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Australian Transport Assessment and Planning Guidelines

T5 Distributional and equity effects of transport initiatives
DRAFT FOR PUBLIC CONSULTATION

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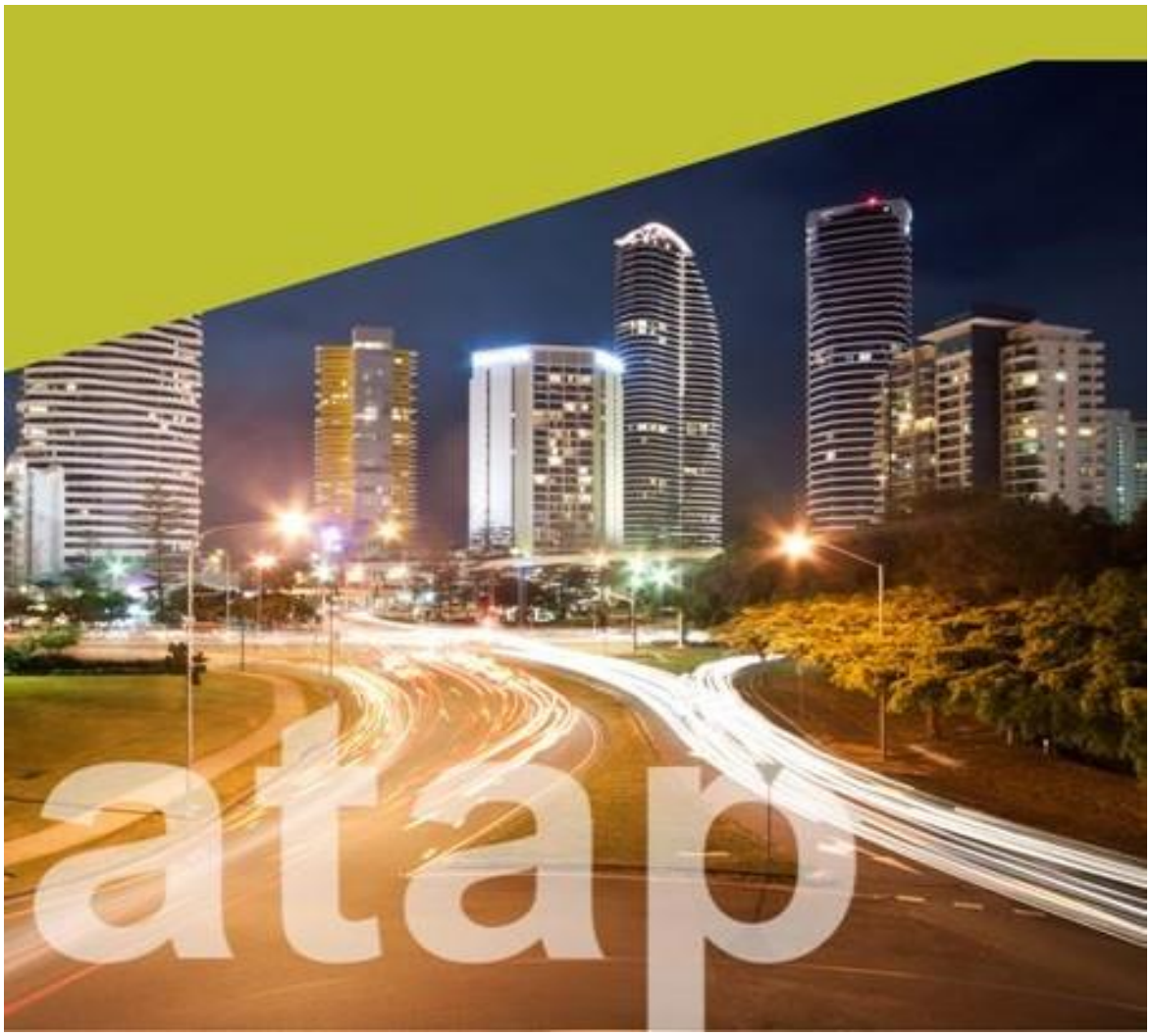

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At a glance

- This guidance considers the distributional and equity effects of transport initiatives (policies, plans and projects). These effects can be a concern where they are significant and have disproportionate impacts on particular user groups. They can be an important consideration in decision making.
- Distributional impact assessment (DIA) is an objective (in the sense of fact-finding) exercise aimed at identifying and describing those impacts. In contrast, equity considerations determine the normative desirability of distributional impacts identified by the DIA. Equity considerations are subjective and based on value judgements. The distinction corresponds to the separate roles of analysts and decision-makers.
- A set of principles and process is provided to guide consideration of distributional and equity effects.
- DIA sits alongside cost–benefit analysis (CBA) as key features of a comprehensive economic assessment. The CBA reports an initiative's combined net benefit (i.e. total benefits less total costs, with gains and losses added together), indicating the economic efficiency of the initiative. Distributional and equity effects concern the relative impacts across members of society, and the fairness of those outcomes. In other words: CBA is concerned with economic efficiency, or the size of the pie; distributional impacts and equity are concerned with how the pie is divided up.
- The distributional impacts of a transport initiative are the differing impacts across social groups and population segments affected by the initiative. These include changes in money costs of travel, accessibility, mobility, travel time, safety, and environmental changes. For the purposes of considering distributional impacts, people are grouped together according to characteristics such as income, location, occupation, age, disabilities and so on.
- The DIA approach presented here consists of three steps: 1) a screening process; 2) an initial assessment; and 3) an appraisal.
- Consideration of distributional impacts can commence in the option development/design stage, with options developed that address or avoid undesirable distributional impacts. This would particularly be the case where distributional impacts are an important objective of an initiative. Distributional impacts can become an issue in any of the three stages of the ATAP assessment process: strategic merit test; rapid appraisal; detailed appraisal. The depth of the assessment will increase with each stage and there will be more information available from the economic assessment at each stage to support the DIA.
- The DIA should be reported in the business case, separately from, but alongside CBA results.
- With consideration of the equity implications of initiatives being a subjective and normative, there is no formal equity assessment process that an analyst can conduct in the same way as for the DIA. However, to support decision-makers, analysts should seek to present the results of the DIA in a way that highlights impacts that might raise equity concerns (based on explicit jurisdictional goals and objectives and on widely-accepted notions of equity).
- The report discusses two widely-accepted notions of equity relevant to transport initiatives — vertical and horizontal equity — providing examples of each, noting that they sometimes overlap or conflict, requiring trade-offs between them.
- The business case should point out situations where selecting one option over another (including the base case) involves trade-offs between economic efficiency and equity or between different equity considerations. CBA results will enable any sacrifices of economic efficiency to be expressed as monetary amounts.
- It is possible to embed judgements about equity in CBAs through use of distributional weights. The consensus in Australia to date has been not to use distributional weights, but rather to convey information about distributional impacts to decision-makers and leave it to them to weigh up efficiency and equity impacts on a case-by-case basis.

