GUIDE TO PROJECT EVALUATION

Part 6: Distributional (Equity) Effects
Guide to Project Evaluation
Part 6: Distributional (Equity) Effects

Summary
Part 6 helps the practitioner to evaluate the distributional (equity) impacts of transport projects, i.e. the winners and losers of projects, and how these impacts can be traded with efficiency gains. The procedures/processes provided help the decision-maker to consider distributional effects of projects as part of the project evaluation process by comparing sets of efficiency outcomes of projects with desired social (equity) outcomes. An Equity Explorer™ software tool is provided as an integral component of Part 6 to demonstrate some of the principles of equity analysis and their application.

Keywords
transport project evaluation, benefit cost analysis, distributional/equity impacts, Equity Explorer™ software tool

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1. INTRODUCTION

Analysis of distributional or equity effects has rarely been undertaken for transport infrastructure projects and policies but a publication series on project evaluation would not be complete without a guide on this aspect of evaluation and decision making.

Distributional effects may have spatial, temporal and social characteristics that have different implications for individuals or groups within the community. Examples of distributional effects of transport projects include increases or decreases in accessibility, mobility, travel time, safety, or environmental changes relating to air, water, land and noise amenity. These distributional effects can create both ‘winners’ and ‘losers’, as they may be considered desirable by some and unacceptable by others. In transport projects it can be the case that the groups which benefit from a project are not necessarily those who incur the costs of the project.¹

Identifying those who gain, pay and lose in transport projects gives the transport analyst insight into the motivations and behaviours of various stakeholders regarding their support or opposition to a proposed project. Identifying the benefits accruing to and the costs borne by disadvantaged members of the population is especially important. This process of identification and evaluation of distributional effects is the equity (as opposed to the efficiency) component of the analysis stage in project evaluation.

While many transport plans, strategies and policies articulate equity as a key consideration in transport infrastructure investments, explicit equity analysis is not usually undertaken as part of project evaluation. This is due to the ambiguity and subjectivity associated with what outcomes are considered equitable and lack of agreed techniques or evaluation methodologies. Commentary A provides some examples of how equity issues are treated in transport decision making.

Part 6 is intended as a resource to help the practitioner evaluate the distributional effects of transport projects through a process of identifying the winners and losers of projects. It will also discuss equity-efficiency trade-offs that may need to be considered when undertaking transport investment evaluation. The procedures/processes provided help the decision-maker consider distributional effects of projects as part of the project evaluation process by comparing sets of efficiency outcomes of projects with desired social equity outcomes.

The analysis of distributional effects may not be necessary for all projects and each agency will need to determine the scope and type of projects that should include equity analysis.

Part 6 is supported by a software tool called the Equity Explorer™. The tool is intended as an exploration environment that enables practitioners to learn more about equity concepts and principles and their application to project evaluation. The Equity Explorer™ tool and a brief introduction to it are provided with Part 6 (as separate pdf files accompanying Part 6).

¹ There are many other equity issues surrounding transport decision-making, for example how funding or resources are distributed between populations, modal systems or networks. These decisions are made in the political sphere. Part 6 does not examine these or even project level decisions that are made in this broader political context. Part 6 only examines equity issues that arise as a result of investment in specific transport projects.
2. WHAT ARE DISTRIBUTIONAL (EQUITY) EFFECTS?

The term equity is normally used to refer to the ethical desirability of distributional effects (for example relating to choice, affordability, livelihood and quality of life) among groups of individuals.

Distributional effects or impacts can be described as both benefits and costs. In transport planning the distribution of effects frequently focuses on three major types of impacts:

- transport benefits including accessibility and mobility, greater transport choice, reduced time travel or safety (reduced risk of crashes)
- transport costs including who pays for the services (through user fees, taxes, etc.), and how do the costs paid compare to the benefits received
- externalities including air and noise pollution, loss of visual amenity and open space, community severance, vibrations, related property price effects and quality of life issues.

Transport decision-makers are interested in the distribution of the range of impacts of transportation alternatives across population groups. The distribution of impacts can take various forms and can be measured in different ways. Impacts may also be compared using a range of distribution dimensions including, for example, geography, age, or mobility limitation. An analysis of the distribution of transportation impacts may also compare overall benefits to overall costs and other effects by population group.
3. WHAT IS EQUITY ASSESSMENT?

Equity assessment or analysis provides a means of explicitly identifying winners and losers of transport projects. Assessment of equity or distributional effects considers:

- accrual of project costs, benefits and other economic impacts to specific population groups
- distribution of these costs, benefits and impacts among these groups.

A brief summary of the foundations of equity theory underlying distributional impacts of projects is presented in Commentary B.

[see Commentary B]
4. WHEN TO UNDERTAKE EQUITY ANALYSIS

Investigation of equity issues can be undertaken at any time during a project’s development stages. Early assessment of equity issues should be undertaken in the planning phase of policy and project development. A more specific evaluation of equity effects that may also include estimating equity and efficiency trade-offs would follow the project evaluation analysis.

4.1 Consideration of equity issues during project planning

It is desirable to consider equity issues from the onset of the planning phase of policy and project development. In this case, equity issues will inform the project conception and assist in developing a diversity of alternatives. These ideas are illustrated below. The figure indicates that equity issues should be considered early in the project inception phase so that broad sustainability criteria inform the project concept development process.

This is consistent with the Triple Bottom Line perspective which requires social, environmental and economic issues to be identified and emphasised during the project planning phase. The general forms of equity issues (i.e. vertical, horizontal, inter-generational) are important when strategies, programs and projects are being developed to provide for equitable outcomes. The figure below shows that both equity objectives and transport system (or efficiency) objectives are considered in the selection of project alternatives. A key point to note is that the depth of the equity analysis may change as specific project development options are considered in more detail.

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2 Part 1 of the Guide discusses project planning and introduces the concepts of sustainability and the triple bottom line perspective. These issues are discussed in more detail in the Austroads Guide to Transport Planning.
4.2 Equity analysis during project evaluation

Equity analysis would be undertaken in the project evaluation phase once an economic assessment (a Benefit Cost Analysis (BCA) or Multi Criteria Analysis (MCA) process) is completed for the infrastructure project. In this case, equity analysis is considered as a further step beyond the BCA/MCA process where the economic efficiency of a project is evaluated (see figure below).

Efficiency concerns the size of the total benefits received by all members of the community as a consequence of a project. The objective of any economically efficient system is to maximise the use of scarce resources and to allocate them to different users in the most efficient way. The key point to remember is that although an economy may be economically efficient; it is not necessarily equitable to different groups or classes of people. Thus, the equity ‘trade-off’ illustrated below represents the trade-off between equity and efficiency. The various approaches used to consider the efficiency versus equity conditions are briefly summarised in Commentary C.
Regardless of when equity is considered during the life of a project (i.e. during the project planning phase or project evaluation phase), equity analysis requires measures of performance or metrics that can inform the decision and evaluation process. Economic metrics can also be considered according to their distributional impacts. The three most common economic metrics used in transport project evaluation are:

- Net Present Value (NPV: the difference between discounted benefits and discounted capital costs over the life of the project)
- Benefit Cost Ratio (BCR: the ratio given by discounted benefits divided by discounted costs)
- Internal Rate of Return (IRR: the discount rate that produces a project NPV of zero).

One of the most common equity metrics is known as the Gini Index, which is described in the following section. Economic metrics, (such as BCR) can be disaggregated using a Gini index, to illustrate the distribution of costs and benefits across different population groups (for example described by income) or spatial areas (for example using measures of traffic concentration, or access to transport infrastructure).
5. TECHNIQUES FOR IDENTIFYING WINNERS AND LOSERS OF PROJECTS

There are various qualitative and quantitative techniques for considering equity impacts in the community. A selection of techniques are presented in Commentary D, these include:

- Indexes to measure equity or inequity between groups or populations have been widely used in transport project evaluation. The Gini index is the most well known and used equity index.

- Equity weights provide a method of formally incorporating concepts of fairness into economic analysis.

- Social Impact Assessment (SIA) is perhaps the most common technique to identify social impacts of transport projects on the community. Derivatives of SIA include Social (equity) Impact Assessment and Cumulative Impact Statements.

- Stated preference surveys are important community consultation tools that are used to inform equity evaluations.

- Spatially based analysis (commonly undertaken with GIS technology) is becoming an important tool to identify equity impacts resulting from transport projects.

