP10 with detailed EEM procedures for the PTSS options essentially covered public transport user time, cost and quality benefits (PTUB) and road traffic benefits (RUB).

This rapid appraisal test compared the results for:

- the EEM detailed appraisal (undertaken as part of the PTSS), is used as the baseline in section 6.3/ table 6.2 above
- application of the EEM simplified procedures SP10 to the PTSS outputs (undertaken as part of this project).

In effect, the test compared the effects of applying 'full' and simplified EEM procedures to an example scheme (in both cases using current EEM parameter values rather than the preferred parameter values from this project)[28].

The key inputs required in the application of SP10 are:

- forecast number of new public transport trips resulting from the proposed project, split between bus and rail modes (reflecting the different average trip lengths on each mode)
- unit benefit rates, expressed per new user, by bus and rail (and split between peak and off-peak periods). These are specified in table 1 of the SP10 documentation (EEM volume 2).

The outputs are the total economic benefits of the project, split between public transport user benefits (PTUB) and road user benefits (RUB), the latter relating to the effects of road traffic reduction (eg congestion relief and associated environmental benefits), resulting from people switching from car to public transport as a result of the project.

6.4.2 Application of EEM simplified procedures (SP10)

Table 6.3 shows our summary of SP10 benefit estimates for year 2031 covering both peak and off-peak periods, and separating the PTUB and RUB components. The SP10 procedures (SP10, table 1) give unit benefit rates for Wellington schemes, according to whether the new users use predominantly bus services, predominantly rail services, or a mixture of these two modes: this distinction is made primarily to reflect the different trip lengths typically involved, rather than any intrinsic differences in modal characteristics[29]. Given that most new public transport users attracted by the spine options are likely to be making relatively short distance trips, we consider it most appropriate to use the SP10 bus value, but also show the all (public transport) modes value for comparison.

The results are perhaps notable in that, for all options, the RUB benefits are similar in magnitude to the PTUB benefits. In our experience, this is a relatively high proportion of RUB benefits for significant metropolitan public transport schemes; it would appear to reflect the relatively high proportion of total scheme benefits that relate to peak period travel, partly offset by the relatively low proportion of new public transport users.

[28] It is not readily possible to determine the effects, if any, on the SP10 unit parameter values of introducing the parameter value changes recommended in this report.

[29] SP10 notes that 'The…values are based on public transport trips of average length for each urban area or mode. Where the values…do not accurately represent local conditions, you should provide additional information that shows what values have been used and whether these have been calibrated to local conditions'.

Table 6.3 Summary of SP10 results (EEM basis)

Option	SP10 unit values[a]	Benefits (relative to do minimum, 2031 $million per annum)			Incremental benefits total	Notes
		PTUB	RUB	Total		
Bus priority	Wellington bus	2.32	2.44	4.75		
LRT	Wellington bus	2.64	2.75	5.39	0.64	Incremental benefits relative to bus priority option
	Wellington all modes	3.51	3.08	6.59	1.84	
BRT	Wellington bus	6.36	6.03	12.38	6.99	Incremental benefits relative to LRT option
	Wellington all modes	8.44	6.79	15.23	8.64	

Notes:

[a] Uses the following benefit values per new user ($2012), taken from SP10: Wellington bus: PTUB $9.03, RUB $13.17; and Wellington all modes: PTUB $11.99, RUB $13.25.

6.4.3 Comparisons with EEM detailed procedures

Table 6.4 compares the results of this SP10 assessment with the EEM detailed appraisal (table 6.2) undertaken as part of the PTSS. Features of note include:

- The PTUB estimates are broadly comparable in the two cases: based on the 'bus' benefit values, the SP10 benefits are between 15% greater and 33% less than the detailed appraisal estimates of benefits; based on the 'all modes' benefit values, these differences are greater in one case, less in the other.
- The RUB estimates are very different in the two cases. The SP10 estimates are positive, of similar magnitude to the SP10 PTUB estimates. The detailed appraisal estimates are negative: this negative result represents a situation where the assessment indicates that:
  - the PTSS proposals produced significant disbenefits to road traffic, associated with the increased level of bus priorities with reallocation of road space and intersection priorities in favour of public transport
  - these disbenefits exceed any road traffic benefits resulting from the transfer of some car users to the improved public transport services. This significant loss of road traffic capacity may be regarded as a relatively unusual situation for public transport improvement proposals, which is not reflected in the basis behind the SP10 RUB formulation.

Table 6.4 EEM appraisal – simplified procedures (SP10) compared with detailed procedures

Item	Option	Annual benefits – $million pa (2031)	
		Detailed appraisal	SP10 procedures[a]
Public transport user benefits (PTUB)[b]	Bus priority	2.01	2.32
	LRT	3.92	2.64 (3.51)
	BRT	6.26	6.36 (8.44)
Road user benefits (RUB)	Bus priority	-1.99	2.44
	LRT	-3.03	2.75 (3.08)
	BRT	-4.84	6.03 (6.79)
Total benefits (PTUB + RUB)	Bus priority	0.02	4.75
	LRT	0.89	5.39 (6.59)
	BRT	1.42	12.38 (15.23)

Notes:

[a] Un-bracketed figures based on Wellington 'bus' unit values, bracketed figures based on Wellington 'all modes' values.

[b] Detailed appraisal figures include a 'resource cost correction' for changes in fare revenues.

6.4.4 Conclusions on effects of applying EEM simplified procedures (SP10) relative to EEM detailed procedures

From our comparative analyses of SP10 and detailed EEM procedures for this PTSS case study, we conclude the following:

- Public transport user benefits
  - In this particular case, the PTUB estimates by both methods are reasonably similar in magnitude, and the options are ranked in the same order as in the detailed appraisal.
  - While it is not clear whether such a result would be replicated for other schemes, in general terms this is to be expected. The SP10 PTUB estimates are driven by the number of new passengers, which in turn is driven by the level of benefits to existing passengers (which account for the great majority of the public transport benefits in the detailed appraisal).
- Road user benefits
  - In this particular case, the RUB estimates by both methods are completely different – the SP10 method indicates positive benefits (reflecting some switching from car to public transport travel); while the detailed assessment indicates negative benefits (as the modal switching effect is outweighed by the effects of enhanced public transport priority measures on road traffic movements).
  - It may be argued that this is an exceptional case, and that most public transport improvement proposals would not have such significant impacts on road space allocation for general traffic. Thus, for most public transport proposals, SP10 may provide a reasonable approximation to RUB benefit estimates from a detailed appraisal, although this cannot be established with any confidence from this single case study.

This case study assessment indicates that the SP10 procedures may have merits as a rapid approach to estimating PTUBs; and may also have merits for estimating RUBs for most public transport proposals (although this is unproven). However we have some qualifications in this regard. Both the PTUB and RUB SP10 estimates depend directly on forecasts of public transport patronage changes (by time period and public transport mode). For the appraisal of relatively straightforward public transport proposals (eg service frequency enhancements or fare changes), elasticity-based methods (or similar) could be applied rapidly to forecast the expected change in patronage, and SP10 could then be applied to derive PTUB and RUB estimates. The SP10 procedures would certainly be 'rapid', 'simplified' and efficient to apply in such cases.

But for more complex public transport proposals, the apparent 'simplifications' achieved through SP10 may be somewhat illusory in practice. The key problem is how to estimate public transport demand, and specifically the change in demand resulting from scheme options. In a case such as the PTSS, this can in practice be done only through some form of network-based modelling approach. Such a model is required whether a detailed or rapid/simplified economic appraisal is to be undertaken. Once the model is set up ready for application in forecasting demand, the difference in effort/resources to the forecast economic benefits associated with this demand change will be relatively small whether SP10 or detailed procedures are applied. Furthermore, the SP10 approach (which focuses on the number of new users) is likely to provide significantly less robust results than the detailed appraisal approach (where benefits to existing users, which comprise the major part of total user benefits, are estimated directly).

In the case of the PTSS project, it is debateable whether the user benefits are more appropriately appraised under SP9 (intended for 'new' public transport services) or SP10 (for 'existing' public transport services). Here we have applied SP10, given the perceived deficiencies in SP9, as outlined in appendix G (section G4).

Given the SP9 deficiencies and the issues outlined above with SP10, we recommend a review of the EEM simplified procedures relating to the economic appraisal of public transport proposals (ie SP9 and SP10). Such a review should cover:

- the case for retaining simplified procedures, and a clearer specification of the circumstances in which they are in practice likely to be appropriate (taking account of the combined demand forecasting/economic appraisal task, and the stage in project development
- if they are to be retained, then consideration of the need for two sets of procedures (as now) or their replacement by a single set (or possibly multiple sets)
- the inclusion in EEM of additional and practical advice on demand assessment for public transport proposals (either within the context of simplified procedures and/or elsewhere in the manual)
- review and updating of any parameter formulations and values specific to the simplified procedures (eg as in SP10 table 1).

6.5 Simple appraisal – brief consideration

The 'simple appraisal' level of analysis was not applied to the case study, as this level of analysis was not considered suitable for a project such as the PTSS. Nevertheless, there are components of the PTSS, such as the optimisation of bus routes through the Wellington CBD that could potentially benefit from a simple appraisal level of analysis. A tool such as the New Zealand Bus Policy Model (refer discussion in section 4.3.3) or a generalised cost and/or scheduling tool would help in such an assessment, as a full SCBA procedure would not be necessary to decide between suitable optimisation approaches (assuming services are being optimised within existing resource and service level constraints).

7 Conclusions and recommendations

Our conclusions and recommendations are set out in table 7.1 (conclusions column 2, recommendations column 3).

Table 7.1 Conclusions and recommendations

Aspect	Conclusions	Recommendations relating to specific conclusions
Economic appraisal approaches (chapter 2)	• A MCA framework is most appropriate for overall project appraisal of transport projects in New Zealand. • Within this overall framework, social cost-benefit analysis, supported by CEA, is the most appropriate approach to economic appraisal. CEA may be particularly appropriate for smaller projects focusing on public transport service changes.	• SCBA, supported by CEA are appropriate economic appraisal approaches • We do not recommend any substantial changes to the current New Zealand approach to economic appraisal (as in EEM). Our other conclusions and recommendations are largely consistent with this.
Economic appraisal procedures (chapter 3)	• Review of economic appraisal procedures in leading countries found that the procedures in Australia and the United Kingdom are based primarily on SCBA, as in the New Zealand case, while those in the USA are based primarily on CEA (within a MCA framework). • The New Zealand (EEM) public transport appraisal procedures provide monetary values for travel time in different situations (access/egress, waiting, in-vehicle including crowding, interchanging), for reliability of travel time, and for infrastructure (bus) and vehicle (bus/rail) quality factors. Notable omissions relate to rail infrastructure factors and public transport mode-specific preferences (apart from quality factors). • The coverage of EEM in terms of these monetised parameters is generally similar to that in the equivalent Australian and UK evaluation manuals. • Our review and previous reviews have identified that practitioners find the EEM difficult to apply.	• We recommend that parameter values for rail infrastructure features and for mode-specific preferences should be incorporated into New Zealand practice and included in the current EEM review/update (specific advice is included in the report). • We recommend that the EEM be redrafted to be easier for practitioners to apply.
Appraisal methodology issues (chapter 3)	• Seven SCBA methodology issues were addressed, principally in the context of the EEM volume 2, and comparing the New Zealand approach with international practices. • The seven issues were:	
	1 Escalation of unit parameter values over time (to reflect changes in real incomes.	• We recommend this be incorporated into future appraisal procedures.
	2 Adoption in appraisal of equity or behavioural valuations of non-work time.	• No recommendations made (largely a policy decision).
	3 Choice of willingness-to-pay or social cost basis in SCBA calculations.	• Recommend no changes to existing EEM procedures (although the EEM text and

<table>
<tr><th>Aspect</th><th>Conclusions</th><th>Recommendations relating to specific conclusions</th></tr>
<tr><td></td><td>4 Choice of market price or factor cost units of account.</td><td>presentation could usefully be enhanced).</td></tr>
<tr><td></td><td>5 Treatment of key benefit and cost items in deriving SCBA decision criteria (NPV, BCR etc)</td><td>• Recommend clarification in EEM of the roles for BCR_N and BCR_G for public transport schemes, and on a number of other aspects.</td></tr>
<tr><td></td><td>6 Discount rate.
7 Analysis period.</td><td>• No recommendations made as these aspects are not specific to public transport and are being addressed in a wider context.</td></tr>
<tr><td>Application of procedures (chapter 4)</td><td>• Identified three key considerations for determining an appropriate level of analysis: type of proposal, cost and risk profile, and stage of assessment (within the decision-making process).
• Three levels of analysis that might be used in the economic appraisal of public transport proposals were identified:
1 ‘Detailed appraisal’ based on full SCBA
2 ‘Rapid appraisal’ based on SCBA with simplified consideration of externalities
3 ‘Simple appraisal’ based on CEA and including operating costs, patronage and revenue impacts.</td><td>• Recommend the appraisal method for public transport proposals be tailored to ensure an appropriate level of analysis, based on a consideration of the type of proposal, cost and risk profile, and stage of the assessment within the decision-making process.
• Recommend further research on the selection of an appropriate level of analysis, based on relevant decision-making requirements.
• Recommend further research to determine the extent to which rapid appraisal procedures might differ for single-stage and multi-stage decision-making processes.</td></tr>
<tr><td>Parameter values
(chapter 5)</td><td>• Undertook an in-depth analysis of evidence on public transport parameter values from market research undertaken since 1990 (principally using SP surveys) in Australia (28 studies) and New Zealand (7 studies), covering the following parameters: values of travel time in a range of situations (access/egress, waiting, in-vehicle including crowding, interchanging), reliability of travel time and vehicle and stop/station quality factors (the latter factors are the focus of a concurrent Transport Agency market research project).
• For each parameter, conclusions were drawn on the mean and distribution of values, any differences between New Zealand and Australian values, values by various market segments (eg public transport mode, peak vs off-peak), and any changes in values over time (where applicable). Comparisons were made with current New Zealand (EEM) and Australian (NGTSM) values.</td><td>• In-vehicle time, headway (frequency), vehicle quality and stop/station quality features. Recommend that any changes to these parameters in EEM be considered once the public transport pricing strategies research project is completed (refer section 5.6)
• Access/egress (walk) time, travel time reliability and seat availability/crowding. Recommend no changes in these parameters in EEM (current parameter values more-or-less consistent with weight of evidence examined).
• Interchange (wait time and transfer ‘penalty’). Recommend changes to both these sub-parameters in the EEM. Also note need for additional New Zealand-based market research on this aspect (important in the context of service and modal integration/coordination policies being considered in Auckland, Wellington and other centres).
• Mode-specific factors. Recommend that:
- these be incorporated into the EEM
- in the short term, adopt the NGTSM formulations
- in the medium term, undertake a more comprehensive review of international evidence and integrate with the findings on quality factors from the public transport pricing strategies project.</td></tr>
</table>

Aspect	Conclusions	Recommendations relating to specific conclusions
Case studies (chapter 6)	Based on the PTSS case study and experience with other projects, we conclude that adoption of our preferred set of public transport user benefit parameter values, in place of the current EEM values, is likely to make material differences to 'detailed' economic appraisal results for public transport proposals, in both absolute and relative terms, including: • generally resulting in increased benefits • benefiting some types of project more than others • in a significant proportion of cases, affecting the ranking of (mutually exclusive) options, in terms of their relative benefits, incremental benefits and hence BCRs.	• This is a good case for implementing our recommendations on parameter values
	From our comparative analyses of SP10 and detailed EEM procedures for this PTSS case study, we conclude that: • In this particular case, the public transport user benefit estimates by both methods are reasonably similar in magnitude, and the options are ranked in the same order as in the detailed appraisal. • While it is not clear whether such a result would be replicated for other schemes (as it is not appropriate to generalise results from single case study), in general terms this is to be expected. The SP10 PTUB estimates are driven by the number of new passengers, which in turn is driven by the level of benefits to existing passengers (which account for the great majority of the public transport benefits in the detailed appraisal). • In this particular case, the road user benefits estimated through SP10 and using detailed (modelling) procedures are very different: this reflects the particular nature and impacts of the PTSS scheme and seems unlikely to be a general finding.	We recommend a review of the EEM simplified procedures relating to the economic appraisal of public transport proposals (ie SP9 and SP10). Such a review should cover: • the case for retaining simplified procedures, and a clearer specification of the circumstances in which they are in practice likely to be appropriate (taking account of the combined demand forecasting/economic appraisal task, and the stage in project development) • if they are to be retained, then consideration of the need for two sets of procedures (as now) or their replacement by a single set (or possibly multiple sets) • the inclusion of additional and practical advice on demand assessment (either within the context of simplified procedures and/or elsewhere in the manual) • review and updating of any parameter formulations and values specific to the simplified procedures (eg as in SP10 table 1).