1. Introduction

This Part of the ATAP Guidelines (T5) discusses the assessment of distributional and equity effects of transport initiatives (policies, plans and projects). These effects can be a concern where they are significant and have disproportionate impacts on particular user groups. They can be an important consideration in decision making.

ATAP Guidelines Part T5 provides broad guidance on considering and reporting distribution and equity effects of transport initiatives.

The assessment of distributional and equity effects requires an understanding who the 'winners' and 'losers' are from transport initiatives. In this guidance, we make a distinction between the assessment of distributional impacts, which is an objective (in the sense of fact-finding) exercise aimed at identifying and describing those effects, and equity considerations, which are subjective, based on value judgements. The distinction corresponds to the separate roles of analysts and decision-makers.

Distributional impacts and equity considerations should be reported in the business case, separately from, but alongside cost–benefit analysis (CBA) results. The CBA reports an initiative's combined net benefit (i.e. total benefits less total costs, with gains and losses added together), and indicates the economic efficiency impact of the initiative. Distributional and equity effects concern the relative impacts across members of society, and the fairness of those outcomes. An understanding of distributional impacts can be especially important where initiatives affect disadvantaged members of the population. It also provides a valuable insight into the motivations and behaviours of various stakeholders in relation to their support for or opposition to a proposed initiative.

Distributional impact assessment differs from environmental or social impact assessments that some jurisdictions may require.

1.1 Links to other parts of the Guidelines

T5 complements a number of other Parts of the Guidelines. Other Parts related to T5 are:

- F3 Options generation and assessment: Chapter 3 in F3 presents the ATAP assessment model
- T2 Cost–benefit analysis: Provides guidance on undertaking and reporting a CBA. Chapter 12 of T2 discusses adjusted CBA, an optional approach for combining equity considerations into the CBA
- T3 Wider economic benefits: Provides guidance for estimating benefits associated with changes in accessibility or land use that are not captured in traditional cost–benefit analysis
- T4 Computable general equilibrium models in transport appraisal. These models would only be used for large transport projects, but if used, they can be a useful source of information on distributional impacts
- T1 Travel Demand Modelling and T9 Urban freight demand modelling: Outputs from demand models, where used to estimate benefits, can be a key source of information for assessing distributional impacts.

1.2 Structure of this Document

Chapter 2 provides a brief summary of the ATAP assessment approach as context for remaining chapters.

Chapter 3 provides a scene-setting framework discussion.

Chapter 4 describes distributional impact assessment.

Chapter 5 discusses equity considerations.

2. The ATAP assessment approach

This chapter provides a brief overview of the ATAP assessment approach as context for the guidance here. It provides the basis for assessing transport problems, opportunities and options.

The ATAP assessment model is presented in Section 3.3 of ATAP Part F3. It consists of:

- Clarification of relevant jurisdictional goals, transport system objectives and targets (see ATAP Part F1). It is important to be clear early in an assessment about which of these are relevant in the given assessment
- Clarification of policy choices that have already been made and are part of the context for the assessment (see ATAP Part F0.1)
- Being clear about the problem or opportunity that is being addressed (see ATAP Part F2)
- Generation of a wide range of options for addressing the problem or opportunity (see ATAP Part F3). Note that Infrastructure Australia (2021a, p. 32) requires that at least two Project Case options, plus the Base Case, be presented in business cases submitted to them.
- A three-stage assessment process:
  - Strategic merit test — consideration of the degree of strategic alignment of the option being assessed with goals, transport system objectives, targets, policies and strategies
  - Rapid appraisal —rapid application of CBA (see ATAP T2), distributional impact assessment (DIA) and the Appraisal summary table (AST, see ATAP F3)
  - Detailed appraisal —detailed application of CBA, DIA and AST
- All benefits and costs — monetised and non-monetised (see Part F3) — are relevant to an appraisal of an option
- The assessment of all options should include an assessment of risk and uncertainty, in order to ensure that the recommended option is robust (see ATAP Part T2 Chapter 11, and ATAP Part T7)
- Bringing together all aspects of the assessment into a Business Case (see ATAP Part F4).

Consideration of distributional impacts can commence in the option development/design stage with options developed that address undesirable distributional impacts. This would particularly be the case where distributional impacts are an important objective of an initiative. In the ATAP assessment process, distributional impacts can become an issue in any of the three stages of the process. Distributional impact assessment sits alongside CBA as key features of a comprehensive assessment.

3. Framework

3.1 What are distributional impacts?

The distributional impacts of a transport initiative are the differing impacts across social groups and population segments affected by the initiative. These include changes in the monetary costs of travel, accessibility, mobility, travel time, safety, and environment. For the purposes of considering distributional impacts, people are grouped together according to characteristics such as income, location, occupation, age, disabilities and so on.

The distributional impacts of transport initiatives typically arise from three sources:

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

The groups that ultimately gain or lose from an initiative are not necessarily those whose welfare gains and losses are measured in the CBA, such as people saving time and money costs. Benefits and costs may be passed on to others for example through changes in product prices, wages and land values. Ideally, distributional impacts would be assessed at their final incidence.

Often, project benefits and costs will be very widely and thinly spread over large numbers of people. The exceptions, where effects on small groups of people are significant, need to be examined and highlighted.

The main costs of transport projects, that is, for infrastructure construction and maintenance are born by governments. Consideration of distributional impacts of changes to government spending is not required as they are spread over very large numbers of taxpayers. Only the distribution of benefits needs to be considered, but interpreted in the broad sense of including disbenefits such as negative externalities (technological externalities) and price increases (pecuniary externalities).[1]

The UK DIA Guidance states that it is not appropriate to conduct distributional analysis of business journeys (business cars and freight) because these impacts are experienced by businesses and not individuals (UK DfT 2020, p. 16). This ATAP Guideline does not rule out consideration of impacts on businesses because governments may be interested in impacts on industries in particular locations where there are effects on individuals such as owners of small businesses (including farms), employees and jobless people. In most cases, the user benefits (time and vehicle operating cost savings) accruing to businesses will be widely and thinly spread throughout the community in the final incidence and so not significant in the DIA. An exception might be where the transport initiative causes changes in turnover of businesses in particular locations by channelling customers towards them or away from them, significant changes to freight costs for inputs or outputs, or where externalities such as noise and visual disamenity affect employees and customers.