- Micro-simulation is another analysis/modelling approach for exploring distributional and equity issues by focusing on personal attributes across individuals in the population.

[see Commentary D]
6. PROCESS FOR UNDERTAKING EQUITY ANALYSIS

While there is no harmonised methodology for undertaking equity analysis in Australia or overseas, there are guiding principles, tools and techniques to consider when undertaking equity investigations. A five stage process for considering equity in transport proposals is presented below and discussed in the following sections. To assist the practitioner in this process, an *Equity Explorer™* software tool has been developed as an integral component of Part 6. This tool and a tutorial on how to use it are provided with Part 6 (as separate pdf files accompanying Part 6).

![Process for considering equity analysis](image)

6.1 Scoping

The first step of equity analysis is concerned with identifying groups and individuals that have an interest in the project. The people affected will be influenced by things such as the characteristics of a project, its location and scale. This step seeks to identify ‘communities of interest’. The term ‘community’ is widely used in the literature to describe various stakeholders. Here, the term ‘community’ is used to represent the diverse points of view (communities of interest) that are likely to contrast and conflict to some degree and change over time.

Identification of communities of interest can be undertaken as part of a Social Impact Assessment or as an independent exercise. SIA is an integral part of the project evaluation process for certain categories of projects (eg. large infrastructure investments with noticeable community impacts). SIA and its derivatives are described in Commentary D.

[see Commentary D]

Once the practitioner has characterised the communities of interest in their project, they must find the most appropriate participation processes to engage these stakeholders. Further information on community participation processes is provided in Commentary E.

[see Commentary E]
Part of the initial scoping step is to provide a detailed understanding of the nature of the project itself. This would entail information about the type of project (eg. freight, passenger movement, public transport, multi-modal and network aspects), function performed, level of demand changes and geographical extent of the project and potential influences.

6.2 Profiling

This step is concerned with developing a profile of the groups and individuals that are identified at the scoping stage. This can be done by developing community social profiles which provide detailed information about characteristics of community groups and individuals impacted by transport projects (see table on page 10).

Distribution effects may impact socio-economic or geographical groups of the community to varying degrees. To identify which sections of the community are exposed to beneficial outcomes and which are exposed to adverse effects, a broad range of characteristics needs to be considered. Income, ethnicity and race have been the most common socio-economic characteristics used in studies of social equity. The major reason for this is that such data are collected regularly, systematically, and are readily available through the Australian Bureau of Statistics who undertake a five yearly census of the population. Most studies compare population attributes in political jurisdictions (states, cities, etc) or data constructs (post codes, census areas). Availability of data at different spatial levels is the determining factor. This data can then be analysed by itself, or used to construct an equity index.

Information about community attributes (characteristics) are often collected using stated preference surveys (described in Commentary D). These are mostly used in the absence of (or as a means of supplementing) available empirical data to inform equity evaluations.

[see Commentary D]
### Variables used to define a Community Social Profile

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Variable</th>
<th>Examples of measures of variables</th>
<th>Possible data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Socioeconomic status</strong></td>
<td>Income</td>
<td>Median income of families and individuals</td>
<td>Census or local government</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% families below poverty level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>Median years of education completed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Employment</td>
<td>% in occupational categories</td>
<td>Census or Centrelink</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% employment by type and location</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% unemployment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Status of employment (temporary or long term)</td>
<td></td>
</tr>
<tr>
<td><strong>Mobility characteristics</strong></td>
<td>Population</td>
<td>Car ownership and availability</td>
<td>Road agency registration data, travel diaries, surveys or focus groups.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use of alternative and non-motorised modes</td>
<td></td>
</tr>
<tr>
<td><strong>Demographic factors</strong></td>
<td>Ethnic composition</td>
<td>% of population from different ethnic groups</td>
<td>Census</td>
</tr>
<tr>
<td></td>
<td>Age composition</td>
<td>% in 10-year age categories</td>
<td></td>
</tr>
<tr>
<td><strong>Housing factors</strong></td>
<td>Homeowner/renter composition</td>
<td>% housing owner occupied</td>
<td>Census or local government</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% housing renter occupied</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Housing quality</td>
<td>% houses</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% units/apartments</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% public housing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Housing value</td>
<td>Median house value</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Median rent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Residential stability</td>
<td>% &gt; 5 years in residence</td>
<td>Census or local government</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% &gt; 10 years in residence</td>
<td></td>
</tr>
<tr>
<td><strong>Family structure</strong></td>
<td>Household size</td>
<td>% single person households</td>
<td>Census or local government</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Median household size</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Household composition</td>
<td>% households with husband/wife</td>
<td>Census or local government</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% single parent households with children</td>
<td></td>
</tr>
<tr>
<td><strong>Land use</strong></td>
<td>Nature of land use</td>
<td>Total land area of community</td>
<td>Local and state government</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% residential, % recreational, % commercial, % industrial, % vacant and farm</td>
<td></td>
</tr>
<tr>
<td><strong>Community institutions</strong></td>
<td>Religious</td>
<td>Number, type and location of institutions. Patterns of use of institutions.</td>
<td>Local and state government</td>
</tr>
<tr>
<td></td>
<td>Government services including libraries, police stations, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Education, including child care</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Health facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recreation facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accessibility characteristics</strong></td>
<td>Transport connectivity to region</td>
<td>Type and frequency of services available.</td>
<td>Regional transport planners, travel surveys and focus group.</td>
</tr>
<tr>
<td></td>
<td>Efficiency and ease of inter-modal connections</td>
<td>Number of inter-modal connections available.</td>
<td></td>
</tr>
<tr>
<td><strong>Quality of transit service</strong></td>
<td>Level of service</td>
<td>Frequency and hours of service</td>
<td>Service providers, local government, focus groups, travel surveys.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of access locations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rates of usage</td>
<td></td>
</tr>
<tr>
<td><strong>Environmental and social stress factors</strong></td>
<td>Existing noise levels</td>
<td>Proximity to major roadways</td>
<td>Local government or road authority</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Existing air pollution levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety</td>
<td>Vehicle and pedestrian accident rates</td>
<td></td>
</tr>
<tr>
<td><strong>Community goals and public attitudes</strong></td>
<td>Goals, aesthetics, health, safety, security, preservation of tax base, attitudes towards development and specific alignments necessary.</td>
<td></td>
<td>Residents’ attitudes.</td>
</tr>
</tbody>
</table>
6.3 Impact characterisation

Transport projects may result in any number of demographic, economic, geographical, political and environmental impacts. Transport practitioners need to undertake as thorough assessment (scoping and profiling) as possible to capture all potential impacts.

Impact characterisation may include identifying impacts under different sets of assumptions or development options or scenarios. The nature of the impacts including descriptions of magnitude, direction, location and range of influence will need to be considered.

Matched comparison and reflexive comparison evaluation methodologies are two common methods of investigation (see table below).

### Matched comparison and reflexive comparison studies

<table>
<thead>
<tr>
<th>Matched comparison</th>
<th>Reflexive comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>With and without project</td>
<td>Before and after project</td>
</tr>
</tbody>
</table>

- An ex-post, retrospective approach that compares one area (with the intervention) to another (without the intervention)
- An ex-post, retrospective approach that utilises a before and after project methodology for comparison

These approaches are not necessarily mutually exclusive and a combination of each is likely to be an element of best practice evaluation.

**Key considerations**

- Need to consider local context and situational differences that may make matched comparison difficult.
- Need to consider distributional effects which may vary across spatial boundaries.
- Applicable to project level evaluation where shorter-term outcomes are desired.
- Need to consider spatial scale of the initiative (local, regional, national), the time horizon (short, medium and long term) and the type of intervention (eg, project, program or policy level).
- Need to consider the desired objectives (such as a shorter-term project result and a longer-term capacity building outcome). This includes differences such as ‘end’ or ‘development process’ measures that reflect the purpose of the intervention. For example, an intervention with a capacity building objective may have a longer-term focus than a specific project level development.
- Need to consider diversity in the criteria set (that goes beyond traditional normative economic measures such as IRR or NPV).

6.4 Analysis

Since direct ‘measures’ of equity are hard to identify, various distributional rules or theories of justice can be applied depending on the outcomes sought. The analyst needs to determine which analytical framework is the most appropriate for the situation under investigation.