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Appendix A: Business case decision making

A1 NZ Transport Agency application of NZ Treasury's Better Business Cases

The NZ Transport Agency ('the Transport Agency') is considering the application of the NZ Treasury's Better Business Cases (TBBC) within its procedures and is looking to adopt a 'principles based approach' (ie not rules) to business case development as part of the Transport Agency's *Planning and investment knowledgebase*. This is significant for public transport proposals in New Zealand, as the appraisal and funding approval of these projects is dependent on meeting Transport Agency requirements.

The Transport Agency considers the current system to be reasonably robust; with only relatively minor changes required to align existing procedures with the TBBC framework (D List, NZ Transport Agency – pers comm, March 2013). One key change would be to include greater emphasis on developing and agreeing on a strategic case for change, prior to committing resources to, for example, the development of a detailed economic assessment of options. Changes will be published as part of the Transport Agency's Planning and investment knowledgebase.

The Transport Agency is also looking to modify aspects of the TBBC framework so that it is 'fit for purpose' when considering transport projects (D List, NZ Transport Agency – pers comm, March 2013). The TBBC framework was developed for use by state sector agencies when seeking Cabinet decisions on capital proposals, whereas transport programmes and projects are generally developed within the local government sector, which is quite a different environment. For example, transport investment within the local government sector requires the agreement and commitment of a diverse range of business owners with different interests (eg local councils, regional councils, transport operators, NZ Transport Agency). There is also a statutory requirement for local and regional councils to consult with stakeholders and the general public, this requirement does not easily fit within the existing TBBC framework.

A2 UK application of business case procedures to transport project appraisal

In the UK, central government requirements for economic appraisal are set out in the HM Treasury's (2003) *Green book*. Supplementary guidance is provided in the form of HM Treasury's (2012) best-practice five case model guidelines for preparing business cases (Flanagan and Nicholls 2007). This has been adapted for use in New Zealand, as discussed above.

The Department for Transport requirements for appraisal and decision making are published online as WebTAG (www.dft.gov.uk/webtag/)[30]. WebTAG is fully consistent with HM Treasury's (2003) *Green book* but has been designed specifically for transport projects. It provides detailed guidance on setting objectives, developing solutions, modelling and appraising options. WebTAG is mandatory for central government funding, and should be considered best practice guidelines in all other instances (DfT 2011b).

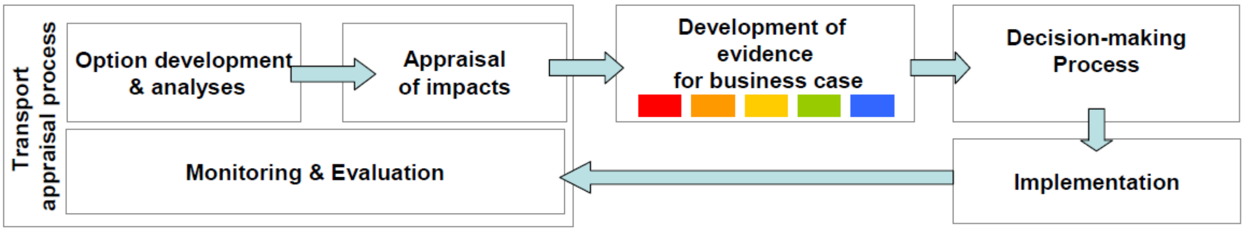
[30] WebTAG is the UK equivalent of the New Zealand EEM.

In 2011, the Department for Transport published *The transport business case* (2011a) based on HM Treasury's five case model guidelines. This decision-making process is distinct from the transport appraisal process. In regard to this distinction, Department for Transport analysis guidance states that:

> *The transport appraisal process is about options generation, development and evaluation of scheme impacts. In contrast, the decision-making process involves a separate governance process concerned with identifying and implementing schemes that deliver the needs of the sponsoring organisation and fits best with its investment funding objectives.* (Department for Transport 2011c, section:1.2.3)

Consequently, the Department for Transport has developed WebTAG2; with a stated intention to provide guidance in a clearer format that is better targeted to specific audiences (Department for Transport 2011c). It attempts to cover both the appraisal process (as per current WebTAG and HM Treasury (2003) *Green book*) and decision-making process (as per HM Treasury's five case model), as shown in figure A.1. WebTAG2 remains 'for consultation' and it is currently unclear as to whether there is any intention for it to replace WebTAG.

Figure A.1 Relationship between the transport appraisal process and the decision-making process from WebTAG2



Source: Department for Transport (2011d)

A3 Australian Transport Council project appraisal

Australia, unlike New Zealand and the UK, appears to have no overriding government business case or economic appraisal guidelines; rather each state generally has its own guidelines, eg New South Wales (Australia) Treasury Guidelines for Economic Appraisal (NSW Treasury 2007).

The *National guidelines for transport system management* (NGTSM) were introduced to help deliver better consistency across the states in transport planning or delivery, although the requirements are not mandatory. Infrastructure Australia also has requirements when seeking funding from the National Infrastructure Fund (Infrastructure Australia 2012). A project is currently underway to update the NGTSM and to ensure that '…the NGTSM is aligned and consistent with the guidelines for planning and project evaluation published by Infrastructure Australia and other relevant government bodies (eg Treasury Departments)' (GHD 2012, p1).

The NGTSM is structured around the eight phases of a Transport System Management Framework introduced by the guidelines. The eight phases can be broadly grouped as follows (ATC 2006a, p11):

- objectives-led strategic planning – phases 1 to 3 (objective setting, direction-setting policy choices, system planning)
- appraisal and programme development – phases 4 to 6 (identification and rigorous appraisal of initiatives, development of business cases, prioritisation of initiatives, programme development), and
- delivery and performance review – phases 7 and 8 (programme and initiative delivery, review of system performance).

The appraisal process (phase 5) involves three stages (strategic merit test, rapid appraisal and detailed appraisal). The economic appraisal of projects takes place at the rapid appraisal and detailed appraisal stages – the key difference being that rapid appraisal is less precise and may even exclude benefits and costs that are small or difficult to estimate (ATC 2006c, p18).

Appendix B: Approaches and methods used in the appraisal of transport projects

This appendix provides an overview of the various approaches and methods used in the appraisal of transport projects. Figure B.1 shows the five broad appraisal approaches identified and associated methods. We note that these approaches overlap and many methods may apply to more than one approach. A summary of these appraisal approaches and methods is given in table B.1.

Figure B.1 Appraisal approaches and methods

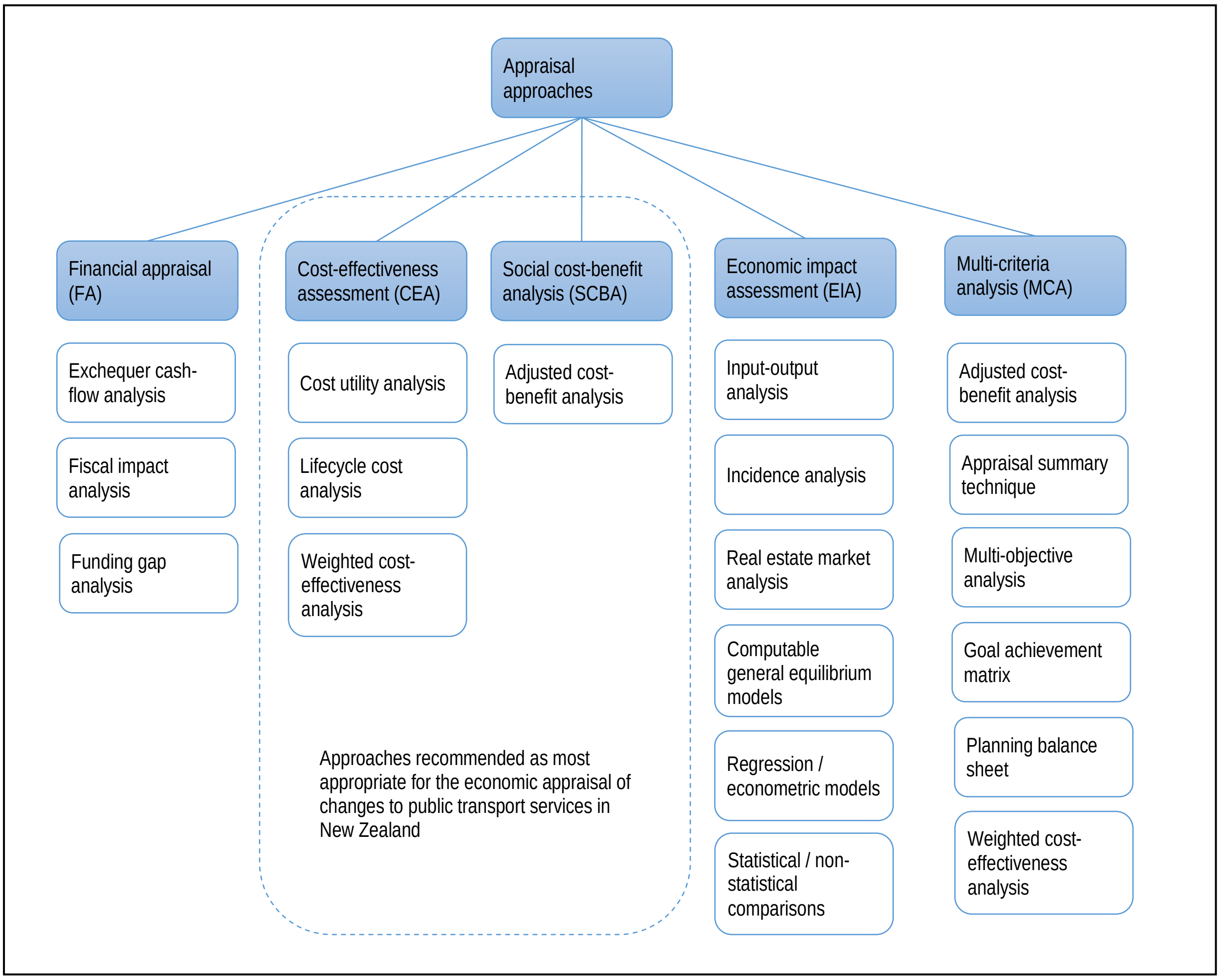


Table B.1 Summary of appraisal approaches and methods

Approach/method	Description	References (selected)
Financial appraisal (FA)	Compares revenue and financial costs directly attributable to a project – the normal 'business' approach.	ATC 2006b section 5.6; Department of Transport 2009; Eijgenraam et al 2000; NSW Treasury 2007, section 2.3; PCIE 1996
• Exchequer cash-flow analysis	Refer fiscal impact analysis.	Department of Transport 2009

Approach/method	Description	References (selected)
• Fiscal impact analysis	Considers impacts on government revenues and expenditures, including tax revenues.	Cambridge Systematics Inc et al 1998, section 4.0; Department of Transport 2009
• Funding gap analysis	Compares service provider costs against predicted revenue using a net present value methodology to determine financial viability. The funding gap is determined by trying different values of funding gap until the sum of the present value of the annual net cash flows is zero	NZ Transport Agency 2010b, section 6.0
Cost effectiveness analysis (CEA)	Compares the costs of alternative projects in contributing towards a particular objective or outcome, eg cost per life saved or cost per passenger-kilometre. In some quarters, CEA is confined to looking at costs of different options in achieving the same (equal/constant) objective or outcome.	Bureau of Transport Economics 1999; Department of Transport 2009; Litman 2006; NSW Treasury 2007, section 2.2.2; NZ Treasury 2005; PCIE 1996; The World Bank 2005b
• Cost-utility analysis	Compares the cost of an action to an increase in utility. Often used in health economics, particular in regard to life expectancy.	McCabe 2009; NZ Treasury 2005
• Lifecycle cost analysis	Identifies the option with the lowest overall cost over a period of time. Largely equivalent of a SCBA, but only considering the cost side.	Litman 2006, p7; Office of Asset Management 2002
• Weighted CEA	Refer MCA.	
Social cost-benefit analysis (SCBA)	Measures in monetary terms the value of all benefits and costs of alternative projects in social economic terms.	Ferreira and Lake 2002, p13; Litman 2006; NZ Transport Agency 2010b; NZ Transport Agency 2010a; NSW Treasury 2007, sec.2.2.1; ATC 2006d; Department of Transport 2009; Cambridge Systematics Inc et al 1998, sec.4.0; Wallis 2009, sec.2.2.1; ATC 2006b; Eijgenraam et al 2000; NZ Treasury 2005; Bureau of Transport Economics 1999; NZ Treasury 2012; UITP 2009; Wignall 2012b; PCIE 1996; Goodbody Economic Consultants 2004
• Adjusted cost-benefit analysis	Refer MCA.	
Economic impact assessment (EIA)	Traces the direct and indirect impacts of a project throughout the economy.	NSW Treasury 2007, sec.2.4
• Computable general equilibrium model	Build on input-output models and typically employ econometrics to allow for the constraints on consumption and government spending that are absent in I-O analysis.	Wallis 2009, sec.2.3; Bureau of Transport Economics 1999
• Economic forecasting and simulation models	Build on input-output models, but add to them additional elements to account for factors such as business cost, competitiveness, the shifting mix of population, and business characteristics. They also differentiate between the short-term construction	Cambridge Systematics Inc et al 1998, sec.4.0

Approach/method	**Description**	**References (selected)**
	impacts and longer-term impacts of maintaining and operating it, and the growth and expansion of user benefits over time.	
• Incidence analysis	Disaggregates the overall impacts of the options according to the impact on individual community groups	NSW Treasury 2007, sec.2.4
• Input-output (multiplier) analysis	In the simplest form of input-output analysis, input-output multipliers are applied to measures of direct impact to determine estimates of flow-on impacts in terms of income and employment (NSW Treasury 2007, section 2.4).	NSW Treasury 2007, sec.2.4; Cambridge Systematics Inc et al 1998, sec.4.0; Wallis 2009, sec.2.2.2
• Land use transport interface models	Refer real estate market analysis.	
• Multiple regression and econometric models	Seeks to isolate the effects of transit investments on mode choice or economic conditions, controlling for non-transit-related influences, such as exogenous economic trends and demographic changes. Regression models also serve as the basis for establishing causal relationships (eg measuring production functions) in many predictive techniques, including input-output	Cambridge Systematics Inc et al 1998, sec.4.0
• National economic modelling	Refer Computable general equilibrium model.	
• Real estate market analysis	Attempts to predict the effects on land use of changes in the price, quality and availability of transport brought about by transport schemes or policies, and also the effect of land-use changes on transport networks.	Cambridge Systematics Inc et al 1998, sec.4.0; Wallis 2009, sec.2.4
• Statistical/non-statistical comparisons	If the data needed to support regression analysis are not available, researchers may opt to make simpler statistical comparisons. Researchers can compare data on development, employment, wages, and other variables from both before and after data on a transit investment (ie longitudinal analysis) and similar data from another transit corridor as a control (ie a cross-sectional analysis).	Cambridge Systematics Inc et al 1998, sec.4.0
Multiple criteria analysis (MCA)	Compares options against a range of criteria, with results often presented in terms of a score. Criteria may have different weightings and be rated subjectively or quantitatively. CEA or SCBA can often provide some of the criteria.	Ferreira and Lake 2002, p13; Litman 2006, p7; Department of Transport 2009; ATC 2006b; Bureau of Transport Economics 1999; NZ Treasury 2012; NZ Treasury 2005; UITP 2009; PCIE 1996; Transport for NSW 2012, sec.3
• Adjusted cost-benefit analysis	Incorporates the concept of applying weights to benefits and costs (and hence objectives) to reflect their relative importance. It is a hybrid of BCA (retaining the monetary measuring rod) and the versions of MCA that use scores or weights.	ATC 2006b

Approach/method	Description	References (selected)
• Appraisal summary technique	An assessment and single table summary of economic, environmental and social impacts.	DfT 2012; Transport for NSW 2012
• Goal achievement matrix	A specific method for MCA.	ATC 2006b; Transport for NSW 2012, pp54–55
• Multi-objective analysis	Another term for MCA.	ATC 2006b; NSW Treasury 2007, sec.2.4
• Planning balance sheet		ATC 2006b
• Weighted CEA	CEA applied to a number of measures, which are weighted.	The World Bank 2005b
Other/non-economic methods		
• Case studies	Review of the experiences of other cities that have made similar transit investments	Cambridge Systematics Inc et al 1998, sec.4.0
• Development support analysis	Combines physical conditions analysis, real estate market analysis, and interviews, and supplements these tools with an analysis of capacity growth constraints	Cambridge Systematics Inc et al 1998, pp4–67
• Physical conditions analysis	Focuses on identifying opportunities for development within a proposed transit corridor. This method is based on the well documented premise that a transit investment will influence development in a corridor only if land is available and the market conditions within the corridor are competitive with other areas of a region.	Cambridge Systematics Inc et al 1998 section: 4.0, pp4–56
• Regional transportation and land-use models	A range of tools that can be used as an input for most economic evaluation approaches.	Cambridge Systematics Inc et al 1998, sec.4.0
• Strategic merit test/ objective impact assessment	A technique used to check if the proposed project aligns with the economic, environmental and social objectives, policies and strategies of the government.	Transport for NSW 2012, p55

Appendix C: International review of procedures for economic appraisal

Table C.1 provides a comparison of the decision criteria (and associated considerations) and benefit parameters included in the economic appraisal procedures reviewed.