[1] Technological externalities (e.g. environmental impacts) have a net impact on bottom-line CBA results (NPV and BCR). Pecuniary externalities (transmitted by the market mechanism) are transfers between one party and another and have no impact on CBA results.

3.2 Distributional impact vs equity

Distributional impact and equity have different meanings in this guidance.

- Distributional impact assessment (DIA) (discussed in chapter 4) is an objective (in the sense of fact-finding) exercise. It identifies and describes how the benefits and costs of a transport initiative are split among demographic groupings such as income, age, and locality. It says nothing about whether these outcomes are desirable or undesirable.
- Equity (discussed in chapter 5) in the context of transport initiatives refers to making judgements about the fairness with which impacts (benefits and costs) are distributed. It is not a mechanical process but involves making subjective judgements about whether distributional impacts are good or bad (Nunns et al. 2019, p. 16; Litman 2022, Waka Kotahi NZTA 2021).[2] Based on value judgements, it determines the normative desirability of distributional impacts identified by the DIA. As such there is no formal equity assessment process to be undertaken by analysts. However, to support decision-makers, analysts should seek to collate the results of the DIA in a way that highlights impacts that might raise equity concerns based on widely-accepted notions of equity and on explicit jurisdictional goals and objectives.

3.3 Distributional versus social impact assessment

DIA differs from Social Impact Assessment (SIA). Social impacts are the likely consequences for individuals or a community of implementing a particular course of action. Distributional impacts relate narrowly to changes in economic welfare. There is some overlap.

The *International principles for social impact assessment* defines SIA as "the processes of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment" (Vanclay 2003). It is common practice (and may be required by legislation) to undertake a SIA in conjunction with an Environmental Impact Statement (EIS) process for major transport initiatives.

SIA identifies and assesses potential social impacts for an area and the community of an initiative, both positive and negative, that affect or concern people, whether directly or indirectly. A social impact is something that is experienced or felt in either a perceptual (cognitive) or corporeal (bodily, physical) sense, at any level, for example at the level of an individual person, an economic unit, a social group, a workplace or by community or society generally (IAIA 2015, p. 2).

In the transport context, SIA 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

[2] All types of analysis require subjective judgements about assumptions, tolerances, methodologies and what is important and what is not. DIA is an exercise in 'positive economics'. It is concerned with facts — descriptions, quantification, explanations — that can be proved or disproved. The term 'subjective' here relates to 'normative economics'. It is concerned with opinions and judgements about what ought or ought not to be. Such statements can neither be proved or disproved.

- An examination of measures available to ameliorate adverse impacts. Sinclair Knight Merz (1998)

Assessment of social impacts relies on community input to gain an understanding of community concerns, values and aspirations. As such, SIA processes and community consultation are inextricably linked (Sinclair Knight Merz 1998, IAIA 2015).

The data required to undertake a SIA process come from community consultation campaigns. It is useful to begin the participation process early in the planning process and carry on throughout the life of individual initiatives. In many transport agencies, community participation/consultation is also a legislative requirement, meaning that an initiative cannot proceed beyond the planning stage without adequate consultation with the community. The support of the community is often needed to ensure successful implementation of a transport initiative and may be a consideration in the Strategic Merit Test.

Note that, in many cases, the SIA is only undertaken after a decision about the initiative has already been made, as part of producing an Environmental Impact Statement. This may limit the influence of social impacts on an initiative.

ATAP Part T5 covers only DIA. The UK Department for Transport publishes separate DIA and SIA guidelines (UK DfT 2020 and 2022). ATAP may develop separate SIA guidance in the future. Several Australian jurisdictions publish guidance on SIA (e.g. NSW Department of Planning and Environment 2021, Queensland Coordinator-General 2018). IAIA (2015) is a useful resource.

3.4 CBA vs distributional impact and equity

A CBA is a form of economic analysis that assesses the benefits and costs (economic, social and environmental) of a proposed option. Benefits and costs for use in the CBA are estimated by comparing changes between the Base Case (the situation without the option) and the Project Case (the situation with the option improvement).

CBA aims to identify and express, in monetary terms, all the gains and losses (benefits and costs) created by an option to all members of society, and to combine the gains and losses into a single measure of net benefit (benefits minus costs). If the result, expressed as a net present value, is positive — that is, total benefits exceed total costs — implementation of the option will be an economically efficient use of resources — Australia, *as a whole*, will be better off. The words ‘as a whole’ are emphasised because there will be losers as well as gainers. A positive result from a CBA means that the total gains exceed the total losses.

Non-monetised benefits and costs are considered and presented alongside the monetised results. (ATAP Part T2 Cost–benefit analysis)

In brief, CBA is concerned with economic efficiency, or the size of the pie. Distributional impacts and equity are concerned with how the pie is divided up.

CBA seeks to determine whether a ‘potential Pareto improvement’ exists. A Pareto improvement occurs where one or more people are made better off without simultaneously making anyone else worse off. Such a criterion is of little practical use because it cannot compare situations where some are better off and others worse off. No initiative changes the size of the pie without also changing the way it is divided up — there are inevitably winners and losers. The less restrictive Kaldor-Hicks compensation criterion asks whether the gainers from a change could compensate the losers out of their gains and still have something left over. In other words, it asks whether a Pareto improvement could *potentially* occur. Compensation of the losers by the gainers would be necessary to convert a potential Pareto improvement into an actual Pareto improvement. But such compensation is hypothetical. If attempted in practice, the administrative costs of transferring funds from winners to losers could jeopardize project’s overall benefit (Adler and Posner 1999).

CBA therefore tests whether an initiative is likely to meet the Kaldor-Hicks criterion and hence lead to improvement in economic efficiency. It adds benefits and costs regardless of to whom they accrue. With compensation ruled out as impractical, a potential Pareto improvement could have distributional impacts that many would regard as undesirable or unacceptable. Hence, the need for CBAs to be accompanied by DIA and consideration of equity.