This step involves the application of different equity principles or theories to determine the types of outcomes that are possible or desirable. Theories of justice are used as input in the development of decision-making procedures. There is no one single theory of justice that will satisfy everyone. Khisty (1996), for example, provides the following six theories of justice chosen because they represent ideas that are either commonly used, understood by society or are documented in the literature.
To illustrate how theories of justice can be applied, Khisty (1996) developed an example of a hypothetical city showing six alternative bus configurations (1-6) as illustrated below. The income distribution (expressed from ‘low’ to ‘high’) on the route alternatives is then overlaid on the area map. Each alternative satisfies the goals and objectives set forth by the citizens of the city, and in each case the aggregate benefits exceed the aggregate costs.

A hypothetical city showing six bus transit configurations

Source: Khisty (1996)

There are five major socio-economic groups in the city and their population percentages are indicated in the table below. It is assumed that each group contributes taxes to the city in proportion to their income. The amount indicated under each alternative (1-6) represents units of benefit that each individual would receive.
Given the details of the project, the question is: which of the six alternatives is the most equitable? The answer to this question depends on which distributional rules or equity principles the decision-maker adopts. Khisty (1996) provides the implications for route selection based on each of the six equity principles:

- **Equal share distribution** (distribution based on an equal share - or as equal as possible - of the benefits among the socioeconomic groups). Alternative 2 is most consistent with this principle with the minimum range between the highest and the lowest benefit received being 2 units and an average net benefit received of 10.45 units.

- **Utilitarian distribution** (distribution based on maximising the benefits to the community as a whole). Alternative 6 is most consistent with this principle. While the disparity between high-income and low-income groups is glaring, this alternative has the highest net benefit among all the alternatives.

- **Distribution based on maximising the average net benefit with a minimum floor benefit of 10 units** (this principle ensures that an attempt to maximise the average benefit is constrained by a certain amount to ensure that certain individuals or groups, particularly ‘at the bottom’ receive a certain minimum amount of benefit). Alternative 5 is consistent with this principle. The choice of a minimum floor is a decision that must be made in advance by the decision maker. This principle also illustrates the nature of an efficiency-equity trade-off; the principle is achieved with a reduction in total net benefits of 250 units compared with the maximum efficiency alternative.

- **Distribution based on maximising the average net benefit with a benefit range constraint not exceeding 16 units** (this principle ensures that an attempt to maximise the average benefit does not allow differences in benefit between the rich and the poor segments of the society to exceed a certain amount). Alternative 4 is consistent with this principle. As above, an efficiency-equity trade-off is apparent. In this case, 565 units of net benefit need to be traded-off.

- **Distribution based on the egalitarian principle** (this principle of ethical conduct attempts to reduce any existing social or economic inequalities among individuals and groups in the community). Alternative 1 distributes higher benefits to the lower end of the income distribution and is therefore consistent with the egalitarian principle. Although this alternative has the lowest total benefit of all alternatives, it probably benefits income groups that are truly in need of public transportation.
Rawls' theory of justice (distribution based on maximising benefits to the lowest income group). Alternative 3 is consistent with this principle. It also has the highest floor among the alternatives, but indicates a need of 625 units of net benefit to be traded for the desired equity outcome.

Which distribution theory to use will depend on the policy maker and the characteristics of the community that are represented. Invariably, when people are affected by the choice of distribution rules, or when they are offered several rules from which to choose, they tend to prefer the rule that favours them. Preferences are a function of culture, political affiliations, gender, economic standing, and so forth (Khisty, 1996).

Khisty (1996) suggests that citizens are generally not bothered by ethical theories as much as they are concerned with their own welfare in terms of ‘quality of life’. Therefore, Khisty defines ‘quality of life’ as the essence of the collective economic, social and physical conditions of people in a community. This example is further examined in the Equity Explorer™ software tool (see separate pdf files accompanying Part 6).

6.5 Response

The response step deals with considering alternative choices for mitigation. There are many potential responses to address equity concerns. Most responses will involve compensating adversely affected parties in some way. This would involve trade-offs between the efficiency gains generated by investing in transport projects and the distributional impacts introduced by these investments.

In general, the most appropriate trade-off option will be sought for the situation. For new transport infrastructure/services, trade-offs between efficiency and equity can be made early in the project planning stage (as the Khisty example above shows). Common evaluation tools such as BCA or MCA can be applied at a disaggregate level (i.e. for different communities of interest) to identify equity impacts as they affect different groups within a population.

For a given project, trade-offs between efficiency and equity can be made using a variety of approaches. The determining factors are influenced by the policy options and tools available to the decision-maker. Some of the common options include monetary compensation, road user charges and rationing of services. Commentary F provides further information and examples of these techniques.
7. INTER-GENERATIONAL EQUITY AND SOCIAL DISCOUNT RATES

Inter-generational and inter-temporal issues are important as transport decisions made today have an enormous impact on the choices available for future generations. This is where the concept of inter-generational equity becomes important. Due to the sheer size and physical presence of transport infrastructure, and its influence on urban form, future generations will bear the consequences of any transport decisions made today.

Inter-generational equity ideas are gaining prominence, largely due to new thinking about sustainable development. Australia’s National Strategy for Ecologically Sustainable Development (NSES D) was endorsed by the Council of Australian Governments in 1992. The Goal of the NSES D is ‘development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends’. Equity is central to the ecological sustainable development concept. A core objective of the NSES D is ‘to provide for equity within and between generations’. This objective is defined by the first guiding principle of the strategy which states ‘decision making should effectively integrate both long term and short term economic, environmental, social and equity considerations’ (CoA, 1992a).

In transport economics, inter-temporal issues are treated using discount rates; adjusting the rate of benefits in future time periods so they compare to values in the present. Discounting implies a preference to consume more now and less in the future, by reducing future benefits in comparison to future costs. Conventional economic practice is to discount all costs and benefits at a social discount rate usually somewhere in the range of 3% to 8% (Rabl, 1996).

This practice is based on the model of ‘discounted utility’ – a model to represent consumer behaviour and choice. The currently accepted economic procedure is based on three critical assumptions:

- that a single discount rate can be used to represent the broad range of factors (including psychological factors) that are likely to influence decisions regarding future action and utility
- the assumption of a constant social time preference rate that does not change over time - alternative approaches known as ‘hyperbolic discounting’ have also been developed where the discount rate declines over time
- that the same rate applies to all types of inter-temporal decisions and types of goods or services.

The discount rate is highly controversial as some analysts believe that under high discount rates, future costs are reduced so much that the interests of future generations may not be taken into account. Therefore, discounting is a key issue that needs to be considered in discussions of inter-generational equity and sustainable development.

The justification for the discount rate within the present generation comes from the conventional market of lending and borrowing activities which expresses preferences between current and future consumption (Rabl, 1996). Because there is no inter-generational market, the future discount rate (for the next generation) can be debated. However, Rabl (1996) still points out that ethical choices can be made about how the future generation can be considered, for example, he presents the view that decisions of the present generation be Pareto-optimal for future generations i.e. that no future generations should be worse off.
If an ethical decision is made to treat each generation equally, it might lead to the suggestion that the discount rate should be zero. Marini and Scaramozzino (1999) point out that under a zero social discount rate the current generation could have an exceedingly low consumption per capita, leading to future generations being better off economically than the present generation, even at modest rates of economic growth. In this case, a positive discount rate could act as compensation against bias in favour of future generations, which occurs when technology changes over time (Marini and Scaramozzino, 1999).

There is no specific guidance provided to practitioners in Australia in relation to inter-generational equity assessment in project evaluation practice. The material presented in this Part of the Guide aims at helping the practitioner to consider some of the issues involved with distributional effects.

As a general rule, the Commonwealth Department of Finance (CoA, 1992b) also recommends:

- responding to decision makers’ need for information about the distributional effects of projects and polices
- displaying gains and losses by the relevant groups, in chart or tabular form as an adjunct to the cost-benefit analysis itself
- applying some form of distributional weights only in those instances where these weights can be reliably extrapolated from stated Government policy objectives.

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3 Recommendations for distributional weights as part of benefit-cost analyses of projects/programs must only flag the need for distributional judgments, which are to be strictly made at the political level. Even in these instances, it is recommended that the estimate of the unweighted net present value should be included in the analysis, so that the absolute cost of the distributional transfer can be fully taken into account by decision-makers.
PART 6 COMMENTARIES

COMMENTARY A: EQUITY ANALYSIS IN CURRENT TRANSPORT PRACTICE

A number of Australian jurisdictions articulate equity as an important element in transport planning and strategies, but no Australian jurisdiction has formally incorporated equity considerations in transport project or program appraisal.