Table C.1 Comparison of the decision criteria (and associated considerations) and benefit parameters

Aspect of methodology		Economic appraisal procedure					
		NZ EEM	Aust. NGTSM	Aust. TfNSW	UK WebTAG	UK TfL	US 'new starts'
Decision criteria and associated considerations							
Approach	SCBA	✓	✓[a]	✓	✓	✓	x
	CEA	✓	-	✓	×	×	✓
Decision criteria	Net present value (NPV)	✓	✓	✓	✓	✓	x
	Benefit-cost ratio (BCR)	✓	✓	✓	✓	✓	x
	First year rate of return	✓	✓	✓	x	x	x
	Internal rate of return	×	✓	✓	x	x	x
	Multi-criteria	✓	✓	✓	✓	✓	✓
Period of analysis	Discount rate (%)	8	Varies	7	3.5	3.5	n/a
	Evaluation period (years)	10–30	20–50	20–50	60	3–40	1–20
	Residual values allowed	✓	✓	✓	✓	✓	X
Public transport user benefit parameters							
Value of IVT	IVT (standard values)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	x
Journey time attributes	Access time • walk time (access/egress) • car access • public transport access[b]	 ✓(M)[f] × ×	 ✓(M) × ×	 ✓(M) ✓(M) ✓(M)	 ✓(M) - -	 ✓(M) - -	 x x x
	Headway (service interval)[c]	✓(M)	✓(M)	✓(M)	✓(M)[i]	✓(M)	x
	Seat availability/crowding	✓(M)	✓(M)	✓(M)[h]	✓(M)[i]	✓(M)	x
	Interchange (transfer penalty and wait time)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	x
	Reliability of travel time[d]	✓(M)	✓(M)	✓(M)	✓(N)	✓(M)	x
	Mode-specific factors[e]	×	✓(M)	×	–	–	x
	Pre-journey/ticketing	x	x	x	x	✓(M)	x
Quality attributes	Vehicle features	✓(M)	✓(M)	✓(M)	✓(M)[j]	✓(M)	x
	Stop/station features	✓(M)[g]	✓(M)	✓(M)	✓(M)[j]	✓(M)	x
Provision for 'simplified procedures'							
Provision for simplified procedures		✓	✓[m]	x	x	x	✓
Benefit parameters included [k]	Public transport user benefits	✓(M)[l]	×	×	×	x	✓(N)
	Road user benefits	✓(M)	✓(M)[n]	×	×	x	✓(N)

Aspect of methodology		Economic appraisal procedure					
		NZ EEM	Aust. NGTSM	Aust. TfNSW	UK WebTAG	UK TfL	US 'new starts'
Other benefit parameters[(o)]							
Road traffic system (de-congestion) benefits	Travel time savings	✓(M)	✓(M)	✓(M)	✓(M)	x	x
	Vehicle operating cost savings	✓(M)	✓(M)	✓(M)	✓(M)	x	x
	Accident cost savings	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)
	Parking cost savings	✓(M)	–	–	✓(M)	x	✓(N)
Environmental factors	Noise	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	×
	Vibration	✓(N)	×	×	×	×	×
	Water quality	✓(N)	✓(M)	✓(M)	✓(N)	✓(N)	×
	Special areas	✓(N)	×	×	✓(N)	✓(N)	×
	Ecological impacts	✓(N)	✓(M)	✓(M)	✓(N)	✓(N)	×
	Biodiversity	–	–	–	✓(N)	✓(N)	×
	Landscape	–	–	–	✓(N)	✓(N)	×
	Townscape	–	–	–	✓(N)	✓(N)	×
	Visual impacts	✓(N)	×	×	×	×	×
	Community severance	✓(M)	✓(M)	✓(M)	✓(N)	✓(N)	x
	Overshadowing	✓(N)	×	×	×	×	x
	Isolation	✓(N)	×	×	×	×	x
	Vehicle emissions (local)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)
	Vehicle emissions (global)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)
	Upstream/downstream costs[(p)]	×	×	✓(M)	×	×	✓(M)
	Journey ambience	–	–	–	✓(N)	x	x
	Accessibility	–	–	–	✓(N)	✓(?)	x
	Personal affordability	–	–	–	✓(N)	x	x
TDM factors	Health benefits	✓(M)	–[(q)]	✓(M)	✓(N)	✓(N)	–
	Reduced car ownership	×	✓(M)	×	×	×	x
Wider economic benefits	Population and employment	–	–	–	–	–	✓(N)
	Agglomeration benefits	✓(M)	×	×	✓(N)	✓(N)	x
	Output change in imperfectly competitive markets	–	–	–	✓(N)	✓(N)	–
	Labour supply impacts	–	–	–	✓(N)	✓(N)	–
	Move to more or less productive jobs	–	–	–	✓(N)	✓(N)	–
	Economic development effects	–	–	–	–	–	✓(N)
	Option and non-use values	×	×	×	✓(N)	✓(N)	x
National strategic factors	Security of access	✓(M)	×	×	×	x	x
	Investment option values	✓(M)	×	×	×	x	x

Notes:

Key: ✓(M) = monetised parameter; ✓(N) = non-monetised parameter; – = unclear/inconclusive; × = not covered

(a) The NGTSM include procedures for an 'adjusted benefit-cost analysis', which is a hybrid of SCBA and MCA that retains the use of dollar values. This adjusted methodology provides a formal way to re-weight or incorporate non-efficiency objectives, eg for safety or environmental outcomes (ATC 2006c).

(b) Public transport access time (eg bus/ferry access to rail) is considered a 'transfer' and covered under 'interchange' in most procedures.

(c) Headway (service interval) is often referred as the expected wait time at a stop or station.

(d) Reliability of travel time includes unexpected wait time at stop or station and unexpected IVT (eg delay due to congestion).

(e) Mode-specific factors are also known as alternative specific constants.

(f) EEM is unclear as to treatment of walk access.

(g) EEM provides parameters for bus stop and station features only (ie excludes rail).

(h) TfNSW seat availability/crowding parameters provided for rail only.

(i) WebTAG headway (service interval) and seat availability/crowding parameters provided for rail only.

(j) WebTAG quality attributes are provided for rail, it is unclear if any apply to other modes.

(k) The review of procedures included consideration as to whether any specific 'public transport user benefits' and/or 'road user benefits' were identified for inclusion in 'simplified procedures'.

(l) EEM provides for 'public transport user benefits' when appraising existing public transport services but not when appraising new services.

(m) Aust. NGTSM includes 'rapid appraisal' and 'detailed appraisal' in the decision-making process.

(n) Aust. NGTSM includes procedures for calculation of decongestion benefits.

(o) Parameters not considered further as they primarily relate to roads and therefore are more appropriately considered as part of any review of roading activities.

(p) Refers to indirect costs of transport including energy generation, vehicle production and maintenance and infrastructure construction and maintenance (Transport for NSW 2012).

(q) Considers disbenefit for less walking/cycling.

Appendix D: Key methodological considerations for social cost-benefit analysis

D1 Variation of unit parameter values over time

Issue description	How should unit parameter values of time (and parameters related to time) vary, in real terms, for future years: should they remain constant, or be escalated in some way; and if so how?
Current EEM procedures	It is assumed in volume 1 of the EEM that unit values of time (and related parameters) remain constant in real terms for all future years: • Section A4 on value of time (VoT) does not indicate any adjustments for future years. • Section A12.3 (update factors) gives factors for updating value of time that appear to indicate adjustment for inflation only since 2002 (ie no real change).
International procedures overview	Australia (NGTSM). Suggests that value of time would vary with real incomes, but does not allow for this in the values given. It suggests this be examined through sensitivity tests (ATC 2006d, p23). Australia (Transport for NSW). States that values of time are generally related to wage levels and should be escalated on this basis (Transport for NSW 2012, p17). United Kingdom (WebTAG). Specifies that values of time are to be increased for future years in line with real incomes, as measured by GDP/capita: • For working time, values are to increase directly with income (ie income elasticity of 1.0). • For non-working time, values are to increase with income, with an elasticity of 0.8 (DfT 2011b, vol 3.5.6/1.2.21). USA ('new starts'). States that unit value of time in future years should be adjusted in direct proportion (ie elasticity = 1.0) to growth in real median household income, for both business and personal travel (Department of Transportation 2011).
Commentary	There appears to be a general consensus among leading countries in this field that unit value of time (and it also appears crash) benefits for future years should vary as a function of real GDP/capita or similar measure of real wage rates. Similar conclusions were reached in a recent research project for the Transport Agency (Parker 2012). There is some on-going debate/difference of opinion as to whether the variation should be in direct (ie 1:1) proportion to changes in GDP per capita; or whether only at some proportion of the change (eg 80%, as in WebTAG). The evidence would need to be examined further. It is not clear whether the same (or similar) approach should be applied to unit crash costs: to the extent a large proportion of these costs comprise people's time, a similar approach would be appropriate. In New Zealand transport modelling/forecasting practice, recent work in Auckland and Wellington has come to the conclusion that future parameter values should be varied with a proportion of the change in GDP per capita, or similar measure (Parker 2012).
Conclusions/ recommend-ations for New Zealand	We consider that the prevailing international approach to this issue is more appropriate than that currently in the EEM procedures. We recommend the EEM be modified to adopt an approach consistent with that prevailing internationally, under which unit values of time for future years vary with some measure of real wage rates. In making any changes, aspects to be considered will be: • What measure of real wage rates should be used (we suggest a measure based on average (real) wages per employed person might be most appropriate). • Whether the adjustment should be applied to: i working time ii non-working time iii accident costs. • Whether the adjustment factor for i–iii should involve an elasticity of 1.0 or a lesser value.

D2 Adoption of 'equity' or 'perceived' valuations of non-work time

Issue description	Perceived non-work unit time values are generally based on willingness-to-pay research and are strongly related to incomes (resulting in ability to pay). If such values are also applied in economic appraisal, it may be argued that project selection will be biased in favour of projects used by high-income people, and this may be seen as undesirable on 'equity' grounds. An alternative is to adopt a single 'equity' value of non-work time for use in all economic appraisals.
Current EEM **procedures**	Current EEM values of non-work time relevant to public transport vary by: • mode (ie car, bus/train, pedestrian/cyclist) • purpose (ie commuting vs other non-work purpose) • person role and situation (ie driver vs passenger for car, seated vs standing for bus/train). EEM also notes that 'the travel time values relating to the original mode (where these values are highest) should be adopted for proposals that have a high proportion of mode switching' (NZ Transport Agency 2010a, sec.A4.2). In terms of the above, it may be said that EEM does not adopt 'equity' values, although there is, inevitably, a considerable degree of averaging within each mode/person/purpose category. In the public transport context, we note that no differentiation is made between unit values for bus, train (and ferry) users. We also note that no information is given in EEM as to the extent to which the spread of values by mode/person/purpose categories reflects: • differences in average incomes within user category • differences in the perceived desirability of different modes, situations (eg seated vs standing etc), or • other factors. Recognising differences in disutility, we note that an 'equity' adjustment, to 'standardise' for the income differences in each category, would not result in a single value across all non-work situations.
International procedures overview	Australia (NGTSM). Recommends a set of default values for public transport user IVT split only between peak and off-peak periods. Also gives option of using public transport mode-specific values (bus, rail/LRT, ferry) where appropriate for specific initiatives – while noting that this may present problems in situations where, for example, a new public transport mode is being introduced. Does not address the issue of 'equity' values between car and public transport users (by implication, does not adopt equity values across these modes). Australia (Transport for NSW 2012, p.154). This adopts an 'equity' value of time. It states the following: From the perspective of strategic resource allocation, the value of travel time savings used in economic evaluation in all transport projects should be harmonised. The higher value used for road projects than public transport projects means that the resource us tilted to road project at the expense of public transport investments. To harmonise the economic evaluation, [Transport for NSW] recommends that: Value of travel time (private) = $13.76 per hour applicable to private car occupants, on-board train time, on-board bus time, ferry travel, cycling time and walking time. United Kingdom (WebTAG). WebTAG essentially adopts an 'equity' approach to the valuation of non-working time. It states the following (DfT 2011b, vol.3.5.6/1.2.14). Time savings to travellers in their own time typically make up a large proportion of the benefits of transport investment. If values of time for appraisal are based on an individual's willingness-to-pay (behavioural values) which are related to income, then strategies and plans will be biased toward those measures which most benefit travellers with higher incomes (which may favour some modes over others). Investment will then be concentrated into high-income areas, and the interests of those on lower incomes, who mat already suffer from relatively lower mobility and accessibility, will be given less weight. For this reason, multi-modal transport appraisal should

	normally adopt the values for non-working time which is common across all modes and journey purposes. Recommended unit values for non-work time are provided, with the same value for all modes, differentiating only between 'commuting' and 'other' trip purposes. However, it is also noted that: • values for public transport waiting time are 2.5 times the standard commuting/other values • values for walking and cycling time, when used as a means of access to/from other transport modes, are 2.0 times the standard commuting/other values.
Commentary	The case for New Zealand (EEM) moving from its current approach to an equity-based approach for valuation of time savings in economic appraisal is not clear cut, and any implications would need to be further explored before taking such a decision. In any event, we regard such a decision as primarily a policy one rather than a technical one (although it can/should be informed by technical advice). Any move to an equity-based approach is likely to throw up greater difficulties in reconciling modelling and economic appraisal results than occur at present. The current EEM appraisal procedures, involving the same time values for bus and train modes, currently create difficulties when modelling and appraising changes in public transport modes (eg as in the PTSS); behavioural changes made in response to the new mode may apparently result in economic disbenefits. Should an equity-based approach be pursued, decisions would also be needed as to how to treat the different utilities of different modes (both between car and public transport, and between public transport modes). As noted above, the current WebTAG approach appears to allow for utility differences in some circumstances (for public transport waiting time and walk/cycle access time) but not in other circumstances (eg travel on bus vs train). We note Chris Nash's comments on the value of time equity issue: The British approach, again like many others, attempts to allow for equity considerations by using common values of time, risk of accidents and environmental amenity regardless of income. This might have been reasonable at a time when appraisal was mainly applied to road schemes which were paid for by the government but gave time savings to users, but now that appraisal is often applied to schemes which trade-off time savings against money cost (eg whether to replace buses with higher priced light rail services, whether to reduce road congestion by means of road pricing), it may be highly misleading. It would be quite possible for the appraisal to conclude that the scheme was desirable on the basis of a standard value of time, when according to the actual values of the users it was not (or vice versa) (Nash 2010, p9).
Conclusions/ recommend-ations for New Zealand	We make no recommendations on this issue. If any change towards equity-based values is to be contemplated, we suggest careful exploration of all the issues involved would first be appropriate.