That is not to say that all transport initiatives assessed will raise distributional concerns. The justification for undertaking a DIA is to check whether the distributional impacts are significant, and if so, to bring them to the attention of decision-makers. The decision-makers will then make the necessary value judgements about whether the distributional impacts are inequitable or not, and whether they can be mitigated or whether the overall gain to society (the gain in economic efficiency) justifies the sacrifice of equity if the initiative proceeds.

In some jurisdictions, a distributional impact assessment is required as part of a CBA (e.g. required by NSW Treasury and TfNSW CBA guides).

3.5 Recommended approach

The next two chapters discuss the recommended approach for practitioners to use. First, here are some broad underlying principles.

3.5.1 Principles

The principles outlined below should guide the consideration of distributional impact and equity effects. They have been compiled with reference to the recommendations of key Government agencies in Australia and overseas (summarised in Appendix A).

- Decision-makers need information about the distributional impacts of initiatives, particularly where they are significant, and where they relate to transport-disadvantaged, low-income and minority groups and other groups mentioned in a jurisdiction's stated transport goals and objectives.
- The assessment of distributional impacts and equity effects should complement, and be presented alongside, the CBA results in the business case
- The CBA is a key source of information for the DIA. When using the CBA outputs in the DIA:
  - Consider which costs and benefits will be widely and thinly spread across the population and therefore do not give rise to distributional questions of any significance
  - Consider which groups experience significant benefits or costs
  - Consider whether the incidence of these costs or benefits is likely to shift to another group.
- It can be helpful to use tables, maps, diagrams and charts to illustrate gains and losses by the relevant groups and their scale
- Any subjective judgements on equity should be made very clear, and kept separate from objective distributional impact descriptions
- Decisions about whether to proceed with an initiative and the preferred option are for the decision-maker to make. They may involve value judgements and potential trade-offs between the results of the CBA (economic efficiency focus) and distributional and equity effects. The analysts can, however, assist the decision-maker by presenting objective information on distributional impacts, highlighting where equity issues are likely to arise. However, to support decision-makers, analysts should seek to collate the results of the DIA in a way that highlights impacts that might raise equity concerns based on widely-accepted notions of equity and on explicit jurisdictional goals and objectives.

- The level of assessment should broadly match the scale and complexity of the project, and the likelihood that the impacts raise distributional concerns, for example, affecting socially disadvantaged groups. The DIA can range from a simple descriptive assessment to an advanced monetised quantitative assessment. A detailed, comprehensive DIA can be costly and time consuming, and all the relevant information is unlikely to be available. Each jurisdiction will need to determine the appropriate level of assessment for their circumstances.
- Monetised assessment is preferable. Where not possible, a quantitative non-monetised assessment is the next preference (e.g. numbers of households affected, decibels of noise). In the absence of quantitative information, the assessment should be presented in qualitative terms.
- As a general rule, the use of distributional weights in CBA is not advised, leaving distributional judgments to be made at the political level. However, if distributional weights are used:
  - Two sets of results should be presented: with and without use of weights.
  - A clearly documented, transparent 'adjusted CBA' should be presented. See ATAP Part T2 Cost–benefit analysis, Chapter 12 on 'adjusted CBA'.
- Where an option is presented on distributional impact or equity grounds, the decision-maker should be advised of the efficiency cost (in terms of loss of net benefits compared to the option with the greatest net benefits or with the base case).
- Transport projects are generally not a good way to redistribute income, or to meet the primary objectives in another sector (e.g. health). This is usually better done through the tax system and provision of social services, or directing greater resources to education, health, or policing in particular locations. However, it is acknowledged that government budgetary systems make it difficult to shift funds between portfolios.
- Some transport services and infrastructure, in particular, public transport services and regional roads, are seen as necessary to meet basic needs of users. They might be categorised as 'merit goods'. Merit goods are goods that would be under-consumed in a free market economy because, at least in the opinion of decision-makers, they create positive externalities or individuals do not recognise the full benefit to themselves from consuming the good. (Musgrave 1957, pp. 12-15)
- Undesirable distributional impacts of options may be reduced by including mitigation measures as part of the options. For example, additional accessibility measures may need to be included in a project that generates severance effects. Another is rebates on road tolls based on income.

3.5.2 Process

Size of distributional impacts

Benefits and costs of transport initiatives can be widely and thinly spread. In many cases, large proportions of the benefits from transport initiatives end up being very widely dispersed so there are no distributional impacts worthy of note. Examples are:

- Where the project benefits transport users with a wide range of origins and destinations so the benefits are spread widely in geographic terms and across industries. In urban areas, this effect can be enhanced by the operation of Wardrop's principle whereby trips attracted to improved roads reduce congestion on many other roads in a network benefiting trips between a much larger number of origin-destination pairs than those using the improved roads, but only by small amounts. Transport models would identify and quantify these effects. Further redistribution of benefits may be found if land-use changes are modelled.

- Reductions in transport costs for freight and business trips can be passed on in the form of higher wages for workers, higher profits for businesses, lower prices for consumers and higher tax receipts for governments. Where they improve international competitiveness, increasing exports and reducing imports, they lead to a stronger exchange rate, which improves the purchasing power of all Australians to buy foreign goods and services (ATAP Part T2, Box 17).

The last example raises the question of 'incidence'. The term 'incidence' is mainly used in the context of the economics of taxation in relation to how the burden of a tax is distributed among firms and consumers or employers and employees. For example, a tax on production paid by producers will be passed on, in part or in total, to consumers. In a competitive market, the division of the tax or the incidence between producers and consumers depends on elasticities of supply and demand. User benefits from a transport improvement accruing to commercial vehicles and business car travellers will not necessarily be retained by truck operators and employers. The benefits may, in part or in total, be passed on in higher wages to employees and lower prices to consumers. Part of the benefits from a new light rail service gained by local residents could be capitalised into land values and end up benefiting land owners.

Analysts need to consider each category of benefit and cost and make judgments about who will ultimately receive them and whether the impacts are widespread or concentrated on particular groups. If there are no significant concentrations of benefits and costs, the analyst should make a case that the distributional impacts do not need to be considered further. Otherwise, a more detailed assessment is needed.

Relationship to ATAP assessment framework

Distributional impacts should be considered from the earliest stages of option development and assessment. This will reduce the risk of expending resources to develop and assess an option that is later ruled out of contention by distributional impact issues.