Many transport plans, strategies and policies articulate equity as a key issue to consider in transport infrastructure investments. Selected examples from different jurisdictions are presented below. South Australia’s draft transport plan (SA Government, 2003), for example, ‘identifies transport’s contribution to social inclusion through recognition that not all South Australians fare equally and some experience acute and disproportionate disadvantage’. As a result, the SA government has identified the following groups and issues as requiring specific consideration:

- age (specifically the mobility needs of older people and the young who are especially dependent on public transport and others for transport)
- gender (specifically people who have particular travel needs regarding access to private transport and in patterns of commuting and employment)
- people with disabilities
- other socially or economically disadvantaged groups such as indigenous people.

Western Australia’s sustainability framework (WA Government, 2003) presents a set of criteria that could be used in the process of sustainability assessment, one of which emphasises increasing ‘access, equity and human rights in the provision of material security and effective choices’.

In NSW, transport planning is undertaken by the Department of Infrastructure, Planning and Natural Resources in conjunction with road and rail agencies (DIPNR, 2004). Transport planning is guided by the four government objectives of social equity, economic development, environmental protection and financial management. In relation to transport these objectives are described as follows:

- social equity reflects access to jobs and services, the affordability of housing and transport, and the provision of transport choice
- economic development includes creating sustainable jobs, supporting exports, developing regions, and minimising the cost of congestion
- environmental protection includes minimising the environmental impacts of transport on air, water, soils, vegetation and noise
- financial management includes ensuring taxpayers receive value for money from public investment, and inter-generational equity issues such as not overburdening future generations with excessive debts or capital requirements.

All these Australian examples emphasise the consideration of equity impacts during strategic planning and decision-making levels. However there is a clear need to further develop and refine methodologies, tools and techniques that enable equity considerations to be incorporated into transport project or program appraisal.
Some progress has been made overseas in this area. The Applied Research Centre in California, for example, has developed guidance for policymakers on preparing an Equity Impact Statement (ARC, 2004). The approach includes identification of the following elements:

- communities of concern (including, for example, gender, income, disability characteristics)
- adverse effects (including social, cultural, economic, environmental, individual and cumulative effects)
- key questions that are integrated into the policy-making process that address specific issues such as compliance with legislation, access to livelihood, quality of life and the distribution of the costs and benefits.

In Europe, the German transport investment appraisal method is both detailed and explicit in its treatment of distributional effects on different regions within Germany (Bristow and Nellthorp, 2000). A unique feature of the approach is the flexibility to assign extra weight to employment impacts to reflect specific socio-economic conditions within specific regions (Bristow and Nellthorp, 2000). These same authors also report that in Finland, distributional effects are assessed and presented as part of a Supplementary Study that is made available to the decision-maker alongside the cost-benefit results and other findings. Bristow and Nellthorp (2000) conclude that in many other EU countries there is little evidence that equity and distributional impacts are given a significant role in project appraisal and reporting of evaluation results.

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COMMENTARY B: FOUNDATIONS OF EQUITY THEORY

The theoretical foundations of economic evaluation techniques can be traced back to welfare economics and optimisation theory. Welfare economics is concerned with formulating and justifying propositions by which alternative economic situations may be ranked. In welfare economics, there is a long-standing tradition of considering social welfare as having at least two dimensions - those of efficiency and equity (or distributive justice).

Economic efficiency concerns the size of the total benefits received by all members of the community as a consequence of a project. The objective of any economically efficient system is to maximise the use of scarce resources and to allocate them to users in the most efficient way. This is called the Pareto efficiency criterion. The key point to remember is that although an economy may be economically efficient it is not necessarily equitable to different groups of people.

B.1 Pareto efficiency criterion

Allocative efficiency or Pareto efficiency is a criterion of economic efficiency suggested by the economist Pareto in the 1880s. According to Pareto, scarce resources should be allocated in such a way that it is impossible to make anyone better off without simultaneously making someone else worse off. Such an allocation is said to be ‘Pareto efficient’. However, the problem with this definition is that it is too strict; even very good projects generally disadvantage somebody.

In 1939, the economists Hicks and Kaldor devised another criterion. ‘Hicks-Kaldor (potential Pareto) efficiency’ requires only that gainers be able to compensate losers—not that they actually do so. Efficiency is promoted when a project generates more benefits than costs, regardless of who gains and who loses. It is this alternative criterion that is central to BCA.

All other things being equal, an increase in economic efficiency is a good thing, provided it is not associated with a decrease in equity.

B.2 Forms of equity

There are different forms of equity that need to be considered when undertaking analysis of transport projects, some of the most important forms of equity for transport projects include:

**Horizontal equity** – refers to the ‘principle of equal opportunity’ and impartial treatment of different users. One form of horizontal equity consists of making the user pay for a ‘good’. In the area of transport, this essentially involves an improvement in quality of service (speed, reliability, comfort) in exchange for an additional payment. Another form of horizontal equity relates to the ‘polluter pays’ principle, which means that the user pays for the ‘damage’ they cause to society i.e. environmental damage, accidents, congestion delays, etc (Raux and Souche, 2004).

**Vertical equity** – refers to the ‘principle of difference’ and considers social inequities in the distribution of benefits among different classes of income groups. This consists of assessing the outcomes of policies with reference to the well-being of the most disadvantaged, which should be maximised. When applied in the context of transport policy it means that travel conditions of socially disadvantaged groups or individuals should be considered (Raux and Souche, 2004).
Spatial or territorial equity – refers to the ‘principle of liberty’ and provision of equal conditions for citizens living in all parts of the country. This principle is associated with the right to mobility and access to jobs, goods, and services from any location (Raux and Souche, 2004).

Inter-generational equity – The benefits from the range of planned interventions should address the needs of all, and the social impacts should not fall disproportionately on certain groups of the population, in particular, children and women, the disabled and the socially excluded, certain generations or certain regions (Vanclay, 2003).
COMMENTARY C: METHODS FOR TRADING EFFICIENCY GAINS FOR EQUITY OUTCOMES

Two theoretical approaches that can be used to analyse efficiency and equity trade-offs are described in this section. The reader should be aware that current quantitative approaches for trading-off efficiency gains for equity outcomes are largely theoretical or adapted from other sectors of social and economic activity (e.g. healthcare). Further development of these and other related methods is required before they can be formally included in the evaluation process for transport projects.

C.1 Utility frontiers

The concept of utility frontiers enables the analyst to consider differences between the maximisation of utility (based on a concept of efficiency) and of equality of utility distribution (based on a concept of equity). The utility frontier is derived from the Pareto Optimality condition, which is achieved when efficiency in consumption and efficiency in production are simultaneously reached.

In a simplified society with two individuals and two goods, Pareto Optimality is represented by the points on a utility possibilities frontier PP' shown in the figure below. The economy is on the utility frontier when it is producing efficiently, i.e. when it cannot produce more of one good without producing less of another. In this case producing more of one good implies sacrificing other goods. Substitution is a fact of life in an efficient economy and the utility frontier depicts the menu of society’s choices.

Utility frontiers are derived to consider the efficiency impacts of varying distributional (equity) effects of projects. This is typically achieved by considering a social-welfare function determined by a map of social welfare contours that indicate how much utility of one individual or social group society would be willing to sacrifice in order to increase the utility of another individual or social group (Sassi et al., 2001). For example a society that is indifferent to alternative distributions will have a social welfare function like the one represented in panel 3 of the figure below where a sacrifice of utility for A is acceptable only if it corresponds to a gain of an equal amount of utility for B (representing a utilitarian view of social welfare). At the other extreme a society may express L-shaped social welfare curves as shown in panel 2 indicating that no gain in utility for A could compensate for sacrifice of utility for B (representing an egalitarian view of social welfare). This is also consistent with Rawls’s principle of justice that states that only by improving the welfare of the ‘worst-off’ can the welfare of society improve, and welfare gains for the ‘best-advantaged’ are of no value to society (Sassi et al., 2001).