D3 Choice of SCBA calculus – willingness-to-pay or social cost basis

Issue description	A SCBA takes into account all the ways in which a project would affect people. It may be described in two different ways: • as a willingness-to-pay calculus – which identifies the benefits and costs to different groups of stakeholders, or • as a social cost and benefit calculus – which measures the net economic (resource) effects on society as a whole. While the two approaches involve different ways of presenting the cost-benefit results, they result in the same valuation of net social benefit. Which way is preferred? The following outlines the two approaches further and their relative merits: The basic approach of the willingness-to-pay calculus is to establish a money measure for the net welfare change for each of the major stakeholders in the project and to sum these to arrive at an

	overall cost-benefit. In contrast, the social cost calculus seeks to measure the resources used by and the benefits arising from the project. This latter approach distinguishes between social costs/benefits and transfer payments, and only takes into account the former. It is important to note that the two approaches represent a difference in presentation only: identical effects are present in both methods. The key advantage of adopting a willingness-to-pay method of calculus is that it allows a comprehensive picture of the impacts of a project to be presented. That is, the effects of a project on differing groups of society (taxpayers, private sector operators, car users, etc.) are identified separately. The impacts of financial (toll revenue, fare revenue, tax revenue) over non-financial (time savings, accident savings) can also be identified. The converse is true of the social cost method, such distributional impacts being hidden through a netting-out of impacts, prior to application of SCBA methods. The willingness-to-pay method therefore lends itself well to understanding the distributional impacts of public transport projects, projects with partnering arrangements (PPP/developer contributions) and toll road projects. For traditionally procured road schemes, without partnering or private sector contributions, the application of social cost calculus would effectively be the same with the exception of the minor impacts on government tax revenue. (Goodbody Economic Consultants 2004) Further discussion of the two approaches is given in WebTAG (DfT 2011b, vol.3.5.4).
Current EEM procedures	EEM volume 2 appears to essentially follow the willingness to pay approach, although clarification in the EEM of the various steps in this approach would be desirable.
International procedures overview	Australia NGTSM (Urban transport, volume 4) adopts the willingness-to-pay approach, although it is noted that other parts of the guidelines follow an alternative (essentially social cost and benefit) approach: In this volume, benefits are estimated on the basis of reduced travel costs perceived by travellers, plus other impacts on travellers and the community that are not perceived by travellers. This method differs from the general approach presented in volume 3, but both methods give the same total benefit. The general formulation of the approach described in this section is commonly used for appraising urban transport initiatives and can more readily draw on the results of computerised travel demand models. Use the approach as described in volume 3 if it is more appropriate. It is essential that only one method is used: it is not appropriate to mix components from the two approaches (ATC 2006d) Australia (Transport for NSW) does not seem to mention this topic. United Kingdom (WebTAG) follows the willingness-to-pay approach. This was adopted following a review by Prof Robert Sugden (1999), which was particularly focused on the most appropriate approach in the context of multi-modal transport appraisal (DfT 2011b, units 3.5.4/3.17).
Commentary	For the economic appraisal of projects having cross-modal impacts (including public transport proposals), there seems to be a reasonable consensus that the approach based on the willingness-to-pay calculus is preferred. This has the substantial advantage that it can show the project impacts on each of the different groups affected – typically for a public transport scheme being the government sector, public transport operators, users, road traffic and other/external impacts. The willingness-to-pay approach is used in the current EEM volume 2 (and in NGTSM volume 4) and WebTAG). In the EEM context, it would be desirable to improve the description of the willingness-to-pay methodology and the various inputs to it (including the treatment of resource cost corrections – refer below).
Conclusions/ recommend-ations for New Zealand	The willingness-to-pay approach adopted in the EEM volume 2 is appropriate, particularly in the context of multi-modal and public transport studies. It would be useful in the EEM to improve the description of the willingness-to-pay methodology and the inputs to it, and to provide examples of outputs (disaggregated by groups affected, separated into financial and non-financial impacts).

D4 Choice of units of account – market prices or factor costs

Issue description	Any SCBA needs a unit of account. Obviously, the most convenient unit of account is money. In an economy with indirect taxes, the unit of account can be either at factor cost (that is, net of indirect tax) or at market prices (that is, gross of indirect tax). Focusing on people's willingness to pay for final consumption, a market price unit of account seems more natural, since prices to consumers are generally quoted gross of tax. Which unit is used in SCBA is of no real significance but consistency is essential. The indirect tax correction factor is the conversion between the two units. If SCBA uses the factor cost unit, a correction factor has to be applied to any costs or benefits that have been measured gross of tax. Conversely, if the market price unit of account is used, the reciprocal of that correction factor has to be applied to costs or benefits that have been measured net of tax. The question to be addressed here is which unit of account (market price or factor cost) is best adopted, given the context that the willingness-to-pay approach to SCBA calculations is preferred to the social costs approach (refer section D3).
Current EEM procedures	EEM volume 2 appears to follow the 'market prices' (including indirect tax component) approach. However, we were unable to find any specific reference on this point within EEM.
International procedures overview	Australia (NGTSM). Somewhat similar to EEM volume 2, NGTSM volume 4 appears to follow the 'market prices' approach: Willingness-to-pay values derived from market surveys have not been adjusted to allow for the indirect tax component in people's valuations. Australia (Transport for NSW). This topic does not appear to be mentioned – given this, we assume the 'market price' approach is adopted. United Kingdom (WebTAG). Following the review by Prof Robert Sugden (1999), the UK appraisal framework used for multi-modal studies was changed from a factor cost unit of account to a market prices unit of account. It was considered that the market price approach would better fit with the change to the willingness-to-pay calculus adopted, as also recommended in the Sugden review. One result is that market price unit values of non-working time include a component (of about 17%) of indirect taxes.
Commentary	The consistent adoption of the willingness-to-pay calculus and the market price unit of account, as in WebTAG, is the preferred approach to SCBA appraisal. It has the significant advantage that it can show the project impacts on each of the groups affected by a project, in the terms with which they will be familiar (ie reflecting how much they pay, including any indirect tax component).
Conclusions/ recommend-ations for New Zealand	The market price approach currently adopted in EEM, along with the willingness-to-pay calculus, is the most appropriate methodology, particularly for appraising public transport and multi-modal projects. It is also consistent with the WebTAG methodology. As noted earlier (section D3), there would be merits in improving the EEM material that covers these aspects.

D5 Basis for benefit-cost ratio calculus – benefit and cost definitions

Issue description

We address three issues under this heading, as follows:

Issue	EEM **volume 2**
Definition of costs (BCR_N)	**'Cost' and 'benefit' definitions within BCR formulation.** The main point here is whether on-going operating/maintenance costs should be treated as a 'cost', in the BCR denominator, or a (dis)benefit, in the BCR numerator. The guiding rule should be that items subject to constrained funding should be in the denominator: if both capital expenditure and operational expenditure are to be funded from the same (constrained) source, then both should be in the denominator; if operational expenditure is funded separately, from an unconstrained/ less constrained source, it should be included in the numerator.
Use of BCR_N versus BCR_G for project ranking/selection	**The use in project ranking and decision making of two alternative BCR measures: national economic welfare perspective (BCR_N) and value for money in terms of public funding (BCR_G)** This difference is of particular importance for public transport proposals, which typically earn significant revenues, and thus ranking by the two measures may give very different results. Given that the main purpose of the BCR ranking, certainly in the New Zealand context, is to rank projects in terms of their value for money in terms of expenditure of government funds, the BCR_G measure is more appropriate.
Treatment of fare revenues in benefit calculation	**Treatment of fare revenues in BCR calculation.** There is often debate as to how fare revenue should be dealt with in the BCR formulation, in the calculation of the 'benefit' term: the correct approach is that fares should not be counted as a 'benefit', as they are not a resource item but only a transfer payment between users and operators. In practice, since user benefits are normally estimated on a willingness-to-pay basis, using a demand model, these include any changes in fare revenues to users. A 'resource cost correction' is therefore required to subtract the fare revenue changes (effectively eliminating fares from the benefit term). In the denominator, any fare revenue changes will occur in the BCR_G calculation, as they affect the net cost of the scheme to the public sector, but not in the BCR_N calculation (which uses the gross scheme costs).

Current EEM **procedures**

Refer to the international procedures overview table below.

International procedures overview

The following table provides an overview of international practices regarding benefit and cost definitions.

Issue	EEM **volume 2**	**Aust. NGTSM**	**UK WebTAG**
Definition of costs (BCR_N)	Capital expenditure Operational expenditure (all components).	Capital expenditure (only)	Capital expenditure Operational expenditure infrastructure (if funded by public sector)
Use of BCR_N versus BCR_G for project ranking/selection	Not clear – both appear to be required for public transport proposals (not specific re application in decision making)	BCR_N only (BCR_G not discussed)	Unclear

	Treatment of fare revenues in benefit calculation	Specifies 'resource cost adjustments' required to net fare payments out of user benefits (EEM2, section 3.8)	Specifies that fares are to be added back in to derive the net resource benefit, ie as in EEM (NGTSM vol. 4, section 3.4.3)	Unclear, but assumed similar to New Zealand and Australia (follows the Sugden approach).
Commentary	Definition of costs. The EEM definition of items for inclusion in the BCR denominator appears appropriate within BCR_N: this assumes that both capital expenditure and operational expenditure are subject to a similar public funding constraint. It is notable that the Australian procedures seem to include only capital expenditure in the denominator. Use of BCR_N versus BCR_G. The EEM appears to require calculation of both measures for public transport proposals, but is not specific as regards the use of the two alternative measures for project ranking/decision making. We would anticipate that BCR_G is the primary measure used for this purpose: it may be that BCR_N is superfluous. Treatment of fare revenues in benefit calculation. The correct approach is clear, as outlined above: this appears to be adopted in the manuals of all three countries. In the EEM case, part of the debate/confusion on the topic appears to arise because the procedures for fare corrections are set out only in the chapter on TDM activities (section 3.8), not in the chapter on transport services (eg section 7.2).			
Conclusions/ recommend-ations for New Zealand	We consider that the EEM volume 2 procedures are technically satisfactory in regards to each of the three issues examined. We suggest that the need for both BCR_N and BCR_G assessments for public transport proposals be re-examined: BCR_N assessments may be superfluous. We suggest that (as part of a wider redrafting of the EEM volume 2) the correct treatment of fare revenues in the benefit calculations for public transport proposals should be set out clearly in chapter 7 and/or cross-referenced to the relevant section of chapter 3.			

Appendix E: Evidence on individual parameters

E1 In-vehicle time (standard values)

The monetary value of (standard) in-vehicle time is an important economic parameter in the evaluation of infrastructure projects, translating travel time savings into dollars to compare against project costs.[31]

A total of 28 studies were reviewed providing 81 values of time. Four of the studies were from New Zealand, providing seven values; most of the values were for Sydney with some for Brisbane and Canberra.

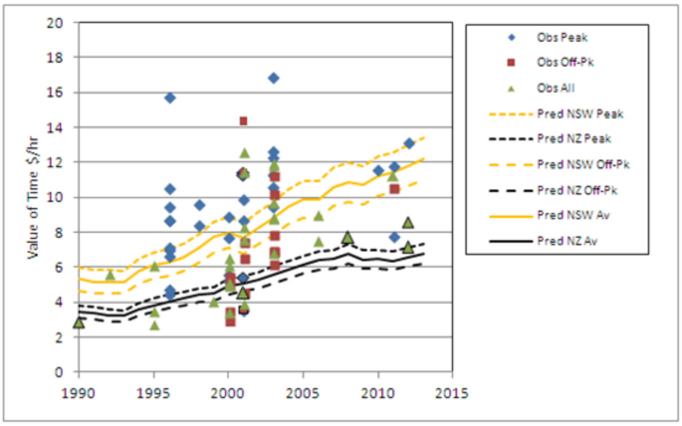
Values of time were estimated for bus, rail, light rail and ferry covering peak, off-peak and 'all day' time periods.[32] Estimates were also categorised by:

- type of study such as SP and RP
- transport mode (eg bus or rail)
- respondent (eg rail or car user).

None of these segmentations produced differences that were statistically significant at the 95% confidence level however.

Figure E.1 plots the value of in-vehicle time over time. The peak, off-peak and all estimates are distinguished by shape with the New Zealand observations outlined in black. The values are shown in nominal dollars either New Zealand or Australia. The values have not been converted into New Zealand (or Australian) dollars, and GDP or consumer price index deflators have not been applied. The values are also expressed in market prices and include GST[33].

Figure E.1 Value of in-vehicle time over time



[31] Other components, eg access time can also be converted into dollars after they have been expressed in equivalent in-vehicle time minutes

[32] Some studies produced estimates by trip purpose rather than peak/off-peak values. Where this was done, commuting to work trips were considered as peak and 'other' trips as off-peak with overall estimates treated as 50% peak and 50% off-peak.

[33] The values are also expressed in 'market prices'. All the estimates are based on a 'trade-off' between travel time and fare and the fare includes goods and service taxation (GST) when levied. It should be noted that before 2000, there was no GST in Australia. Since 2000, a 10% GST has been levied on public transport fares. In New Zealand, GST was set at 12.5% until it was raised to 15% in October 2010. The evaluation has not adjusted the values to remove indirect taxation. It is understood that the EEM has removed indirect taxation (estimated at 15%).

The graph also shows the predicted value of time for each year for New Zealand and Australia or more particularly New South Wales (Australia). Three lines are shown for each: peak (the highest-value); average and off-peak (the lowest value). The predictions are based on GDP per person (GDPP). Alternative models using a time trend and a consumer price index (CPI) were also fitted but a GDP-based model was preferred because it gave a better fit than CPI and had the benefit of being able to explain the projection unlike a time-trend model.

GDP per person for New Zealand was calculated using Statistics NZ figures of national GDP and population. For Australia, it was calculated using Australian Bureau of Statistics figures of gross state product and population for New South Wales[34] divided by population were used. To relate to values of time which are on an hourly basis, annual GDP per person was divided by 2000 working hours per year (based on US and UK DoT).

Rather than modelling the value of time itself, the model fit the ratio of the value of time over hourly GDPP. The best prediction model allowed for different responsiveness to GDP for New Zealand and also for peak trips. Equation E.1 shows the fitted model with standard errors in parenthesis.

$$VOT/(GDPP/hr) = -0.577 + (0.276 + 0.063NZ + 0.024Pk)\ (\text{in } GDPP/hr)\ (0.401)\ (0.126)\ (0.028)\ (0.011) \qquad \text{(Equation E.1)}$$

The fitted model indicates that the ratio of the value of time to GDPP increased over the 20-year period as GDP increased. People were willing to spend proportionately more to save time as incomes rose. This is reflected in the 0.276 parameter. New Zealand was estimated to be more responsive per dollar (New Zealand versus Australian dollar) than New South Wales (Australia) (reflected in the 0.063 parameter). Finally, peak travellers were more responsive than off-peak travellers (reflected in the 0.024 parameter). The functional form means that the relationship flattens off as GDPP continues to increase.