In line with the ATAP Framework (summarised in the ATAP Guidelines Overview under 'About'), societal, whole-of-government and transport system goals and objectives will have been identified before any assessment begins. Some of these may relate to distribution and equity. Widely-accepted notions of equity should also be considered where they are not explicit in stated goals and objectives. Chapter 5 of this guideline aims to give a sense of what these notions of equity are. ATAP Part F1 *Goals, objectives and targets* gives as examples of social goals and objectives; fairer distribution of income, social cohesion and inclusion, equity between geographic areas (for example, in access to services and jobs), and reducing social and economic disadvantage.

As described in Chapter 2, the ATAP assessment model comprises three stages:

- Strategic merit test (SMT): To assess alignment with objectives and feasibility.
- Rapid appraisal: To reduce the long list of options to a short list (or for small projects).
- Detailed appraisal: To select a preferred option from the short-list.

Distributional impacts should be considered at each stage. The depth of the assessment will increase with each stage and there will be more information available from the economic assessment at each stage to support the DIA.

The strategic merit test (SMT) stage in the ATAP assessment process is an early opportunity to consider whether an option has significant distributional impacts and if so, whether the impacts support or detract from stated goals and objectives. The SMT checks how well an option aligns with jurisdictional economic, environmental and social goals, transport system objectives, and approved strategies and policies. See ATAP Part F3 *Options generation and assessment* for discussion of the SMT. The SMT employs an Objective Impact Table for reporting an option's contribution to achieving the goals and objectives. The SMT can lead to some options being dropped from further consideration. Unacceptable distributional impacts (e.g. a toll road within a low socio-economic spatial region) could be a reason for an initiative or option failing the SMT. An option that fails the SMT may however pass once it is redesigned (e.g. rebates on a toll road based on income).

In the SMT stage, an initial understanding should be gained, through a high-level indicative assessment, of whether an option is likely to have any significant distributional impacts.

The SMT is also an opportunity to check whether an option complies with legal frameworks such as the *Disability Standards for Accessible Public Transport 2002 (Cth)* and safety and environmental standards set by governments.

The three steps of the DIA methodology described in Chapter 4, based on the UK DIA process, and the three ATAP assessment stages do not align. All three DIA steps should be implemented for the each of the SMT, rapid and detailed appraisal stages of the ATAP assessment model. The level of detail in the DIA will be greater at each stage and more supporting quantitative information should be available.

Project size

For small projects and projects at the SMT and rapid CBA stages, a purely qualitative DIA should suffice. The level of detail and extent of quantification should be proportionate to the size of the project. As proportionality applies to CBAs, a greater depth of information will be available for larger projects to support the DIA in each assessment stage.

4. Distributional impact assessment methodology

4.1 Overall approach

This chapter outlines broad guidance for undertaking a distributional impact assessment (DIA) as a complement to the CBA. It draws much from the detailed guidance provided by the UK Government (UK DfT 2020). A standardised system of DIA for transport initiatives is not established in Australia at this point in time. In the absence of an Australian approach, practitioners are directed to the well-established and documented UK Department of Transport (2020) approach (TAG A4.2). While it has features unique to the UK, the principles and robustness of the approach make it a sound foundation for Australian DIAs. The UK approach is sufficiently summarised below to give Australian practitioners an overall understanding to enable them to broadly apply it. Some modifications have been made to the UK approach to suit Australian conditions and terminology.

In the UK in 2009, eight distributional impact indicators were nominated around which a national approach to transport distributional impact assessment (DIA) could be developed. Associated guidance was subsequently released in 2011 and has since received several rounds of updates, culminating in the present TAG A4.2 unit (Atkins and MVA 2010). The DIA is a mandatory part of the UK appraisal process, and is reported in the UK Appraisal Summary Table (AST).

The UK approach uses the following eight distributional impact (DI) indicators:

- user benefits
- noise
- air quality
- transport safety
- personal security
- severance
- accessibility
- personal affordability.

An explanation for each indicator in given in Table 1, The DIA approach uses three-steps:

- Step 1: Screening process
- Step 2: Assessment of impacts on identified groups
- Step 3: Appraisal of impacts on identified groups.

An overview of these three steps is provided in the next three sections. A key part of the outputs of the process is a series of completed tables. In the discussion below, where a table has been completed, the entries are illustrative only.

4.2 Step 1: Screening Process

Step 1 uses an easy-to-apply qualitative screening proforma (see Table 1 below) that identifies the likely broad impacts of the transport initiative, and whether the assessment needs to proceed further. This helps ensure a proportionate assessment for the initiative.

The proforma is completed for each indicator by considering the appraisal output criteria to determine if any potential impacts of the intervention are expected.

Table 1 Screening proforma

Scheme description:				
Indicator	**Appraisal output criteria**	**Potential impact** (yes / no, +'ve / –'ve if known)	**Qualitative Comments**	**Proceed to Step 2** (yes/no)
User benefits	Note the user benefits from the CBA, and consider which user benefits are likely to display distributional impacts (e.g. benefits are concentrated).			
Noise	Any change in alignment of transport corridor or any links with significant changes (>25% or <-20%) in vehicle flow, speed or % heavy vehicles content.			
Air quality	Any change in alignment of transport corridor or any links with significant changes in vehicle flow, speed or % heavy vehicles content • Change in 24-hour AADT of 1000 vehicles or more • Change in 24-hour AADT of heavy vehicles of 200 heavy vehicles or more			
Safety	Any change in alignment of transport corridor (or road layout) that may have positive or negative safety impacts, or any links with significant changes (>10%) in vehicle flow, speed, % heavy vehicles content or any significant change (>10%) in the number of pedestrians, cyclists or motorcyclists using road network.			
Security	Any change in public transport waiting/interchange facilities including pedestrian access expected to affect user perceptions of personal security.			
Severance	Introduction or removal of barriers to pedestrian movement, either through changes to road crossing provision, or through introduction of new public transport or road corridors. Any areas with significant changes (>10%) in vehicle flow, speed, % heavy vehicles content.			
Accessibility	Changes in routings or timings of current public transport services, any changes to public transport provision, including routing, frequencies, waiting facilities (bus stops / rail stations) and rolling stock, or any indirect impacts on accessibility to services (e.g. demolition & relocation of a school).			
Affordability	In cases where the following charges would occur; Parking charges (including where changes in the allocation of free or reduced fee spaces may occur); Car fuel and non-fuel operating costs (where, for example, rerouting or changes in journey speeds and congestion occur resulting in changes in costs); Road user charges (including discounts and exemptions for different groups of travellers); Public transport fare changes (where, for example premium fares are set on new or existing modes or where multi-modal discounted travel tickets become available due to new ticketing technologies); or Public transport concession availability (where, for example concession arrangements vary as a result of a move in service provision from bus to light rail or heavy rail, where such concession entitlement is not maintained by the local authority.			