Social welfare functions allow the identification of an optimal point among the efficient combinations lying on the utility possibilities frontier. This will correspond to the point in which the frontier is tangent to the highest social welfare curve (e.g. point X in the figure on page 22) (Sassi et al., 2001).
C.2 Cost utility analysis

In cases where benefits for BCA are difficult to monetise, an alternative criterion called cost-effectiveness analysis (CEA) can be applied. CEA can be described as a subset of a MCA process which compares the cost of interventions, while their benefits are measured in a common non-monetised/physical unit. CEA is mostly used to appraise investments with a strong social element.

Cost utility analysis is a variation of the CEA approach which is widely used in the healthcare sector. Under this approach health benefits are measured by an index called quality-adjusted life years (QALYs). Many approaches to development of QALYs have been tried and techniques are subject to considerable debate, however QALYs is commonly defined by a value of 1 to a year lived in good health, with quality adjustment factors used to assign a value to a year lived in ill health (constructed from individual's answers to questions about their quality of life). The costs of different medical treatments are then compared with the gain in QALYs.

Else (1992) applied this approach to the transport sector. The basic need supplied by transport services that is analogous to health status is accessibility. The obvious problem is that accessibility is a multi-dimensional concept which cannot be easily measured. Furthermore, it is harder to identify mutually exclusive categories in transport than health. There are various things to which people require access: such as employment, shopping centres and personal services, recreation and leisure activities. Else (1992) proposes two dimensions to an accessibility index including proximity to transport and availability of transport. From these dimensions a utility index of accessibility (ranging in value from 0 to 1) can be constructed. Under such an index, a rating of 1 would be assigned to a situation where someone with access to a car and the highest category of public transport services (the accessibility component of the index), located within half an hour’s journey of a centre with all relevant facilities (the proximity component of the index). By contrast a rating of 0 would apply to someone with no public or private transport access, who is located more than 10km for example, from basic facilities. An appropriate sample of individuals is asked to rank all other possible situations from 0 to 1.
The cost utility analysis allows for individuals’ views on the extent to which their needs are met by particular levels of transport provision to be included in the decision-making process. With some modifications, Else (1992) suggests that there is potential for adapting the cost-utility analysis approach to estimate accessibility or a ‘quality adjusted access’ index arising from given improvements in the transport network. This approach, for example, can guide policy-makers in deciding on the allocation of public transport subsidies.
COMMENTARY D: TECHNIQUES TO ESTIMATE DISTRIBUTIONAL (EQUITY) IMPACTS ON THE COMMUNITY

There are various quantitative and qualitative techniques for considering equity impacts on the community. Some common techniques described in this section include equity indexes and weights, social impact assessment, stated preference surveys and spatial analysis techniques.

D.1 Equity indexes and weights

A number of indexes have been developed to measure equity or inequity between groups or populations. This type of analysis is mostly used to estimate income inequity in the population; however it is also being applied to concepts such as accessibility. The choice of which index to use will depend on the decision-makers' needs, data availability, and the level of development within the community of interest.

Gini index

The Gini index is used to measure the distribution of a good in a society. The Gini coefficient of concentration and the Lorenz curve\(^4\) have most commonly been used to measure income inequality. However rather than income, it could be used to measure a range of variables, for example, the distribution or quality of a transport services.

The distribution of total income is represented by the Lorenz curve, and the statistical analysis is done using the Gini coefficient which is a measure of the degree of inequity. The Gini coefficient is a number between 0 and 1, where 0 means perfect equality (everyone has the same income) and 1 means perfect inequality (one person has all the income, everyone else earns nothing). See figure below.

\(^4\) Lorenz curve is a graph showing cumulative percentage of population on the horizontal axis and cumulative percentage of income received on the vertical axis. It is used to show the degree of equality or inequality in income distribution. The greater the departures of the Lorenz curve from the 45° line, the more unequal the distribution of income (Samuelson et al., 1992).
If the percentage of households is plotted on the x axis and the percentage of income on the y axis, the Lorenz curve shows, for the x% of households, the percentage of the total income which they have (y%).

A perfectly equal income distribution in a society would be one in which every person has the same income. In this case, the bottom n% of society would always have n% of the income. Thus a perfectly equal distribution can be depicted by the straight line y=x; called the line of perfect equality. A perfectly unequal distribution, by contrast, would be one in which one person has all the income and everyone else has none (Wikipedia, 2003).

On the figure above, the Gini coefficient is the area between the line of perfect equality and the Lorenz curve, expressed as a percentage of the area between the line of perfect equality and the line of perfect inequality (Wikipedia, 2003).

**Welfare index**

Loeis and Richardson (1997) identified a welfare index for use in transport analysis and evaluation. Travel demand estimation and the evaluation of travel proposals often rely on personal or household income as one of the explanatory variables. However, the financial significance of a unit of income varies from person to person and household to household. For example, at the same income level a small household can buy more for its individual members than a larger household. Consequently, it is by itself not an adequate economic explanatory variable for travel behaviour or evaluation.

Loeis and Richardson (1997) developed their ‘Welfare Index’ through practical application of the welfare economics concept of *equivalence scales*, used in classifying households based on the relative cumulative needs or living costs of their members. Applied in combination with after-tax income, it rates households on relatively uniform standards of financial or welfare capacity. The result is therefore a better explanatory variable for travel behaviour than personal or household income.

**Equity weights: prioritising between interventions**

Equity weights provide a method of formally incorporating concepts of fairness into economic analysis. Equity weights are numbers that express the relative importance of equity concepts. Weights express the extent society is prepared to sacrifice efficiency in pursuit of fairness. The greater the equity weight, the more efficiency gain a society is willing to trade-off to achieve improved fairness (Sassi et al., 2001).

The underlying assumption to the development and application of such weights is that the concepts of equity and efficiency can be traded off against each other. The application of weights is thus used to effect a balancing of conflicting, but commensurable objectives when making complex resource allocation decisions (Sassi et al., 2001). An example of how to apply equity weights is provided below.

Equity weights can be derived from two major sources: the view of a (representative) sample of the population and/or the views of decision-makers (Sassi et al., 2001).

Application of equity weighting can be controversial. Some opponents argue that equity weights are subjective and that a detailed description of the equity effects should be provided to the decision-maker who can then assess any distributional effects.
How to apply equity weights

Equity weighting is a simple concept. Say that a particular project provides benefits for two different population groups A and B. The net benefit is given by:

$$\text{NetB} = W_a \Delta A + W_b \Delta B,$$

where $W_a$ and $W_b$ are the distributional (or equity) weights.

In situations where population groups are equal, the weights are set to one. If there are equity differences between population groups (involving, for example, different income distributions) then the 'marginal utility of income' will be different for these two groups. The net benefit in such cases may be defined as:

$$\text{NetB} = W_h \Delta H + W_l \Delta L,$$

where $W_h$ is the marginal utility of income for the high income group and $W_l$ is the marginal utility of income for the low income group.

If we say that the marginal utility of income is 0.40 for the high income group (i.e. a $1 change in income for this group results in a 0.4 change in economic welfare) and 1.25 for the low income group (i.e. a $1 rise in income causes a 1.25 change in economic welfare), then the net benefit equation becomes:

$$\text{NetB} = 0.4 \Delta H + 1.25 \Delta L \text{ (example taken from Sassi et al., 2001).}$$

D.2 Social Impact Assessment in transport projects

Social impacts are the likely consequences for individuals or a community of implementing a particular course of action. It is common practice (and often required by legislation) to undertake a Social Impact Assessment in conjunction with an Environmental Impact Assessment in the process of evaluating major transport projects.

Social Impact Assessment relates to the identification and assessment of potential impacts for an area and the community of a project. Sinclair Knight Merz (1998) state that a Social Impact Assessment requires:

- a description of the existing and likely future social characteristics of an area
- a description of proposed changes
- an analysis of how these changes will impact on the community at both a broad (regional level) and a local level
- an examination of measures available to ameliorate adverse impacts.

Assessment of social impacts relies on community input to gain an understanding of community concerns, values and aspirations. As such, Social Impact Assessment processes and community consultation are inextricably linked (Sinclair Knight Merz, 1998).