For 1990, hourly GDP was NZ$11.85 for New Zealand and A$19.34 for New South Wales (Australia). New Zealand hourly GDPP was therefore 61% that of New South Wales (Australia). The first-value of time was an estimate of $2.87 per hour for Wellington rail travel. Thus the value of time was around one quarter of hourly GDPP. The first tabulated Australia value of time was $5.61 per hour for Sydney rail in 1992, around 30% of hourly GDPP.

By 2012, hourly GDPP in New South Wales (Australia) had increased to A$29.60 and to NZ$16.30 per hour in New Zealand. By comparison, values of time increased to just over A$13 per hour for Sydney public transport and to NZ$8.56 and NZ$7.13 per hour for Wellington rail and bus services. As a percentage of hourly GDPP, the average value of time in 2012 had risen to 41% for New South Wales (Australia) and 42% for New Zealand. Thus with these examples, it can be seen that the value of time increased proportionately more than GDPP over the two decades from around 25% to 30% in 1990 to just over 40% in 2012.[35] Moreover, as can be seen from figure E.1, the value of time rose consistently with the rise steeper for New South Wales (Australia) than for New Zealand.

Comparing 2012 with 1992, New South Wales (Australia) GDPP rose by 156% and New Zealand GDPP by 142% which compares with more than a doubling in the predicted average value of time (New South Wales 228% and New Zealand 203%). Thus at 1.45, the elasticity of the value of time with respect to GDPP was

[34] Gross state product is equivalent to GDP.

[35] By comparison, in the 1970s and 80s, the Ministry of Transport in the United Kingdom set the standard value of time at 25% of the average gross wage rate. In 1987, the Department of Transport increased the standard value to 43% of average hourly earnings of full time adult employees and updated the value in proportion to the change in real income (DfT 1987).

estimated to be elastic; a finding which contradicts the proportional growth assumptions and is less than proportional estimates for the UK and Denmark[36].

For 2006, the NGTSM recommended an average value of time of $10 per hour (2006 prices) for Australian urban bus and rail travel with a peak value of $10.80 and an off-peak value of $9.20. The predicted values using equation 1 are remarkably similar at $9.89, $10.93 and $8.84 per hour respectively.

Nevertheless, figure E.1 does highlight the variability in the value of time estimates especially between 1995 and 2005 when most of the studies were undertaken. To some extent, the variability reflects the peculiarities of the individual studies, most of which were not undertaken first and foremost to estimate value of times but to provide parameters for project demand forecasts.

To develop an indicative range in New Zealand estimates for 2012, the prediction model was used to update the all the observed estimates. Then, the inter-quartile range (75% and 25% values) was calculated, the results are shown in table E.1. The average value of time for bus and rail was estimated at $6.80 per hour with a quartile range of $5.30 to $8.30. The peak value of time was higher at $7.30 and the off-peak value lower at $6.20 per hour.

These values compare with EEM estimates for 2012 of $6.44 per hour for peak travel and $4.18 per hour for off-peak travel (both values excluding GST). The peak values are therefore similar (once GST is removed from the $7.30 estimate) with the off-peak value around $1 higher than the EEM updated estimate. The similarity is not surprising since the EEM value derives from a 2002 SDG study (Beca Carter Hollings & Ferner et al. 2002) and this study also provides two influential data points in the New Zealand model.

Table E.1 Predicted values of time for 2012 (2012 prices including GST)

Statistic	New Zealand			New South Wales (Australia)		
	Peak	Off-peak	Average	Peak	Off-peak	Average
75th percentile	9.00	7.60	8.30	15.40	13.70	15.00
Average	7.30	6.20	6.80	13.40	11.00	12.20
25th percentile	5.70	4.80	5.30	11.40	8.30	9.40

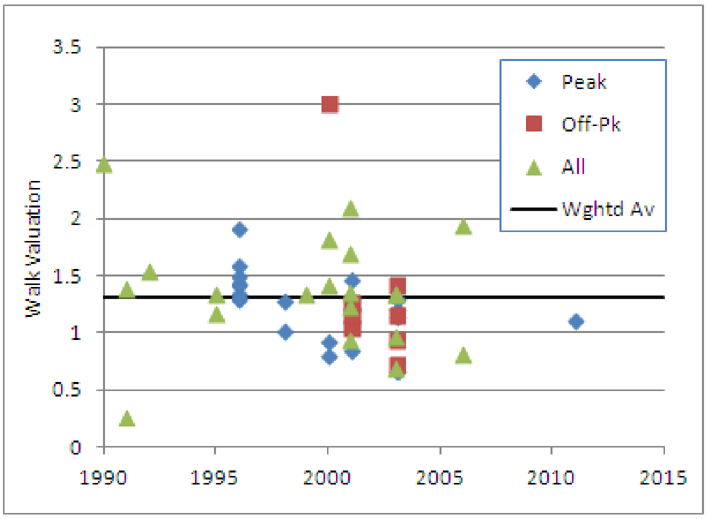
E2 Walk time (access/egress)

Walk access/egress differs from general walk time, in that it is a valuation specifically relating to walking to and from bus stops, train stations and ferry terminals. As the NGTSM notes, although the terms are self-explanatory, studies can be unspecific in what access and egress actually refer to. For example, rail studies often treat access/egress generically, lumping walk with bus and car.

A total of 21 studies provided values for access/egress time relative to in-vehicle time. Of these, three were New Zealand and 18 were Australia studies, predominately New South Wales (Australia) studies. Altogether, the studies provided 48 values. Figure E.2 presents a scattergram of the values highlighting the concentration of values between 1995 and 2005.

[36] Wardman (2001), for example, estimated an income elasticity of 0.6 based on cross-sectional UK data and a GDP elasticity of 0.5. For Denmark, an income elasticity of 0.63 has been estimated using before-tax income and 0.79 using after-tax income (Fosgerau 2005).

Figure E.2 Value of walk access/egress time



The average value was 1.30 for walk time (a weighted t-value average) which is lower than the recommended value of 1.4 in the EEM and NGTSM.

The 1.30 valuation is lower than the common assumption of valuing walking time twice that of in-vehicle time but is reasonably close to the valuation of 1.48 produced for the UK in a meta-analysis of 143 values, reported by studies undertaken in the 1980s and 1990s (Wardman 2001).

There was little difference in the peak and off-peak valuations as table E.2 shows with an inter-quartile range of 1.04 to 1.42 over all 48 observations.

Table E.2 Value of walk time

Statistic	Peak	Off-peak	Average	Overall
75th percentile	1.42	1.30	1.59	1.42
Average	1.26	1.21	1.32	1.30
25th percentile	1.08	1.02	1.12	1.04
Observations	20	8	20	48

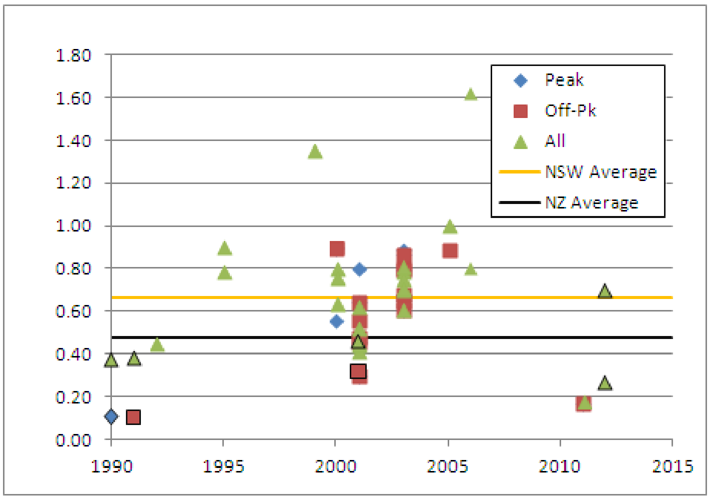
All but two of the studies were SP surveys and in this regard it is worth mentioning a potential problem in getting respondents to hypothesise a different location for a bus stop or train station they normally use. The exceptions were two Sydney RP studies (Fox et al 2010; Hague Consulting 1996) in which the value of walk time was estimated cross sectionally based on household travel survey data. These two revealed preference studies estimated a higher valuation of walk time of 1.5.

E3 Headway (service interval)

The headway (service interval) parameter measures the number of minutes between departures: the higher the frequency, the lower the service interval. It expresses the perceived value of reducing service headways by one minute relative to the value of saving one minute of in-vehicle time. For example, if a bus service frequency was increased from three buses/hour (ie every 20 minutes) to four buses/hour (ie every 15 minutes), the average headway would reduce by five minutes. With a typical headway factor of say 0.5, this would result in the benefit to passengers (reduced waiting time at stop and reduced inconvenience) equivalent to 2.5 minutes of in-vehicle time.

27 studies were reviewed that produced 74 service interval valuations or valuations that could be converted into service interval. Of these, five studies were New Zealand and 22 Australian mainly New South Wales. Figure E.3 presents the observations.

Figure E.3 Value of service interval



Most of the studies reviewed were SP surveys that usually described services as ‘every X minutes’. Some presented a ‘maximum wait time’ which is effectively the service interval. A few studies presented wait time and where wait time was used, the review converted the reported wait time valuation into service interval by halving the estimate.

One study valued ‘service displacement’, ie the cost of not being able to travel at the ideal time. The valuations were low, however, when converted into service interval valuations and were not included in the statistical analysis.

As set out in table E.3, the average value over all the values was 0.64 with an inter-quartile range of 0.46 to 0.78. The average valuation for New Zealand was lower at 0.48 than for Australia (New South Wales) at 0.66. These values are higher than in EEM (0.36) and in the NGTSM (0.46).

Table E.3 Value of service interval

Statistic	New Zealand	New South Wales (Australia)	All
75th percentile	0.64	0.79	0.78
Average	0.48	0.66	0.64
25th percentile	0.33	0.48	0.46
Observations	8	63	71

E4 Seat availability/crowding

Twelve studies undertaken in Australia and New Zealand covered crowding; four were New Zealand studies and eight were Australian. Three of the Australian studies were undertaken specifically to value crowding. Two studies looked at on-train crowding (one Sydney study of double deck trains and one pan capital city study looking at single deck train crowding). The other study looked at rail station crowding in Sydney. All the studies used SP choice games to estimate the valuations.

Half the studies covered bus crowding either solely or part of a public transport versus public transport (bus vs rail or light rail) choice game. Three levels of crowding were covered by the studies: crowded seating, standing and crush standing. Altogether, 15 crowding values were compiled with figure E.4 showing the values.

Figure E.4 Value of crowding

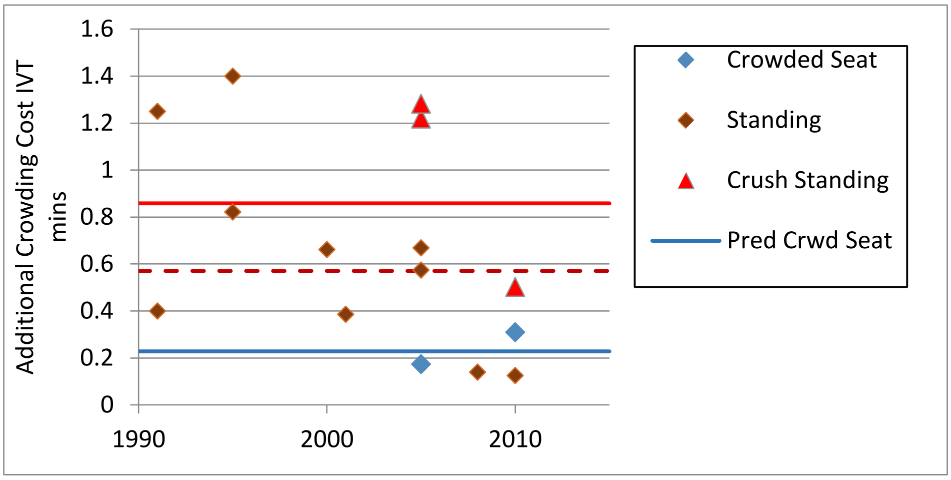


Table E.4 presents the average and quartile values. Crowded seating adds a 0.23 to on-board travel time. Thus, 20 minutes spent in crowded seating would add a cost of 4.6 minutes. Standing increases the crowding cost to 0.57 per minute with crush standing raising the cost to 0.86 per minute. The EEM only tabulates a standing cost of 0.4 which is lower than the 0.57 estimate.

Table E.4 Additional cost of crowding (using in-vehicle minutes) relative to uncrowded seating

Statistic	Crowded seat	Standing	Crush standing
75th percentile	0.28	0.78	1.25
Average	0.23	0.57	1.00
25th percentile	0.21	0.39	0.86
Observations	2	10	3

Only one Sydney rail study looked at the length of stand finding the per-minute cost to increase for longer stands. For stands of less than 10 minutes, the cost was estimated at 0.34 per minute whereas for stands of 20 minutes or longer, the cost per minute rose to 0.81.

In applying the values, the level of crowding in the 'base' value of time should be taken into account.

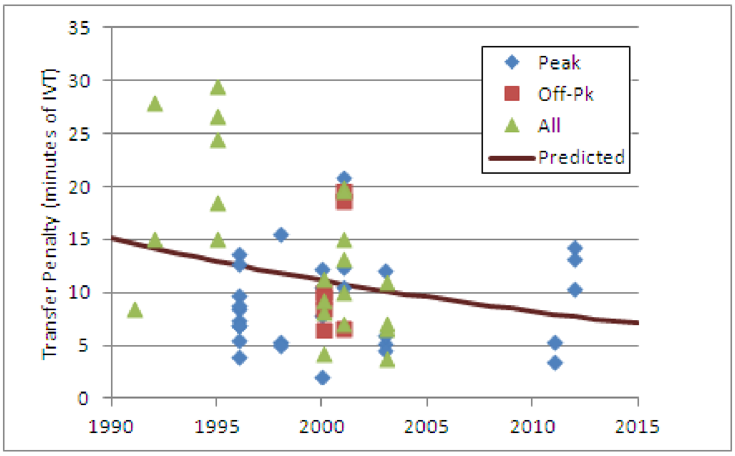
E5 Interchange

Changing trains or buses adds an 'interchange penalty' of added journey 'hassle', extra anxiety from potentially missed connections and added informational costs.

Disentangling the 'penalty' from the extra waiting and walk connection time is problematic. Indeed, many studies have not attempted to do so and have reported 'gross' penalties that incorporate some connection/wait time into the total cost of the interchange.

In total, 18 studies providing 64 interchange penalties were reviewed. Only one was a New Zealand study with the other 17 being Australian, mainly New South Wales (Australia) values. Figure E.5 presents a scattergram of the transfer penalty estimates. The graph shows some evidence for a decline in the transfer penalty; from around 15 minutes in 1990 to 7.5 minutes in 2013. However, this analysis masks a difference in 'time period' since the pre-1995 values were 'overall' and the post-2005 were peak only. When limited to the peak observations, there was little evidence for a decline in the transfer penalty over time.

Figure E.5 Value of transfer penalty



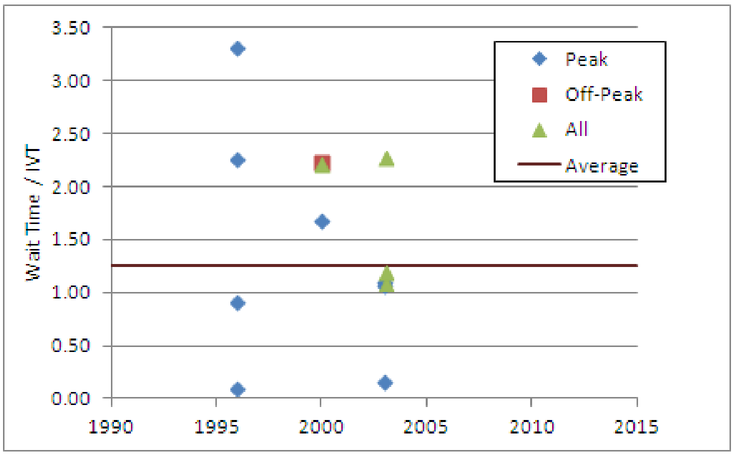
Most of the values were for rail transfers with a few estimates for bus, light rail and ferry. Values for 'same mode' and different mode transfers were reviewed.