Source: Modified from UK DfT (2020), pp. 67-8.

The screening process seeks to:

- Identify impacts of the intervention
- Identify the materiality of those impacts
- Determine whether those impacts are concentrated on particular groups.

Due to the nature of the appraisal process, much of the data available to screen potential distributional impacts may not be available until a later stage of the appraisal process. As it will be difficult to predict which indicators will need to be assessed until all the information is available, an appropriate timescale needs to be allowed for the assessment.

The output of step 1 is a completed screening proforma along the lines of Table 1.

Where the expected impacts are marginal and dispersed among many demographic groups or spatially, it may be acceptable not to continue to step 2 for that indicator. In these cases, a justification of the decision not to proceed to step 2 should be reported.

4.3 Step 2: Initial assessment

Step 2 has four components

- 2a — Confirmation of areas impacted by the initiative
- 2b — Identification of each social group in the impact area
- 2c — Identification of amenities in the impact area.
- 2d — Identification of impacted vulnerable transport user groups

As a preliminary step, tabulating the results of the CBA in a disaggregated manner can provide an initial perspective on who gains and who loses. For example, Box 1 shows how Eliasson (2008) presented the results of a CBA of congestion pricing in Stockholm. The breakdown of the results into components in tabular form can separate out net benefits accruing to private cars, business cars, freight, public transport users, governments, and third parties (externalities).

For transport initiatives, the location of people's activities plays a large role in the extent to which they are affected, hence the spatial focus of DIA. **Step 2a** investigates the spatial footprint of an initiative. For each indicator, the geographical area experiencing impacts needs to be defined. The impact area will vary for each indicator. The impacts may be localised (e.g. noise), while the impacts for other indicators may be more wide spread (e.g. user benefits, accessibility).

Showing the impacts spatially helps visualise the winners and losers from a project, e.g. using GIS mapping functionality. Several approaches are illustrated here. The example in Figure 1 is a spatial mapping of benefits for an initiative on a Perth freeway, using outputs from a 4-step strategic transport model. It shows the total quantum of benefits at a disaggregated link-based level across the metropolitan area. It demonstrates that the project has significant benefits on some links and disbenefits on others. For the geographical area in which links are located, the display also indicates the benefits and disbenefits for local traffic. Visual displays such as this help decision-makers understand the geographical dispersion of impacts across the network of a transport project. This display could also be generated for separate benefit components: travel time, vehicle operating cost and safety benefits, and/or private cars, business cars and freight.

Box 1 Distributional impacts drawn from CBA results breakdown

CBA results can be presented in a manner that highlights societal groups who benefit and lose from a transport initiative. This is illustrated in Table 2 below, showing the cost and benefits of the 2006 Stockholm congestion charging trial (Eliasson 2008).

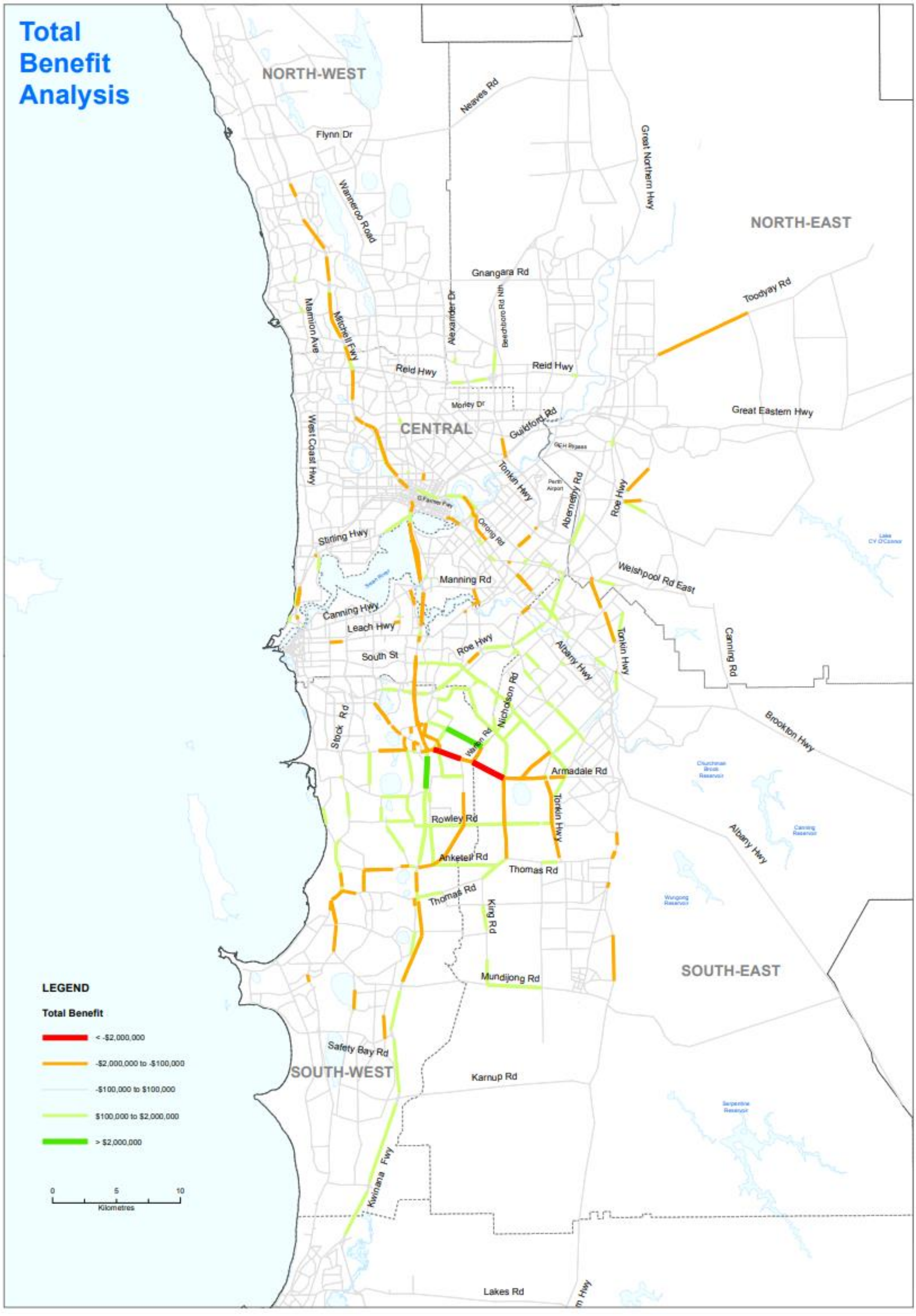
Table 2 Cost and benefits of Stockholm Trial