The range of social impacts which can result from a transport project can be very large. The table on page 22 provides some common social impacts of a freeway construction (or extension) project.
### Selection of social impacts to consider when undertaking a road development project

<table>
<thead>
<tr>
<th>Social impact</th>
<th>Issues to consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement or isolation of residents</td>
<td>Adequacy of the compensation and the relocation process, reduced land value, emotional issues including grief.</td>
</tr>
<tr>
<td>Displacement or isolation of commercial and community facilities</td>
<td>Adequacy of the compensation and the relocation process, economic hardships for existing or new businesses, reduced land value, clientele cut off, inaccessibility of services or inconvenience for customers.</td>
</tr>
<tr>
<td>Barrier effects: effects on social interaction</td>
<td>Effects on community cohesion, disruption of friendships or family contact, changes in convenience and travel time.</td>
</tr>
<tr>
<td>Barrier effects: effects on business, recreation or services</td>
<td>Inconvenience, changes to accessibility and travel time.</td>
</tr>
<tr>
<td>Noise effects</td>
<td>Physiological, psychological and social changes due to increased noise levels.</td>
</tr>
<tr>
<td>Safety</td>
<td>Effects on personal, family or child safety on a localised scale i.e. dependent on proximity to freeway or changes to traffic conditions in surrounding area.</td>
</tr>
<tr>
<td>Health effects</td>
<td>Physiological changes resulting from air and water quality.</td>
</tr>
<tr>
<td>Environmental quality effects</td>
<td>Changes in air or water quality as they affect people's lifestyle and enjoyment of their environment, recreation, indoor and outdoor living.</td>
</tr>
<tr>
<td>Land use changes</td>
<td>Changes in zoning from residential to commercial areas or development in a previously undeveloped area, loss of recreational or public space.</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>Changes to visual landscape, physical intrusion, scale, loss of open space, changes in flora or fauna.</td>
</tr>
<tr>
<td>Cultural heritage</td>
<td>Disturbance or destruction of heritage sites.</td>
</tr>
</tbody>
</table>

Source: adapted from FHWA, 1982

The data required to facilitate a Social Impact Assessment process are firmly based on community consultation campaigns. Community participation is a major component of Social Impact Assessment. It is useful to begin the participation process early in the project planning phase and carry on throughout the life of the project. In many transport agencies, community participation/consultation is also a legislative requirement, meaning that a project cannot proceed beyond the planning stage without adequate consultation with the community. The support of the community is also often needed to ensure successful implementation of a transport infrastructure project.

An added complication to impact assessment is that social impacts are classified differently by different practitioners. For example air pollution is classified as an environmental issue in an Environmental Impact Assessment. A Social Impact Assessment should also include air pollution as a social issue because of its consequences on the health of the community. Air pollution mitigation would also be included in a BCA due to the economic costs of pollution mitigation measures.

The practitioner is often faced with a series of complexities inherent in impact assessment statements, which can lead to serious double counting issues in the economic evaluation of projects. It is very important to remember that a thorough evaluation (BCA) should take into account a broad range of social impacts, especially those which are easily quantifiable and monetised such as relocation, pollution mitigation measures and safety. Furthermore, an MCA type evaluation has the added benefit of including social impacts which are more difficult to monetise such as community severance or loss of character or open space.
D.3 Equity Impact Assessment

Social (equity) Impact Assessment statements consider the winners and losers of the particular project investment. As stated by Levinson (2002), a set of specified (winner and loser) population subgroups would be normally identified. Then the outcomes of the project (e.g. travel time and delay, accessibility, consumer surplus, air pollution, noise pollution, accidents) would be assessed for each of these population subgroups.

Levinson (2002) provides an Equity Impact Statement checklist as shown below. The checklist includes a range of stratification variables (for example population, gender or spatial extent), specific process requirements (such as the opportunity to participate in decision-making) as well as desired outcome areas (such as mobility, economic, environmental and health outcomes) for transport projects.

<table>
<thead>
<tr>
<th>Process</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stratification</td>
<td>Mobility</td>
</tr>
<tr>
<td>Population</td>
<td></td>
</tr>
<tr>
<td>Spatial (or jurisdictional)</td>
<td></td>
</tr>
<tr>
<td>Temporal</td>
<td></td>
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<tr>
<td>Modal</td>
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<tr>
<td>Generational</td>
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<tr>
<td>Gender</td>
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<tr>
<td>Racial</td>
<td></td>
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<tr>
<td>Ability</td>
<td></td>
</tr>
<tr>
<td>Cultural</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td></td>
</tr>
</tbody>
</table>

Source: Levinson, 2002.

D.4 Assessing cumulative impacts

The distribution of effects can change over time and through the cumulative effects of successive project activities. Transport practitioners involved in equity analysis should therefore be aware of procedures for conducting Cumulative Effects Assessment (CEA) or Cumulative Impact Assessment (CIA).

A cumulative impact on a resource is one which results from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions (see below). Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Cumulative impacts may also include the effects of natural processes and events, depending on the specific resource in question (FHWA, date unknown).

Cumulative impact analysis is resource specific and generally performed for the environmental resources directly impacted by a government action under study, such as a transportation project. However, not all of the resources directly impacted by a project will require a cumulative impact analysis. The resources subject to a cumulative impact assessment should be determined on a case-by-case basis early in the process, generally as part of early coordination or scoping (FHWA, undated).
It is generally recognised among practitioners that specific methodologies for the assessment of indirect and cumulative impacts, particularly for predicting reasonable foreseeable impacts, are not as well established or universally accepted as those associated with direct impacts, such as traffic noise analysis or wetland delineation. Determining the most appropriate technique for assessing indirect and cumulative impacts of a specific project should include communication with the cooperating agencies and community stakeholders (FHWA, undated).

**D.5 Stated preference surveys**

Stated preference surveys are important community consultation tools that are used to inform equity evaluations (e.g. cost-utility analysis). They are particularly useful in situations where empirical information does not exist. Stated preference surveys might be used, for example, because no data has yet been generated on a new type of travel mode or a special type of pricing instrument with unique characteristics (US EPA, 1998).

In a stated preference approach, it is possible to derive statistical estimates of ‘trade-off’ rates between various alternatives or their attributes by making respondents choose from among them in measured ways that indicate the relative importance of key attributes. These rates can then be evaluated in relation to each traveller and their circumstances (US EPA, 1998).

The validity of the derived statistical relationships relies on how well the alternatives are portrayed to (and understood by) the respondent, and their comparison with known ‘standards’. While stated preference surveys rely on hypothetical situations, comparison of ‘elasticity’ relationships derived from stated preference with more conventional revealed preference surveys or models have shown corroboration. The results from these surveys should be used with caution, but they offer an important interim tool for agencies to estimate relationships between pricing instruments and travel behaviour response, not just in mode choice but in relation to destination, time of day, route choice, etc (US EPA, 1998).
Stated preference methods were developed by the private market research industry, and have been used successfully for many years to aid companies in identifying the critical attributes of their product, and maximising those attributes to gain market share over competitors. Use of the techniques in transport is a fairly recent development, however there are examples where it has been used to explore time of day choice or assist in the development of a route choice model (US EPA, 1998).

D.6 Spatial analysis techniques

This section discusses the potential of spatially based analysis and micro-simulation modelling to explore distributional or equity issues.

Spatially based analysis

Since transport infrastructure occurs on a spatial scale, it is usually the case that physical or social impacts resulting from transport impacts can also be quantified over a spatial scale. This is most commonly undertaken with Geographic Information Systems (GIS) technology which is now readily available and widely used to quantify various effects, for example emission of environmental contaminants or noise modelling. Most transport impacts have a geographical component; for example property prices can be easily represented in geographic form.

Once the distributional impact is defined over a geographical scale, relevant socio-economic characteristics need to be transposed onto the geographical representation of the impact. Some of these characteristics will be derived from a community social profile.

Due to the aggregate nature of common data sources on population characteristics (such as the census) Statistical Local Area or Local Government Area population characteristics are generally used as a proxy for specific groups being examined. For example, if concern is expressed over impacts on low income or minority populations, the impacts are measured for neighbourhoods that exceed a certain percentage of those population groups, rather than for specific minority persons or households. This provides the decision-maker with a representation of the distributional effects of projects on the communities of interest, i.e. the ‘winners’ and ‘losers’.

The biggest problem with spatial techniques is that some factors which affect impact distribution are difficult to determine. It is often difficult to identify the geographic location of a population class according to social characteristics. An additional complicating factor is that people’s decisions about where they live may be affected by transportation investments. For example, positive externalities such as good public transport or highway access can lead to higher property values and a migration of higher-income people to the area served (FHWA, 2003).