Most of the penalties were 'gross' and did not separate out transfer connection time. However, 19 studies did provide transfer wait/walk valuations.

An attempt was made to remove wait time from the 'gross' transfer penalties to leave a net or pure transfer penalty. This required a two-stage process: in the first stage, the average value of wait time was estimated, then the transfer time weight was applied to an assumed five-minute transfer and the weighted time deducted from the gross penalty. If negative penalties resulted, the value was set equal to zero.

There were 19 transfer wait valuations which ranged from close to zero to 3.4. Figure E.6 presents the values. The highest-value was for 'second' waiting time in the Sydney Travel Model (Hague Consulting 1996). This study did not include a transfer penalty, however, and so this value was not included in the estimate.

Figure E.6 Value of transfer wait time

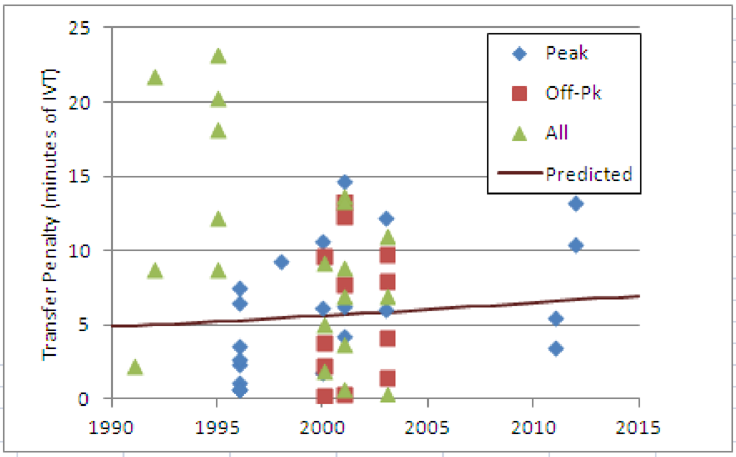


The average value of transfer waiting time was 1.25 with a quartile range from 1.05 to 1.44. The value is lower than the conventional assumption of valuing wait time at twice in-vehicle time. A possible reason for the low value is respondents discounting the wait times shown on the SP questionnaires and simply viewing the transfer as a 'gross' cost. In reality, however, they would notice the waiting time and value it accordingly ('traffic light' syndrome)[37].

Alternatively, the assumption of valuing wait time at twice that of in-vehicle time may be too high. Supporting evidence for this is provided by a meta-analysis of wait times by Wardman which calculated a wait valuation of 1.56 (Wardman 2001).

The valuation of 1.25 was used to deduct the cost of a five-minute transfer from the gross penalty estimates. Figure E.7 presents the resultant pure penalty which averaged around six minutes.

Figure E.7 Value of pure transfer penalty



A variety of models were fitted to explain the variation in the pure transfer penalty. As well as year, trip length was tested but both relationships were statistically insignificant.

Where there was significant variation in the pure transfer, penalty was by time period and by type of transfer. A lower pure penalty was estimated for peak trips compared with off-peak trips which may be attributed to:

- a greater familiarity among commuters
- higher service frequencies which reduce the chance and cost of missed connections
- less baggage/greater mobility.

A lower penalty was estimated for same mode transfers, eg bus to bus or rail to rail than for different mode transfers, eg bus to rail.

Table E.5 presents the average values and inter-quartile range for the pure transfer penalty and transfer wait time. For the peak, a penalty of four minutes was estimated for a same mode transfer and 12.5 minutes for the off-peak. A different mode transfer increased the penalty by around five to nine minutes in the peak and 17 minutes in the off-peak.

As an example, a four-minute same mode transfer during the peak would add nine minutes of in-vehicle time to the trip (five minutes of weighted wait time and a four-minute pure transfer penalty).

[37] In fact, two studies took action to increase the value of wait time by constraining the parameter to service interval. For these studies, the unconstrained values were used.

Table E.5 Value of pure transfer penalty and wait time

Statistic	Same mode penalty		Different mote penalty		Wait time
	Peak	Off-peak	Peak	Off-peak	
75th percentile	9	15	15	21	1.44
Average	4	12.5	9	17	1.25
25th percentile	0	10	4	14	1.05

E6 Reliability of travel time

Surveys of customer opinion have consistently shown that timetable reliability is a critical factor in service quality[38] .

Timetable reliability covers two components: the reliability in arrival/departure time at the bus stop or train station and the reliability in the travel time spent on the bus or train.

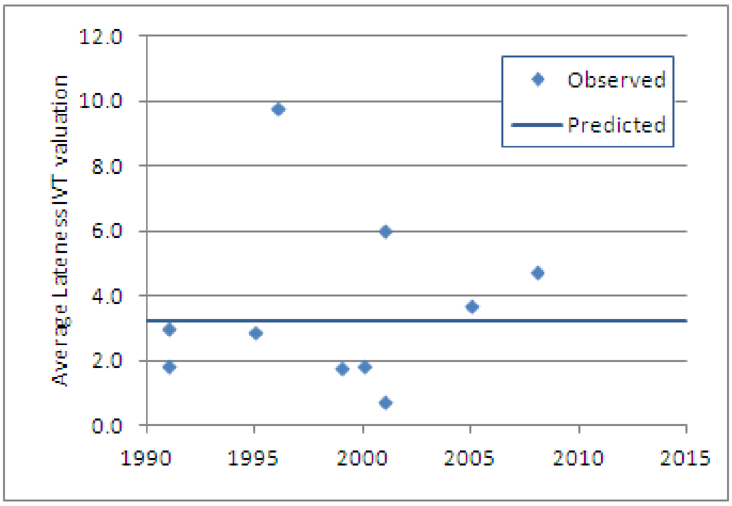
Ten studies were reviewed that estimated values for reliability; four were New Zealand studies and six were Australian. One New Zealand study by Vincent (2008) was undertaken specifically to value reliability. The other studies studied reliability amongst a list of attributes.

All the studies measured reliability in terms of average lateness which can be calculated as the percentage of services late multiplied by the number of minutes late. For example, if 20% of buses are five minutes late, average lateness would be one minute (0.2 x 5). If 15% of buses are five minutes late and 5% 10 minutes late, average lateness would be 1.25 minutes (0.15 x 5 + 0.05 x 10).

Figure E.8 and table E.6 present the study estimates of average lateness. The weighted average over the 10 studies for a minute of average lateness was 3.2 with the four New Zealand studies producing an average of 2.7 and the six Australian studies, a value of 3.6. As can be seen from the scattergram, there were two high values of 6 and 10 estimated by two Sydney studies (Rust PPK 1996b; Booz Allen Hamilton 2001) and one low value of 0.7 estimated by SDG in 2001 for the EEM (Beca Carter Hollings & Ferner et al 2002). The EEM adopts a higher value of 3.9 based on the Vincent (2008) study.

[38] A 2009 survey of Sydney bus users by the Independent Transport Safety and Reliability Regulator (ITSRR) found 88% of respondents considered that 'buses keeping to timetable' was important or very important (ITSRR 2009). In the UK, a national survey of rail passengers by MVA ranked service punctuality first out of 30 attributes in importance in 2005 and third in 2006 (MVA 2007). For Sydney, a 2006 survey found reliability to be the dominant factor in explaining rail passengers' overall rating of service accounting for 25% of the overall rating (Douglas and Karpouzis 2006) and in the UK, the bus group First found reliability to be even more dominant, explaining 34% of passengers' overall service quality rating (Balcombe et al 2004).

Figure E.8 Value of reliability - minute of average lateness in in-vehicle minutes



Apart from the Vincent (2008) study, it was not clear whether lateness was measured at the departure stop/station or the destination stop/station.[39] Bus passengers tend to think in terms of bus stop arrival times whereas rail passengers are more concerned with arrival time at the destination station.

The NGTSM provide estimates for four reliability measures: average unexpected wait time which had an average relative value of 5.8, standard deviation in unexpected wait time (1.44); unexpected in-vehicle time (0.98) and late on arrival (3.31) which is the combined impact of wait time and in-vehicle time. The last measure is closest in definition and value to the estimates presented in this review.

Table E.6 Value of reliability – minute of average lateness in in-vehicle minutes

Statistic	New Zealand	Australia	All
75th percentile	3.4	5.4	4.5
Average	2.7	3.6	3.2
25th percentile	1.6	2.1	1.9
Observations	4	6	10

E7 Quality attributes

This section presents a review of bus and rail service quality undertaken by the study team as a guide to developing market research to estimate pricing strategies for public transport in the Transport Agency's research project on pricing strategies for public transport[40]. It is anticipated that the results of the market research will provide the basis for a set of quality values for New Zealand. Unlike the preceding review of travel time attributes and mode-specific factors, which was limited to Australasian studies, the review includes the UK, USA and a Norwegian study. A number of aspects of quality were reviewed as listed in table E.7.

[39] Vincent (2008) undertook analyses of departure and arrival time reliability but only arrival time reliability has been included in the review analysis.

[40] The material in this section is based on the literature review undertaken as part of the pricing strategies research project (Douglas Economics 2012a).

Table E.7 Attributes reviewed

#	Attribute
1	Bus and train 'vehicle' quality package
2	Bus stop and rail station qualitiy package
3	Vehicle design appearance, ambience and facilities
4	Stop design appearance, ambience and facilities
5	Information
6	Personal safety, security
7	Maintenance, cleanliness, graffiti removal
8	Staff availability, appearance, friendliness and performance

Thirteen studies were reviewed covering two decades and dating back to a 1991 survey of Wellington public transport services. Table E.8 lists the studies. Three studies covered bus and rail services, five covered bus and five covered rail. Two New Zealand studies were included: a 1991 SP survey of bus and rail quality undertaken in Wellington and a 2002 survey of Wellington rail station quality. Five Australian studies were included, three UK, a US and a Norwegian study.

Table E.8 Studies reviewed

#	Study	Label	Location	Modes Covered	Year of Survey	Citation
1	Quality of PT Transport - Steer Davies & Gleave NZ Ltd Wellington	SDGWTN	Wellington, NZ	Bus & Rail	1991	ATOC
2	Values of Rail Service Quality PCIE (Douglas Economics) Sydney	SYDRI95	Sydney, Aus	Rail	1995	ATOC
3	Liverpool-Parramatta Transitway Market Research – PPK / PCIE	SYDTW	Sydney, Aus	Bus	1998	ATOC
4	Developing a Bus Service Quality Index – Hensher NSW Australia	HenBS	Sydney, Aus	Bus	1999-2002	ATOC, Balcombe, Bristow
5	Valuing UK Rolling Stock – Wardman & Whelan	UKRS	UK	Rail	Pre 2001	Balcombe, Bristow
6	Survey of Rail Quality - Dandenong Victoria	RQVIC	Victoria, Aus	Rail	2003	ATOC
7	Values for Rail Service Quality using Ratings - Douglas Economics	SYDRI04	Sydney, Aus	Rail	2004-5	Litman, Bristow
8	Tranz Metro Wellington Station Quality Survey	WTNRST	Wellington, NZ	Rail	2002 & 2004/5	*
9	London Bus & Train Values – SDG 1995, 1999 & 2007 surveys	SDGLND	London, UK	Bus and Rail	1995-2007	Balcombe, ATOC, Bristow
10	Values for a Package of Bus Quality Measures in Leeds	LDSBQ	Leeds, UK	Bus	2007	Bristow
11	Soft Measures Influencing UK Bus Patronage AECOM	AECOMBS	UK Provincial Cities	Bus	2009	*
12	Valuing Premium Public Transport Services in US	USPT	US Cities	Bus & Rail	2010	*
13	Valuing Universal Design Measures in Public Transport in Norway	NORPT	Norway Cities	Bus	2007	*

Sources: Balcombe (2004); ATOC (2006); Bristow(2009); Litman(2011); * Not previously reviewed

Most of the studies estimated values using only used SP as opposed to RP based on actual patronage response. The Wellington rail study (8) used a priority evaluator which presented a shopping list of service improvements for the respondents to choose from. By including a fare reduction or a travel time saving in the list, the relative importance of the quality attributes can be established.

The reported valuations were converted into:

- equivalent minutes of on-board bus/train time (in-vehicle time)
- the percentage of the average fare paid.

Where only fare or in-vehicle time-values were provided, an 'external' value of time was used. This was the case in the 2004 Sydney Rail rating based study (7) which used a value of time estimated by a contemporary SP survey (Douglas Economics 2004a). For other studies, a value of time referenced in the report was used, eg 2007 London Bus valuations (9) or was taken from a known source, eg the Wellington rail station survey (8) for which the EEM volume 1 value of time was used.

All the studies presented average valuations. Six studies segmented the results by either trip length or time period (or both) but seven studies only provided average valuations. Some studies explored the effect of user and trip profile on the valuations but none reported valuations by market segment.

The strongest evidence for willingness to pay increasing with trip length was provided by the 2004 Sydney rail rating study (7). For bus, there was no strong evidence reported for valuations to increase with trip length.

None of the studies provided a willingness-to-pay profile that gave the percentage of respondents willing to pay more than a certain amount for the provision of an attribute or an improvement in service. This lack of detail reflects the orientation of the studies. Considered the closest in specification to producing a willingness-to-pay profile was the 1991 Wellington study (1) that directly asked passengers if they were willing to pay a higher fare for their preferred choice. Unfortunately only the average willingness to pay was reported.

Four studies surveyed non-users as well as users (1, 3, 11 and 12) with the results suggesting that car users tend to have higher values of quality than bus and rail users.

The review found mixed results regarding the issue of whether the value of an improvement package comprising several attributes was greater or less than the sum of the individual attribute values. To a large extent, however, the estimated package effects reflected the survey designs.

The most extreme 'package effect' was the US study of premium transit (12) which found that the sum of the individual attribute valuations estimated by a detailed 'MaxDif' SP was 10 times greater than the package quality value estimated by an overall mode choice SP experiment of bus vs rail vs car.

The 1996 SDG London Bus (9) SP survey, which was used to develop values for the Transport for London (2008) *Business case development manual* estimated a value for passengers' ideal package of 26 pence which was regarded as a willingness-to-pay cap. However, the sum of the SP attribute values totalled around £1.

Wardman and Whelan (5) estimated a package effect of 0.5 in their analysis of SP/RP studies of UK rolling stock refurbishment, whereby the sum of the individual effects associated with ride quality, seating layout, seating comfort, noise, ventilation and ambience as estimated by SP studies need to be halved to get the value of the overall package.

The Norwegian study of bus/tram stop facilities (13) asked transfer price questions of the package of improvements which gave a value that was only a quarter of the sum of the attributes values estimated by the SP.

Two studies estimated a contrary package effect whereby the value of the sum of the individual attributes was less than the package effect. The 2004 Sydney rail study (7) estimated a package effect of 1.17 for trains and also stations by comparing the forecast-value of improving the overall rating with the individual attribute ratings.

The AECOM study (11) was undertaken in 10 corridors in provincial UK cities. AECOM compared the sum of attribute valuations with the package SP estimate and found the package effect to be 10% higher than the sum of parts estimate.

Table E.9 presents the wide range in the package value for bus and train quality improvements. What can also be seen is that measuring in terms of on-board time or percentage fare has a major bearing on the relative valuation.

In part, this is due to differences in the make-up of the packages which make ‘like for like’ comparison very difficult. Particularly important are whether ‘on-going’ aspects of service quality such as cleanliness, graffiti removal, staff friendliness, driver performance, announcements are included. For the SDG Wellington study (1), New South Wales (Australia) transitway study (3) and UK rail refurbishment (5) only design factors were included.