		Loss/gain (million Swedish krona per year)
Consumer Surplus`	Shorter travel times	536
	More reliable travel times	78
	Loss for evicted car drivers and gain for new car drivers	-74
	Paid Congestion charges	-804
	Increased transit crowding	-15
	Consumer surplus, total	-279
Externalities	Reduced greenhouse gas emissions	64
	Health and environmental effects	22
	Increased traffic safety	125
	Externalities, total	211
Government costs and revenues	Paid congestion charges	804
	Increased public transit revenues	138
	Decreased revenues from fuel taxes	-53
	Increased public transport capacity	-64
	Operational costs for charges system	-220
	Government costs and revenues, total	606
Tax effect	Marginal costs of public funds	182
	Correction for indirect taxes	-65
	Tax effects	117
Net social benefit, excluding Investment cost		654

Source: Eliasson 2008, p13, (also discussed in ATAP O6).

Presenting the CBA in this tableau format shows that the Stockholm system yields a large social surplus after covering investment and operational costs, yet it also shows there are losers from this project. The way in which groups are defined can affect the analysis. The example in Table 2 for the Stockholm congestion charging trial does not show how the consumers' surplus changes are split up among people with different incomes, and hence different values of time. Congestion pricing schemes benefit people with high values of time, because the value of their time savings exceeds the congestion charges they pay. A further breakdown of consumers' surplus benefits by income band would be instructive.

Figure 1 Perth freeway example: Benefits by link



Step 2b requires analysis of the socio-economic, social and demographic characteristics of several categories of people:

- **Transport users** who will experience changes in travel generalised costs resulting from the intervention
- **People living in the area** of the transport initiative who are impacted even if they are not users
- **People travelling** in areas identified likely to be affected by the initiative.

Analysis of the characteristics of transport users should reflect, and be based on, travel demand estimation and modelling (see ATAP Part T1). The associated assessment of user benefits and costs should be based ATAP Parts F3, T2 and mode-specific guidance (M1 to M5).

For resident populations in the impact area likely to be affected by the intervention, a summary table as in Table 3 can show, across different groups, which indicators are likely to be relevant. The table indicates the aspects that will require assessment. Note that not all aspects need to be considered for each group, as only some will be relevant. The markings only indicate that there is an impact requiring further assessment. They do not indicate the direction or size of the impact.

The first five rows divide the impacted population into income quintiles. Other splits might be used or alternatively, one of the SEIFA indexes split into a number of bands. After the high-income groups in the first few rows, Table 3 shows only disadvantaged groups. While maintaining the focus on disadvantaged groups, analysts should feel free to vary the number and the headings of the rows. For example, a row might be added for small businesses.

The initial assessment will be qualitative, based on judgement combined with knowledge of the locations of gainers and losers and their characteristics (income, socio-economic advantage or disadvantage, demographic characteristics). Note that impacts of externalities on high-income groups are noted in Table 3 and in tables below. Negative impacts on better-off people are a concern where they affect their health and comfort as explained in Chapter 5.

Spatial mapping can be helpful. For example, Figure 2 shows spatial maps with degrees of coloured shading representing three different impact perspectives for a hypothetical project:

- Panel 1: Showing aggregated net benefits by Perth metro suburb
- Panel 2: Using the ABS Index of Relative Socio-Economic Advantage and Disadvantage, one of the four indexes in the Socio-Economic Indexes for Areas (SEIFA), the map shows areas of disadvantage across Perth
- Panel 3: A distributional impact map plotting areas with high benefits and high relative disadvantage, i.e. those with low ABS SEIFA scores.

The SEIFA consists of four indexes:

- index of relative socio-economic disadvantage
- index of relative socio-economic advantage and disadvantage
- index of education and occupation
- index of economic resources.

Each of the four indexes summarise a different subset of Census variables and focuses on a different aspect of socio-economic advantage and disadvantage. Each index captures a slightly different aspect of relative advantage and/or disadvantage and is constructed using different variables. It is therefore likely that a given area may have a different ranking across each index. For example, an area may rank relatively poorly in the ‘Disadvantage index’ but not in the ‘Advantage and Disadvantage index’, because these indexes include different variables (Australia Bureau of Statistics, 2022).

Further details are available from the ABS website.

Table 3 Checklist for socio-demographic analysis: residential populations

Social group — resident population in impact area Cells marked with ■ indicates distributional impact analysis required	User benefits	Noise	Air quality	Safety	Security	Severance	Accessibility	Affordability
Income group (can be split into income quintiles or other bandwidths; can use a SEIFA index split into ranges as well or instead)	■	■	■				■	■
Income quintile 80%–100%	■	■	■				■	■
Income quintile 60%–80%	■		■				■	■
Income quintile 40%–60%	■		■				■	
Income quintile 20%–40%		■	■				■	
Income quintile 0%–20%		■	■				■	
Children aged <16		■	■	■	■	■	■	
Young adults: aged 16-25				■			■	
Older people: aged 70+		■		■	■	■	■	
People with a disability					■	■	■	
First nations people					■		■	
Recent migrants								■
Households without access to a car						■	■	
Carers: proportion of households with dependent children							■	

Note: To create the 'halfwidth black square' character ■ in MS Word to complete this and the next table, type the Unicode number 25A0 (Note, the last character is a zero, not a capital 'O'.), select all four characters, then press the 'Alt' and 'x' keys together. The character can then be copied and pasted as required.