Micro-simulation

Micro-simulation modelling techniques forecast travel by modelling a set of actual or synthetic individuals or households that represent the population as the basic unit of analysis rather than dealing with population averages by postcode or statistical region. A ‘synthetic’ sample is composed of a hypothetical set of people or households with characteristics that as a whole match the overall population. Results are aggregated only after the individual or household analyses are completed, allowing the user great flexibility in specifying output categories. This is more commonly referred to as sample enumeration or discrete choice analysis. Sample enumeration relies on the modelling of behaviour for a representative sample of the population generally derived from a regional home interview survey or stated preference survey (FHWA, 2003).
The benefit of this modelling approach for analysing distribution of impacts is that travel patterns, and therefore the travel benefits of transportation improvements, can be tracked across any population characteristic that is included in the sample of persons modelled. Historically, this has been done by income level, since income is commonly used to predict travel behaviour. However, the characteristics of the sample can be broadened to include other attributes (FHWA, 2003). An example of a micro-simulation program from the United States (STEP) program is presented below.

**STEP: a micro-simulation program**

STEP is a travel demand analysis package composed of an integrated set of travel demand and activity analysis models, supplemented by a variety of impact analysis capabilities and a simple model of transportation supply. STEP has been used by the US Department of Transport and the US Environmental Protection Authority to analyse travel impacts of pricing scenarios (with the intention to reduce transport emissions) by income group.

STEP program models are applied using actual or forecast data on household socioeconomic characteristics, the spatial distribution of population and employment (land use), and transportation system characteristics for the selected analysis year(s). STEP reads through the household sample, attaching level-of-service and land use data to each household record as necessary. For each household, STEP uses its models to predict a daily travel and activity pattern for each individual in the household. Finally, household travel is summed up and household totals are expanded to represent the population as a whole.

Testing the effect of a change in conditions or policies is a simple matter of re-analysing the household sample using the new data values, and comparing the results with previous outputs. For example, a new highway or new transit service can be represented by changed travel times and costs for the areas served; a parking price increase can be represented by an increase in out-of-pocket costs; an increase in income in a particular area or for a particular population subgroup can be represented by editing the household file to incorporate the revised incomes.

The sampling framework preserves the richness of the underlying distribution of population characteristics and permits tabulation by any subgroup with sufficient observations to be statistically significant. For example, the results can be disaggregated by income level and age, which would allow an assessment of effects for, say, various income classes among the retired population. This is a significant advantage over an aggregate model, which uses zonal averages for most socioeconomic and economic data. A possible STEP model structure is illustrated on page 32.
Guide to Project Evaluation Part 6: Distributional (Equity) Effects

STEP model structure

- **Major household location choices:**
  - residential location
  - primary workplace location for each worker

- **Household characteristics dependent on travel:**
  - number of cars owned

- **Daily household trip choices:**
  - (including home-based work trips, home-based shopping trips, home-based other trips, non-home based trips)
  - trip frequency
  - trip destination
  - trip mode choice

- **Time characteristics of household travel:**
  - work arrival time

- **Transportation system performance:**
  - highway corridor delay


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COMMENTARY E: COMMUNITY PARTICIPATION PROCESSES

There are varying degrees of public participation; from information provision and consultation to substantial support for community initiatives (see below). Higher degrees of participation are not necessarily ‘better’ - different levels are appropriate for different situations and interests (Wilcox, 1994). The most commonly applied form of participation is community consultation.

Levels of community participation

- **Supporting**: Local groups or organisations are offered funds, advice or other support to develop their own agendas within guidelines.
- **Acting together**: Encouraging additional options and ideas, and providing opportunities for joint decision-making.
- **Deciding together**: Not only do different interests decide together on what is best, they form a partnership to carry it out.
- **Consultation**: Offering some options, listening to feedback, but not allowing new ideas.
- **Information**: Telling people what is planned.

Source: Adapted from Wilcox, 1994.

The desired level of participation needed for a project will inform the selection of participatory methods and techniques. Choice of method should directly reflect the type of information needed and the purpose for which it will be used. The following table provides common purposes for which community input is sought and the methods generally effective in achieving the task. More detail on community consultation processes is provided in the Austroads Transport Planning series.
### Matching participatory instruments to purpose

<table>
<thead>
<tr>
<th>Participatory approach</th>
<th>Characteristics</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose: To gain ideas and input from the public.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public hearing/ community meeting</td>
<td>A public hearing is often formal, with statements going into an official record of the meeting. A community meeting will often be an informal gathering where people come to share ideas with local officials.</td>
<td>An open gathering of people from the community who wish to be heard about a topic or issue.</td>
</tr>
<tr>
<td>Focus groups</td>
<td>A small gathering of stakeholders who meet in a confidential setting to discuss an issue or react to a proposal. The assumption is that through discussion, new information will emerge that would not otherwise come to light from individual questioning. These meetings are often facilitated by a trained individual. Local officials may or may not actively participate in the discussion.</td>
<td>Selected stakeholders.</td>
</tr>
<tr>
<td><strong>Purpose: To complete a specific task with citizen input.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop</td>
<td>A meeting focused on a predetermined task to be accomplished. Rather than soliciting general opinion, workshops are intended to focus on specific concerns and produce a predetermined product. The benefit of such meetings is that those most directly affected by an issue are directly involved in addressing it.</td>
<td>Primary stakeholders are often involved because of a high level of interest in the issue. To be most effective in addressing a public issue, the full range of interests should be represented in the workshop.</td>
</tr>
<tr>
<td>Task force</td>
<td>Purpose is to complete a clearly defined task in the planning process. A task force is often appointed to study a particular issue and offer a report of findings and recommendations to the policy-making body.</td>
<td>A small (usually 8 to 20 people) ad hoc citizen committee.</td>
</tr>
<tr>
<td><strong>Purpose: To have a discussion about citizen priorities associated with community projects.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Priority-setting committee</td>
<td>Citizen group appointed to advise local officials regarding citizen ideas and concerns in planning community projects.</td>
<td>Participants would be trusted to represent the concerns of citizens and sometimes function as a ‘go-between’ with residents and the local government.</td>
</tr>
<tr>
<td><strong>Purpose: To discuss citizen priorities associated with community projects.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delphi procedure</td>
<td>The objective is to work toward a consensus of opinion that can be used by policymakers for decision making. Successive rounds of presented arguments and counterpoints move the group toward consensus, or at least to clearly established positions and supporting arguments.</td>
<td>A panel of citizens chosen for their knowledge about an issue.</td>
</tr>
<tr>
<td><strong>Purpose: To quickly and quietly ascertain public sentiment about an issue.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interviews, polls, and surveys</td>
<td>Detailed information can be gathered. While confidential, the information can be informative both in content and overall emotional/political reaction to an issue.</td>
<td>Interested citizens are given a chance to speak directly with someone about their views.</td>
</tr>
<tr>
<td><strong>Purpose: To gain input about the alternatives and consequences of an issue.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Media-based issue balloting</td>
<td>Coupled with a media-based effort to discuss alternatives and consequences of potential solutions, letters to the editor or radio call-in shows are monitored to gain a sense of public reaction. Unscientific and not a reliable indicator of overall community sentiment, it can be a good way to gain a quick reaction to proposals by those most likely to be active on an issue.</td>
<td>Citizens are asked to respond through the local media.</td>
</tr>
<tr>
<td><strong>Purpose: To give citizens broad decision-making powers.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citizen advisory boards or councils</td>
<td>An advisory board studies an issue and makes recommendations to policy makers. The range of decision-making authority can vary and, in some cases, may be binding.</td>
<td>Appointed representatives of one or more community interests.</td>
</tr>
<tr>
<td>Referenda</td>
<td>Direct and binding decision-making authority by the electorate. Protracted campaigning leading to a referendum can become a divisive force.</td>
<td>All eligible voters.</td>
</tr>
<tr>
<td><strong>Purpose: To stay informed about the needs of certain neighbourhoods or interest groups.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group or neighbourhood planning council</td>
<td>This council serves as advisory to policy makers. Such councils keep decision makers informed about neighbourhood or group concerns, formulate goals and priorities on behalf of the neighbourhood or group, and evaluate plans and programs affecting the neighbourhood or group.</td>
<td>Organised by, and composed entirely of citizens.</td>
</tr>
</tbody>
</table>

Source: Adapted from Leatherman and Howell, 2000.
COMMENTARY F: EQUITY CONSIDERATIONS AND ROAD PRICING

This section provides a discussion of equity issues associated with road pricing. The purpose is to illustrate how equity considerations are a key component of transport policy decision making. An example of providing for equity in road pricing is provided from the European Communities’ AFFORD Project.