Table E.9 Vehicle package values

#	Label	Package Description	IVT mins	% Fare
1	SDGWTN	Old to New Bus	3.1	11%
		Standard to New Bus	1.4	5%
		Standard Bus to Trolley Bus	1	1%
		Old to New Train	3.4	8%
		Standard to New Train	1.2	4%
		Standard Bus to Standard Train	1.1	4%
2	SYDRI95	10% Rating Point Improvement in Overall Train Rating	1.9	8%
		Improvement from Av to Best Train in Fleet Rating	4	16%
3	SYDTW	Std Bus to TWay Bus (incl stop) - SP Bus Users	0.4	5%
		Std Bus to TWay Bus (incl stop) - SP Rail Users	6	51%
		Std Bus to TWay Bus (incl stop) - SP Car Users	5	63%
		New Modern Bus v Standard Bus - PE Bus Users	5	22%
		New Modern Bus v Standard Bus - PE Car Users	6	43%
		New Modern Bus v Standard Bus - PE Rail Users	3	15%
4	HenBS	1999 Survey - Wide Entry, V.Clean & V.Smooth, V.Friendly Driver	32	90%
		2000SP- Wide Entry, V.Clean, V.Smooth,V.Friendly Driver	19	65%
5	UKRS	Train renewal (30 minute trip)	1.3	1.5%
6	RQDnd	Train package (air con, clean seats, no graffiti safe) PE	4.6	77%
7	SYDRI04	10% Improvement in Overall Train Rating with	2.2	12%
		" " " strong trip length & pk/off-pk effects	0.7S-5.3L	5%S-16%L
		Improvement from Worst to Best Train in Fleet Rating	2.7	15%
		Improvement from Average to Best Train in Fleet Rating	1.3	8%
8	WTNRST	Vehicles not covered	na	na
9	SDGLND	Worst to Best Bus 2007 Survey	2.4	73%
		Worst to Best Train 2007 Survey	3.6	50%
10	LDSBQ	Quality Bus Package v Std Bus (incl. stop attributes) - SP	4.3	9%
		Quality Bus Package of Quality v Std Bus (incl. stop attributes) - TP	7.4	15%
11	AECOMBS	On-bus Quality Package	14.8	27%
12	USPT	Value of Premium Service Package (4 cities)	3.1-5.8	nc
		Salt Lake City - Work Commuters - Bus	4.3	nc
		Salt Lake City - Non Work Commuters - Bus	5.5	nc
		Salt Lake City - Work Commuters - Rail (Constant + per min)*	4.3+.13/m	nc
13	NORPT	not covered	na	na
14	EEM2	Summation of bus (vehicle) attributes ^	5.4	12%
		Summation of train (vehicle) attributes ^	11.4	25%

^sum of attribute values (no downwards adjustment for multiple attributes); * only work model presented
nc: no data on average fares and non commuting value of time to calculate % Fare valuations

The method of estimation is also considered to have a large influence on the package valuation with the SP and rating valuations tending to be lower than the priority evaluator and transfer price estimates.

A third factor influencing the value was how the package value was calculated. That is, whether it was (a) a package that was actually presented to respondents enabling a direct estimate to be reported or (b) whether it has been subsequently calculated by adding the estimated values for individual attributes. If (a), the package value may have then been adjusted or constrained. A fourth factor was the 'base' quality from which the improvement was measured. Lastly, as should be expected, some of the variation was due to study context: differences in attribute quality (both base and 'improvement'); differences in fare and travel time by which the qualitative attributes were measured against; and differences in respondent and trip profile.

The highest package values were estimated by Hensher from a 1999 survey of bus users. The vehicle package offering wide entry doors, very clean and smooth buses and very friendly drivers was valued equal to 32 minutes of travel time or 90% of fare (Hensher and Prioni 2002).

Next highest was the AECOM (11) study which estimated a value of 14.8 minutes (27% of fare) for a bus quality package including new low floor buses, with climate control (air conditioning), trained drivers, on-screen displays, audio announcements, CCTV, leather seats, customer charter and in-vehicle seating plan.

The US study of premium bus services (12) estimated lower package values of between 3.1 to 5.8 minutes. However, the package covered fewer attributes: Wifi, on-board seating availability, seating comfort, temperature control and vehicle cleanliness. For rail, the package value was estimated to increase with trip length (0.13 minutes per minute of on-board train time).

The values for London included in the Transport for London (2008) *Business case development manual* (9) were lower when expressed in terms of travel time at 2.4 minutes for bus and 3.6 minutes for rail but higher in terms of fare (73% and 50%). It should be noted that the values were estimated in terms of fare and were converted as part of this review into minutes by applying an externally derived value of time.

The EEM package values were reasonably exhaustive in attributes included but had not been halved as recommended in the NGTSM. The estimated bus value of 5.4 minutes was similar to the US public transport study but was only half the AECOM value. The rail value was higher than the other estimates when measured in train minutes (11.4) but lower when measured in percentage fare (25%).

A summary of the estimated value of bus stop and rail station values is presented in table E.10. An issue that was not well addressed was whether the bus stop and rail station values applied to only the board stop or to the board and alight stops (ie the values were an average for the two stops).

For bus, most of the value was likely to be for the board stop because that is where passengers spend most of their time (waiting for a bus). Virtually no time is be spent at the alight stop. However, city centre bus stations may add value through the provision of facilities. Also, the return trip reverses the board and alight stations.

For rail stations, amenities and ambience offered at an alight station were more important. These included ease of getting off train, alighting the platform, attractiveness/lighting of the accessways and concourse and the ease of exiting the ticket barriers. There were also interchange stations to consider where passengers both alighted, moved around the station and waited for trains.

Only the 1995 Sydney rail study (2) made reference to the number of stations. The station values were factored down to represent station values according to the number of stations used per trip (2.1) whereas the 2004 study (7) asked passengers only about their board station. The 2004 study referred to board station on the questionnaire and the Wellington survey (8) referred to a nominated station.

Like the vehicle package values, the composition of the packages varied which makes comparisons difficult. Some included information such as the Hensher value (4). The US study (12) included personal security whereas others were limited to weather protection, seat provision, lighting etc.

The highest package value was 44 minutes estimated using the priority evaluator for the redevelopment of a station in Wellington (8). The high value is considered to result from questionnaire design focusing passenger attention on station improvements.

Next highest was the Norwegian study (13) which estimated value of 13.8 minutes for bus stops with weather protection and seating versus neither. This study, by focusing attention on bus stop facilities, probably overestimated passenger valuations.

The London 2007 survey estimated low values when expressed in in-vehicle time of 1.9 minutes for improving bus stops from worst to best and 3.6 minutes for rail stations. Higher values of 58% and 50% respectively were produced when the values were expressed in terms of fare. A similar finding was produced for the Dandenong priority evaluator (5.4 minutes but 91% of fare).

The EEM values of four minutes for a full package of bus stop improvements and seven minutes for a rail station were towards the lower end of the estimates.

Table E.10 Bus stop and station package values

#	Label	Package Description	Mins	Fare %
1	SDGWTN	Shelter & Seats versus unprotected bus stop	6	3%
		New v Standard rail station - Rail Commuters	22	11%
		New v Std Rail station - Bus, Car & Non Rail Commuters	8	4%
2	SYDRI95	10% Rating Point Improvement in Station Rating^	1.1	4%
3	SYDTW	Modern Bus Stop Weather Protected & Seats PE Bus Users	6	na
		as above Car Users	17	na
		as above Rail Users	6	na
4	HenBS	1999 Survey - Shelter with Seats, Timetable & Map	2.8	10%
5	UKRS	not covered	na	na
6	RQDnd	Station package PE	5.4	91%
7	SYDRI04	10% Rating Point Improvement in Overall Station Rating*	1.3	7%
		" " " increase with trip length+	0.4S-2.4L	3.4%S-9.3L%
		Value of Improving from worst (39%) to best station (75%)	4.5	25%
8	WTNRST	Value of Petone Station Redevelopment (PE)	44	115%
9	SDGLND	Worst to Best Bus Stop 2007 Survey	1.9	58%
		Worst to Best Train 2007 Survey	3.6	50%
10	LDSBQ	not reported (stop quality included in vehicle value)	na	na
11	AECOMBS	Bus Stop Quality Package	7	13%
12	USPT	Value of Premium Service Stop/Station Package (Av. 4 cities)	4.4	na
13	NORPT	Bus Shelter with sitting place versus no shelter/seats	13.8	na
14	EEM2	Full package of bus stop improvements	4	9%
		Bus station	3	8%
		Rail Station	7	15%

^ value for single station (survey values were divided by 2.1 stations); * rating of station passenger boarded:
+ figures given for short S and long L for peak trips. PE Priority Evaluator

E8 Mode-specific factors

Mode-specific factors (MSF), sometimes known as alternative specific constants (ASC), account for residual qualitative differences in modes as perceived by users after travel times, frequencies and fares have been taken account of.

In the NGTSM, the MSFs are split into a constant and an in-vehicle time factor. The first component accounts for differences in 'accessing the system' and 'boarding' the vehicle. The MSF thus reflects the quality of stop/station facilities and aspects of boarding the system (such as negotiating steps and payment).[41]

The in-vehicle time factor accounts for differences in the quality of in-vehicle travel (such as comfort and air conditioning) and is distance/time related. The NGTSM adopted a 'rule of a half' to split the reported values into the constant and in-vehicle time factor. Half the MSF was assumed to relate to the constant (ie account for stop/boarding) and half was assumed to be related to travel time and reflect differences in vehicle quality.

In this review, a total of 13 Australasian studies were found to provide MSF information. Only four studies 'compartmentalised' the MSF into a constant and a time factor. The remaining nine studies presented only a constant MSF.

Eleven of the studies used SP market research with most undertaken as part of producing patronage forecasts for new transport services. As such, the values were based more on respondent perceptions of likely future services rather than attitudes to existing services. Logically, MSFs based on actual experience should provide valuations that are more accurate valuations and less prone to policy response bias.

The remaining two studies used RP data. For these studies, the MSF was a direct result of comparing observed and predicted patronage against modelled travel times and costs. As a result, the MSF may be more an artefact of the modelling process than reflecting true qualitative differences between modes.

In total, 40 MSFs were reported for five mode comparisons: bus-rail (21 observations); bus–light rail (10 observations); bus-transitway (five observations); rail-transitway (one observation) and bus-ferry (three observations).

Table E.11 presents the average and quartile range for each MSF. All the MSFs are positive indicating the extra time cost (in in-vehicle minutes) of travelling by the first mode compared with the second. Thus the MSF of 12 minutes for bus-rail indicates that 12 minutes needs to be added to travelling by bus to account for the lesser stop/station and vehicle 'quality'.

Table E.11 Mode-specific factors in in-vehicle minutes

	Bus – rail	Bus – light rail	Bus – transitway	Rail – transitway	Bus – ferry
75th percentile	15	19	6	4	25
Weighted average	12	16	5	4	21
25th percentile	0	1	4	4	7
Observations	21	10	5	1	3
Studies	9	4	2	1	1

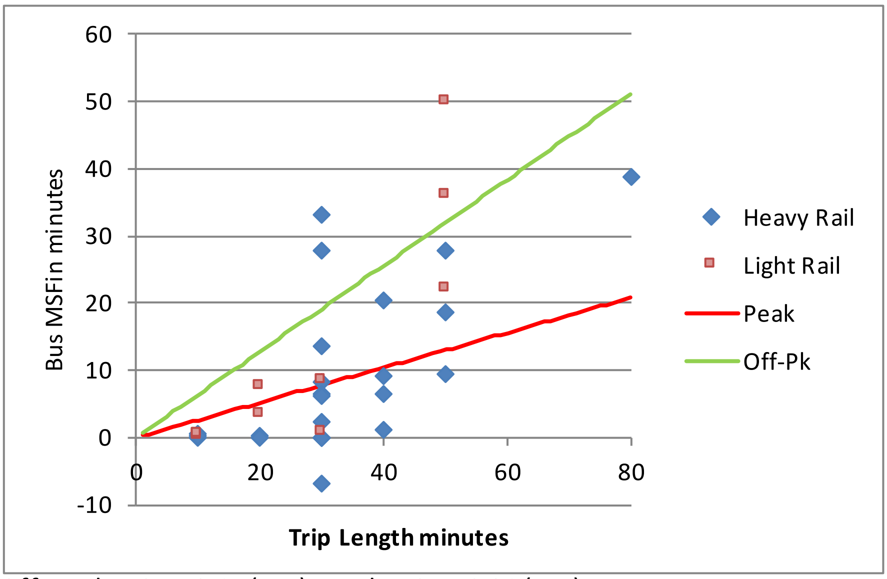
A higher MSF of 16 minutes was estimated for bus versus LRT which at face value implies that LRT is perceived to be four minutes better than heavy rail. However, the estimate is based on only four studies and the quartile range of 1 to 19 minutes overlaps the range in the bus-rail MSF.

The transitway or busway MSF was smaller at five minutes. The value for rail-transitway of four minutes was based on one observation for a Sydney transitway demand forecast.

[41] The MSF constant also presumably accounts for egressing the system and alighting the vehicle.

The MSFs for bus-rail and bus-light rail were combined and compared against trip length. Figure E.9 presents the fitted model. As can be seen, off-peak trips had a bus-rail MSF around 1.5 times that of peak trips. For a trip length of 30 minutes, the MSF for bus adds eight minutes to a peak trip and 19 minutes for an off-peak trip compared with travelling by rail. Mathematically, the peak bus-rail MSF is calculated by multiplying the bus in-vehicle time by 0.26 and the off-peak in-vehicle time by 0.64.[42]

Figure E.9 Mode-specific factor with trip length in in-vehicle minutes



	MSF	
Time	Peak	Off-Pk
0	0	0
5	1	3
10	3	6
15	4	10
20	5	13
25	7	16
30	8	19
35	9	22
40	10	26
45	12	29
50	13	32
55	14	35
60	16	38

Off-Peak MSF = 0.64 (IVT); Peak MSF = 0.26 (IVT)

Unlike the NGTSM, there is no MSF at a zero travel time. In fact, the analysis estimated a negative constant term indicating that bus was preferred to rail at short distances. The constant was not statistically significant, however, and was not included in the final model.

[42] To calculate the reduction in rail time (as per the NGTSM) the MSF factor should be subtracted from 1 and multiplied by the travel time (ie 0.74 for the peak).