Over recent years, the concept of road pricing has been gaining momentum due to concerns about road capacity and congestion management. However, there is still a great deal of controversy surrounding the wider introduction and application of road pricing. As stated by Stough et al. (2004), there are misunderstandings over what road pricing seeks to do, concerns over how the revenues will be spent, and issues relating to welfare distribution (equity) consequences.

Road pricing is intended to improve transport efficiency by rationing road capacity. In terms of reducing travel demand and making traffic flow more efficient, it does not matter how road pricing revenue is allocated. From an overall economic perspective, the revenue must be used to benefit society and the greater the benefit the more economically efficient the program. There is no requirement, however that the money be allocated in any particular way (Litman, 1999).

The major equity consideration of road pricing concerns the distribution of road pricing revenue. Two components of equity that need to be considered regarding road pricing are horizontal equity and vertical equity. Many people instinctively feel that horizontal equity implies that revenues should be dedicated to road improvements or to provide other benefits to people who pay the fee. However, horizontal equity is complicated by the existence of external costs – those that are borne by non-vehicle users (see table below). So horizontal equity is only fulfilled when revenue is returned to vehicle users as a class, but only after external costs are compensated. Since most estimates of motor vehicle external costs are larger than the expected revenue of road pricing proposals, the horizontal equity justification of returning revenues to drivers is reduced or eliminated (Litman, 1999).

The vertical equity component is more complex. Vertical equity requires that disadvantaged people receive more public resources (per capita or unit of service) than those who have a relative advantage, to accommodate their greater need. So revenues must benefit low-income drivers as a class at least as much as the costs they bear, and disadvantaged residents (including non-drivers) must benefit overall. Litman (1999) explains that vertical equity can be defined with respect to the ability to drive. As a class, non-drivers tend to be economically or socially disadvantaged. Road pricing has the potential of benefiting non-drivers overall by increasing the use of alternative travel modes. Vertical equity considerations justify using road pricing revenue in a broad range of ways including the support of alternative transport programs, reduction in taxes, or funding of public services that benefit disadvantaged populations. The table on page 36 illustrates an approach developed by Litman, (1999) to evaluate the distribution of road pricing revenues to four classes of people based on horizontal and vertical equity considerations.
Road pricing revenue distribution equity analysis

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
<th>Horizontal equity</th>
<th>Vertical equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-drivers</td>
<td>People who cannot drive, usually due to age, disability, or low income. Non-drivers use automobiles as passengers, but their overall use of congested roads is typically low.</td>
<td>Although this group would pay little in road pricing, they deserve a share of revenue if it is considered compensation for existing external impacts of driving.</td>
<td>Non-drivers include many people who are economically, physically and socially disadvantaged, maximum use of road pricing revenues to benefit this group is justified.</td>
</tr>
<tr>
<td>Low-income drivers</td>
<td>People who can drive and have access to an automobile, but whose travel decisions are significantly affected by vehicle expenses. They will be frequently tolled off by road pricing.</td>
<td>This group pays a relatively small share of road pricing fees but incurs costs from travel charges which provide a large portion of congestion reduction benefits. They deserve a share of toll revenues in compensation.</td>
<td>This group is, by definition, disadvantaged so use of road pricing revenues to benefit this group is justified.</td>
</tr>
<tr>
<td>Middle-income drivers</td>
<td>People who can drive and have access to an automobile, but whose travel decisions are only moderately affected by vehicle expenses. They will sometimes be tolled off the roadway and their net benefits of travel are reduced by road pricing.</td>
<td>These drivers pay a large portion of total road pricing and lose net benefits. They deserve to benefit from road pricing revenues on the basis of horizontal equity, but only after all external costs are compensated.</td>
<td>Since this group is not disadvantaged there is no vertical equity justification for using road pricing revenue to benefit them.</td>
</tr>
<tr>
<td>Upper-income drivers</td>
<td>People who can drive and have access to an automobile, but whose travel decisions are not affected by vehicle expenses. They benefit overall from road pricing due to reduced congestion.</td>
<td>These people enjoy net benefits from reduced congestion. They deserve a share of the revenue only after external costs are compensated.</td>
<td>Since this group is not disadvantaged, there is no vertical equity justification for using road pricing revenue to benefit them.</td>
</tr>
</tbody>
</table>


F.1 Road use charges: an example from the AFFORD project

The European Commission undertook a study of marginal cost transport pricing in three European cities: Helsinki, Oslo and Edinburgh, as part of the ‘Acceptability of Fiscal and Financial Measures and Organisational Requirements for Demand Management’ (AFFORD) study (Fridstrom et al, 2000).

The study distinguished between ‘first-best’ and ‘second-best’ road pricing policy packages. The first-best solution involves charging the user the true cost, i.e. the marginal cost of road use determined by the level of congestion, environmental and accident costs. The second-best pricing package was based on the use of a package of policy instruments that are available for use by transport authorities (e.g. time differentiated cordon toll rates or time differentiated parking charges) (Fridstrom et al, 2000).

The study concluded that inequity within a population increased when road pricing is implemented (based on a Gini coefficient defined in terms of household income per consumption unit before and after revenue redistribution). However, in most cases the changes to income distribution appeared to be relatively moderate.

Fridstrom et al, (2000) noted that if revenue is redistributed proportionately by personal income, which is given as a percentage point relief in the income tax rate, it does nothing to correct the initial, adverse equity effects between people in the different income brackets. It does, however, reverse the potentially unpopular transfer of funds from private consumers to the public treasury.
However, if the same, absolute amount of money is redistributed to each adult individual (a ‘poll transfer’ or ‘flat distribution’) income inequity in the population improves considerably. According to model simulations, this is because the out-of-pocket expenditure on road charges represents a higher share of the household income in low income groups than among the more affluent. Both of these scenarios represent clear trade-offs between equity and efficiency: equity can be improved by redistribution but only at the expense of the efficiency gains from the road pricing strategy.

Fridstrom et al. (2000) suggest that in principle it is possible to conceive of a road-pricing scheme with revenue redistribution, which enhances economic efficiency as well as equity. It will usually be sufficient to redistribute a certain component of the revenue generated in a progressive manner, in order to keep the less affluent households at least equally well off. The main reason why road pricing schemes do not lead to any deterioration in the income distribution is that the more affluent people, exhibiting higher rates of car ownership and use, tend – in general – to incur higher road pricing expenditure.

### F.2 Non-pricing mechanisms for providing equity in road use

While road pricing is one method of rationing road capacity, there are other transport demand management mechanisms that do not involve pricing. These include priority measures such as high occupancy vehicle lanes and alternative rationing schemes. These measures are aimed at reducing total vehicle traffic and encouraging the use of efficient modes. Many of these strategies support equity objectives by improving travel choices/alternatives or affordability, especially for low income or mobility-disadvantaged groups (Litman, 2000).

Australia currently has a number of high occupancy vehicle lanes, commonly referred to as ‘transit lanes’. Transit lanes provide travel priority by allowing specified users (usually two or more people per private vehicle and public transport vehicles) exclusive use of part of the roadway to travel through congested sections of road. Transit lanes provide a high degree of horizontal equity (because they do not discriminate in regard to who can participate). This option benefits all existing users, especially public transport users by reducing travel times.

Road rationing schemes designate a certain percentage of the travelling population to use a road link on certain days or times of day. Those who have not been designated to use the road link at a particular time may still do so upon payment of a toll. Rationing schemes have been applied in many countries, for example in Athens and several Brazilian cities, with varied results. In these cities, access prohibitions have led to increased multiple car ownership and average fleet age, and after some years they lose their effectiveness (Viegas, 2001). Because of these results Viegas (2001) suggests that the ‘ration’ should be attributed to individuals, not to vehicles, so it is useable for driving and for riding on public transport (this also serves as an incentive to shift to public transport). Attributing the ration to individuals instead of vehicles prevents misuse of the system by those who own more than one car (Viegas, 2001). Nevertheless, rationing schemes are associated with high administration costs and are open to abuse by both users and administrators.

These are ‘second best’ options because of administrative, spatial or other deficiencies. However, under certain scenarios, they provide a valid response to tackling complex equity issues.

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