Appendix F: Summary of parameter value studies

#	Label	Reference	Locat'n	Data year	For	Survey	Type	Users	Survey	Sample	MSF	Acc	Frq	Wait	Disp	IVT	Trf	Crd	Rel	VQL	SQL	Fare	Car	Description
1	WR90	(Steer Davies Gleave 1990)	WLN	1990	NZRail	SP	RvBvC	Rail	Interview	1005	y	y	y			y						y		Forecasting the demand effect of bus competition on rail
2	WQ91	(Steer Davies Gleave 1991b)	WLN	1991	WRC	SP	PTvPT	All	Interview	335			y					y	y	y	y	y		Effects of quality improvements in public transport
3	ALRT91	(Steer Davies Gleave 1991a)	AKL	1991	ARC	SP	LvB	All	Interview	750	y	y	y			y				y	y	y		Public preferences for Auckland LRT & Busway for ARC/no VOT reported
4	SydR92	(Steer Davies Gleave & GHD-Transmark 1993)	Sydney	1992	CityRail	SP	RvBvCvW	Rail	Interview	1077	y	y	y			y	y					y	y	Estimation of elasticities for primary service attributes for Sydney Rail
5	SL95T	(Travers Morgan 1995)	Sydney	1995	NSW DoT	SP	B/L v C	B,C,W	Interview	nk	y	y	y			y	y	y				y	y	Mkt research for demand forecasts for western CBD extension of Sydney LRT
6	SL95B	(Booz Allen Hamilton & Pacific Consulting 1995)	Sydney	1995	NSW DoT	2 SPs	PTvPT & Trnsfr	B,R,W	Interview	≈500	y	y	y			y						y		Parameters for Ultimo Pyrmont light rail pax study 2 SPs (main mode & Glebe Trf)
7	SRQ95	(Pacific Consulting 1995)	Sydney	1995	CityRail	2 SP/PE	RvR	Rail	Interview	2780								y	y	y	y	y		2 SP surveys plus priority evaluator to value rail service quality
8	PC96	(Rust PPK 1996b)	Sydney	1996	NSW DoT	SP	PTvPT PTvC	C,B,R	Interview	nk	y	y	y			y	y		y			y	y	Estimate parameters for forecasting patronage for Parramatta-Chatswood rail link
9	M2_96	(Rust PPK 1996a)	Sydney	1996	NSW DoT	SP	PTvPT PTvC	C,B	Interview	nk	y	y	y			y	y		y			y	y	Estimate parameters for forecasting patronage for M2 Busway
10	STM96	(Hague Consulting 1996)	Sydney	1996	NSW TDC	RP	MMRP	Rail	HSTS	nk	y	y	y	y		y	y					y	y	Sydney Travel Model based on Household Travel Survey. Calibration report
11	LivTW98	(PPK 1998)	Sydney	1998	NSW DoT	SP/PE	PTvPT PTvC	C,B,R	Interview	1196	y	y	y			y	y					y	y	SP+priority Evaluator to estimate parameters for Liv-Par TWay pax forecasts
12	SBQ99	(Hensher & Prioni 2002)	Sydney	1999	STA NSW	SP	Bus	Bus	Self comp	3849		y	y			y			y			y		Estimation of model to develop service quality index for bus service
13	SBQ00	(Hensher et al 2003)	Sydney	2000	STA NSW	SP	Bus	Bus	Self comp	1478		y	y			y		y	y			y		Estimation of model to develop service quality index for bus service
14	BSG00	(PCIE 2000)	Brisbane	2000	Ove Arup	SP	PTvPT	C,PT	Interview	623	y	y	y			y						y		Parameters estimation for demand forecasts for suburban Brisbane rail services
15	BJ00	(Halcrow 2000)	Sydney	2000	Lend Lease	SP	RvR	C,B,R	Interview	1649		y		y		y						y		Estimate parameter for patronage forecasts for extending Bondi Junction rail line
16	SdNw00	(PCIE & BNR Consulting 2000)	Sydney	2000	SRA	SP	RvR	Rail	Interview	255			y			y	y					y		Parameter estimation for demand forecasts for faster Sydney-Newcastle rail
17	Bri01	(Douglas et al 2003)	Brisbane	2001	BCC	SP	PTvPT PTvCar	C,B,R,F	Interview	≈3000	y	y	y			y	y					y	y	Estimate demand parameters for forecasting model
18	SFry01	(Booz Allen Hamilton 2001)	Sydney	2001	SydFerry	SP	FvB FvC	C,B,F	Interview	841	y	y	y			y	y		y			y		Estimate demand parameters for business model of Sydney ferries
19	NZEM02	(Beca Carter Hollings & Ferner et al 2002)	WLN,AKL,CHC	2001	Transfund	2 SPs	BvB RvR	B,R	Comp int	815			y			y	y	y	y			y		Two SPs (VOT & Rel/Crwd) to estimate values for NZ Economic Eval Manual
20	Can03	(Booz Allen Hamilton 2003a)	Canberra	2003	ACT	SP	BvB BvTxi/C	C,B,T	Interview	586	y	y		y		y						y	y	Estimate parameters for fare elasticities for Canberra bus services
21	SydR03	(Douglas	Sydney	2003	SRA	SP	RvR	Rail	Interview	1578			y			y	y					y		Estimate parameters for economic appraisal

#	Label	Reference	Locat'n	Data year	For	Survey	Type	Users	Survey	Sample	MSF	Acc	Frq	Wait	Disp	IVT	Trf	Crd	Rel	VQL	SQL	Fare	Car	Description
		Economics 2004a)																						of rail services
22	SNW03	(Hensher & Rose 2003)	Sydney	2003	NSW DoT	SP	Multi modal	C,B,R	Comp int	453	y	y	y	y		y	y					y	y	Estimation of parameters for model to forecast demand for new PT in NW Sydney
23	SLRT03	(Booz Allen Hamilton & Douglas 2003)	Sydney	2003	NSW DoT	SP	LvB LvBvR	C,B,R	Interview	1063	Y	y	y	y		y	y					y		Parameter estimation for Sydney LRT ext. demand forecasts.
24	SRSC04	(Douglas Economics 2004b)	Sydney	2005	RailCorp	SP	RvR	Rail	Interview	335		y		y				y						Estimation of station crowding values relative to platform waiting
25	SRQ05	(Douglas Economics 2006a)	Sydney	2005	RailCorp	Rating	RvR	Rail	Interview	nk						y			y	y	y	y		Estimation of service quality via passenger ratings
26	DND05	(Halcrow 2005)	Melb	2005	VTIDpt	SP/PE	RvR	Rail	Interview	103					y	y		y	y	y		y		Estimation of parameters to assess rail options for Dandenong corridor
27	SRTC06	(Douglas Economics 2006b)	Sydney	2005	RailCorp	SP	RvR	Rail	Interview	584				y		y		y						Valuation of Sydney train crowding for economic evaluations
28	STM06	(Fox et al 2010)	Sydney	2006	BTS Syd	RP	MMRP	All	Interview	55812	y	y	y	y		y						y	y	Sydney Travel Model based on Household Travel Survey
29	WTLY08	(Ian Wallis Associates Ltd 2008)	WLN	2008	NZ Bus	SP	BvB	Bus	Interview	122						y		y						Mkt research on trolley bus seat layout
30	NZRI08	(Vincent 2008)	WLN, AKL	2008	Transfund	SP	RvR BvB	B,R	Internet SP	751						y			y			y		Valuation of reliability for economic appraisals
31	AusTC10	(Mueller et al 2011)	CapCiti es	2010	CRC	SP	RvR	All	Internet SP	1800						y		y				y		Valuing train crowding of rail and non rail users in Adelaide, Brisbane, Melbourne, Sydney & Perth
32	SMet11	(ITS Sydney 2011)	Sydney	2011	NSW DoT	SP	Multi-modal	All	Internet SP	524	y	y	y			y	y	y				y	y	Estimation of parameters to forecast demand for metro services in NW Sydney
33	SRVoT12	(Douglas Economics 2012c)	Sydney	2011	RailCorp	SP	RvR	Rail	Interview	1672					y	y						y		Valuation of time and displacement for rail economic appraisals
34	NZPS12	(Douglas Economics 2012b)	WLN	2012	NZ Transport Agency	SP	BvB RvR	B,R	Self comp	112			y			y				y	y	y		Pilot survey market research to estimate values of quality for pricing strategies for PT
35	SIC12	(Douglas N & Jones 2013)	Sydney	2012	BTS Syd	SP	PTvPT	B,R	Interview	939						y	y					y		Value of different types of interchange

Key to abbreviations:

Acc = access; AKL = Auckland; B = bus; C = car; CHC = Christchurch; Crd = crowding; Disp = service displacement; Frq = frequency; IVT = in-vehicle time; L = light rail; MSF = mode-specific factor; NSWDoT = New South Wales Department of Transport; PE = priority evaluator; PT = public transport; R = rail; Rel = reliability; RP = revealed preference; SP = stated preference; SQL = service quality; Trf = transfer time; VOT = value of time; VQL = vehicle quality; Wait = wait time; WLN = Wellington; WRC = Wellington Regional Council

Appendix G: Review of existing ‘simplified procedures’ in NZ Transport Agency *Economic evaluation manual*

G1 Basis of assessment

This appendix outlines the implications of any suggested/recommended changes in public transport parameter values (as assessed in chapter 5 of the report) on the EEM volume 2 ‘simplified procedures’ relating to public transport services, ie:

- SP9: new passenger transport services
- SP10: existing passenger transport services.

Our assessment sets out which public transport benefit parameters are included (explicitly or implicitly) in the simplified procedure formulations, and hence the modifications that would be appropriate to the current formulations should any change to the relevant parameter values be adopted.

The appendix also comments more generally on the differences between the SP9 and SP10 procedures and on issues relating to their application (the project’s case study application of SP10 and points relating to this are described in chapter 6).

G2 Scope and application of EEM simplified procedures SP9 and SP10

EEM volume 2 states that SP9 may be used for evaluation of all **new** public transport services; while SP10 may be used for evaluation of all **improvements to existing** public transport services. However, it does not set out the distinction between these two types of service enhancement.

Apart from these words, there seems to be little difference between the assumptions and applications for the two procedures. For example, for SP10, EEM states the following:

> *This procedure provides a simplified method for appraising the costs and benefits of activities to improve an existing passenger transport service through the provision of capital infrastructure and/or service improvements.*
>
> *This simplified procedure assumes that:*
>
> *Service improvements primarily concern existing peak period services and as a result of improvements commuters change modes from private vehicle to bus or rail.*
>
> 1. *The primary benefits are travel time savings (including congestion reduction), vehicle operating cost (VOC) savings, accident cost savings, parking and environmental benefits (including CO_2 reduction), reliability benefits and vehicle and infrastructure benefits.*
> 2. *The activity will not generate road maintenance and renewal cost savings, as the majority of traffic removed from the road network will be light vehicles. There will also be no road capital cost savings.*
> 3. *Other benefits (positive or negative) are not significant. However, allowance can be made for other benefits in these procedures.*

The corresponding statement for SP9 is essentially similar, except for the replacement of the phrase 'to improve an existing passenger transport service' with 'new passenger transport activities'.

G3 Implications of parameter value changes for SP10

Table G.1 sets out for SP10:

- the four benefit categories that make up the total benefits under these procedures
- within each category, the benefit parameters involved in the calculation of the relevant benefits
- how the suggested/recommended changes in the individual benefit parameter values (from chapter 5 of this report) should be incorporated in the benefit formulations for each category, and hence affect the combined parameter values used in the simplified procedures.

If our recommendations on changes in parameter values are adopted, it is noted that:

- In the shorter term, the main impacts would, in principle, be on benefit category 2.2 (public transport user benefits – time and costs).
- However, the SP10 table 1 figures are composite values based on estimates of two aggregate parameters: (a) the typical total generalised user cost for public transport trips of different lengths (not broken down by user cost components); and (b) the generalised cost elasticity of demand for such trips. Item (a) will vary in proportion to the standard value of (in-vehicle) time, but is likely to be affected to only a small extent by the other proposed changes in component parameter values. Item (b) would be essentially unaffected by the proposed changes.
- In the medium term (once the results from the public transport pricing strategies project surveys have been considered), there are likely also to be significant impacts on benefit category 4 (public transport user benefits – quality factors).
- If the proposed changes in parameter values are adopted, then we suggest the public transport user benefit formula in SP10 be reviewed across all its sub-categories.
- It is not possible to comment on any potential impacts on benefit category 1 (road traffic benefits), as a review of evidence on the appropriate parameter values for road traffic is outside the project scope (refer section 5.2).

Table G.1 Implications of proposed parameter value changes on EEM simplified procedures for existing public transport services (SP10)

Item ref(a)	Benefit category	Market segments	Parameters applied in estimation(b)	Implications, comments
2.1	Road traffic benefits	Urban area Rail, bus/ferry Peak, off-peak	Changes in road user: • travel time • vehicle operating cost • accidents • environmental (emissions etc) Composite values given in SP10, table 1.	Values for these parameters are outside scope of project. Details of basis/composition of SP10, table 1 values are given in *Values for project evaluation – mode switching user benefits* (2005), which also refers to an earlier patronage funding report to Transfund NZ (Booz Allen Hamilton 2003b). Note that values are based on trips of average length (by mode, time period).
2.2	Public transport user	Urban area Rail,	Changes in public transport user time and cost	Values (SP10, table 1) would, in principle, be affected by any changes in parameters

Item ref(a)	Benefit category	Market segments	Parameters applied in estimation(b)	Implications, comments
	benefits – time and costs	bus/ferry Peak, off-peak	attributes: • journey time • service frequency (table 7.2) • interchange time (section 7.2) • fares. Composite values given in SP10, table 1.	for (i) standard IVT values; (ii) service intervals (frequency); (iii) transfers (transfer penalty, transfer walk and wait functions). Refer text for further discussion. Details of basis/composition of SP10 table 1 values as above. Note that values are expressed per additional passenger, but cover both additional and existing passenger benefits. Note that values are based on trips of average length (by mode, time period).
3	Public transport user benefits – reliability	Departure stop, in-vehicle, combined	Average minutes late (AML) factor * standard in-vehicle time values. AML factors given in SP10, table 2, drawn from table 7.1.	Values will be affected by any changes in values for either (or both) of these parameters.
4	Public transport user benefits – quality factors	Attribute and sub-attribute	Unit values for public transport infrastructure and vehicle features (tables 7.3, 7.4, 7.5).	Values will be affected by any changes in values for these infrastructure/vehicle features.

Notes:

[a] Reference numbers as in SP10, worksheet 4.

[b] References all relate to EEM volume 2.

G4 Implications of parameter value changes for SP9

The methodology used in SP9 for categorising benefits and estimating benefits in each category appears, prima facie, to be considerably different from that in SP10, although the principles behind the methods are similar:

- Both SP9 and SP10 calculate road traffic benefits as a separate category. The formulations for the calculations in the two procedures are structurally somewhat different (compare SP9 table 1 with SP10 table 1 for road traffic reduction benefits). The SP9 formulation for road traffic does not incorporate any of the parameters researched in the project, and therefore any consideration of changes to this formulation is outside the project scope.
- For public transport user benefits, SP9 essentially incorporates into one formulation the three public transport user benefit categories used in SP10 (see table G.1, items 2.2, 3, 4). The simplified procedure explanation (worksheet 4) states that ‘the calculation of the passenger transport user benefits for a new service is based on the willingness to pay of the users for the new service in the peak period, usually expressed as the maximum user charge (fare) they are willing to pay. The proposed user charge is subtracted from the maximum user charge to find the net passenger transport user benefit’.
- This ‘guidance’ appears of limited assistance to the analyst in practice. Its reference to the ‘net public transport user benefit’ should probably be to the user (consumer) surplus associated with use of the

service: the net benefit of the service to its user is more usefully related to their consumer surplus from using the mode relative to that of travelling by their next best alternative.

- In terms of guidance, SP9 goes on to state: 'for a new passenger transport service, the evaluator may draw on information from existing services to derive a willingness-to-pay value for the new service'. It is unclear how this guidance would be applied in practice[43].
- We would expect that, for appraising the economic benefits of a new service, some form of transport model (public transport-only or multi-modal) would be used. With such a model, the benefits per user are essentially the difference between the user's generalised cost of travel with and without the new service. Such a benefit formulation would thus potentially incorporate any differences (with/without the new service) in all the public transport parameters covered in this report.

Hence, in regard to the current SP9, we conclude that:

- Any changes in the parameters covered in this report would be expected to affect the 'generalised costs' of public transport travel, and hence have implications for the calculation of user benefits under SP9.
- SP9, as currently defined, does not provide much helpful guidance to the analyst: there would be merits in restructuring these procedures and possibly combining them with SP10.

[43] To the best of our knowledge, no public transport proposals submitted to the Transport Agency for funding have been based on a SP9 economic appraisal.

Appendix H: Glossary

ASC	refer MSF
ATC	Australian Transport Council
BCR	benefit–cost ratio
BPM	Bus Policy Model
BRT	bus rapid transit
CBD	central business district
CEA	cost-effectiveness analysis
CPI	consumer price index
EEM	NZ Transport Agency *Economic evaluation manual*
EIA	economic impact assessment
FA	financial appraisal
GPS	Government Policy Statement on Transport Funding
GDP	gross domestic product
GDPP	GDP per person
GST	goods and services tax
IVT	in-vehicle-time (in minutes)
LRT	light rail transit
MCA	multi-criteria analysis
MSF	mode-specific factor, sometimes referred to as alternative specific constant (ASC)
NGTSM	Australian Transport Council, *National guidelines for transport system management in Australia*
NPV	net present value
PT	public transport
PTSS	*Wellington public transport spine study*
PTUB	public transport user benefits
RP	revealed preference
RUB	road traffic (user) benefits
SCBA	social cost-benefit analysis
SP	stated preference
TBBC	New Zealand Treasury Better Business Cases
TDM	travel demand management
Transport Agency	New Zealand Transport Agency
VoT	value of time (savings)