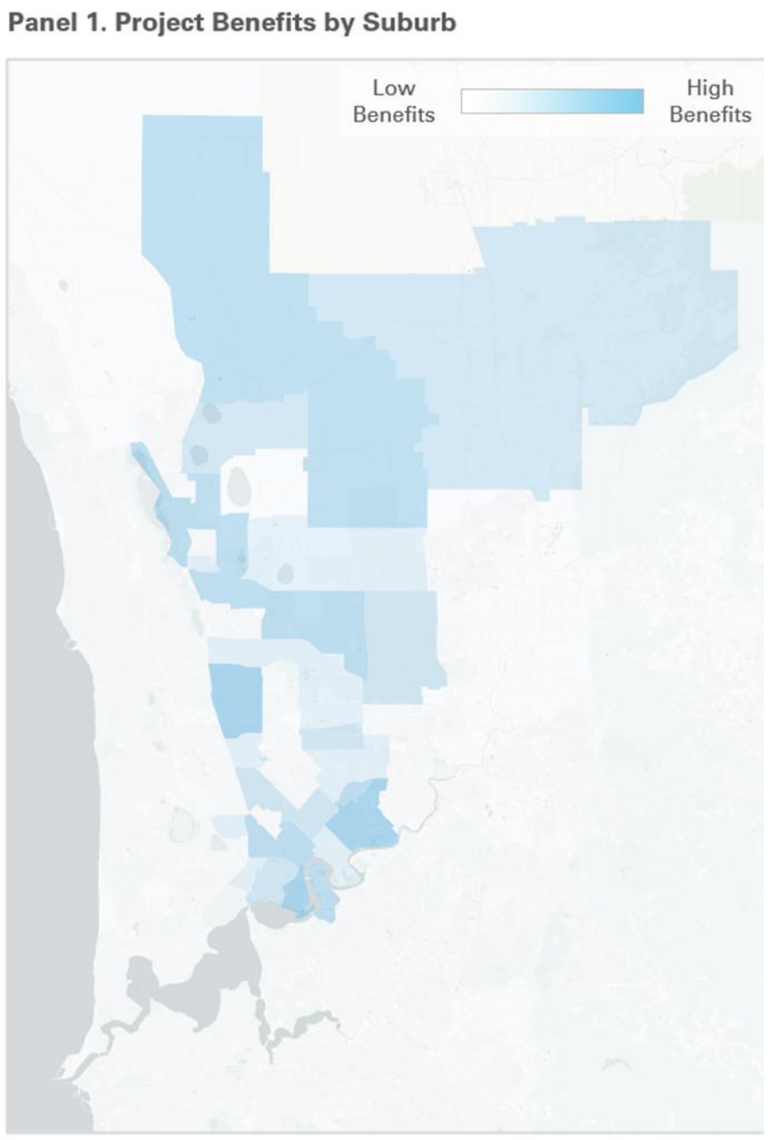
Source: Modified from the UK DfT (2020) Table 2, pp. 6-7 and upper section of Table 4, p. 12.

Figure 2 displays visually the geographical dispersion of transport benefits. Panel 1 shows the benefits of a transport initiative aggregated by suburb. It was derived by linking strategic modelling of origin–destination zones to SA2 areas. Panel 2 presents SEIFA data showing the Index of Relative Socio-Economic Disadvantage (IRSD). Panel 3 combines benefits with SEIFA data to show distributional impacts of a project in terms of where net benefits accrue to low IRSD areas (i.e. relative disadvantage areas).

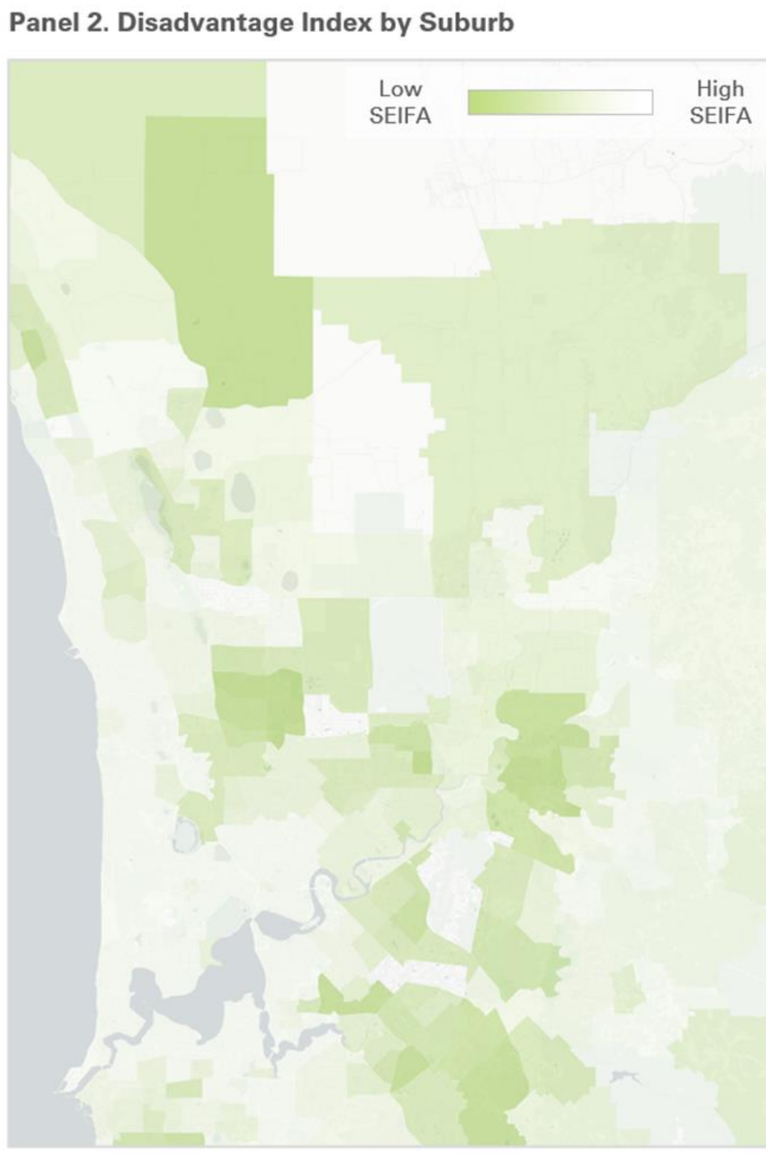
Where transport benefits are allocated to spatial units and conclusions drawn based on demographic characteristics of those units such as average income or SEIFA index, care should be taken that there is not too much heterogeneity within each spatial unit. The size of spatial units and location of boundaries can conceal distributional impacts of interest where the boundaries group together people with quite different socio-economic characteristics or people affected in quite different degrees by the transport initiative. (UK DfT 2020, p. 18)

There may be other ways besides residential location to obtain information on the socio-economic characteristics of gainers and losers from a transport initiative such as surveys of users or transport models that distinguish between users based on income.

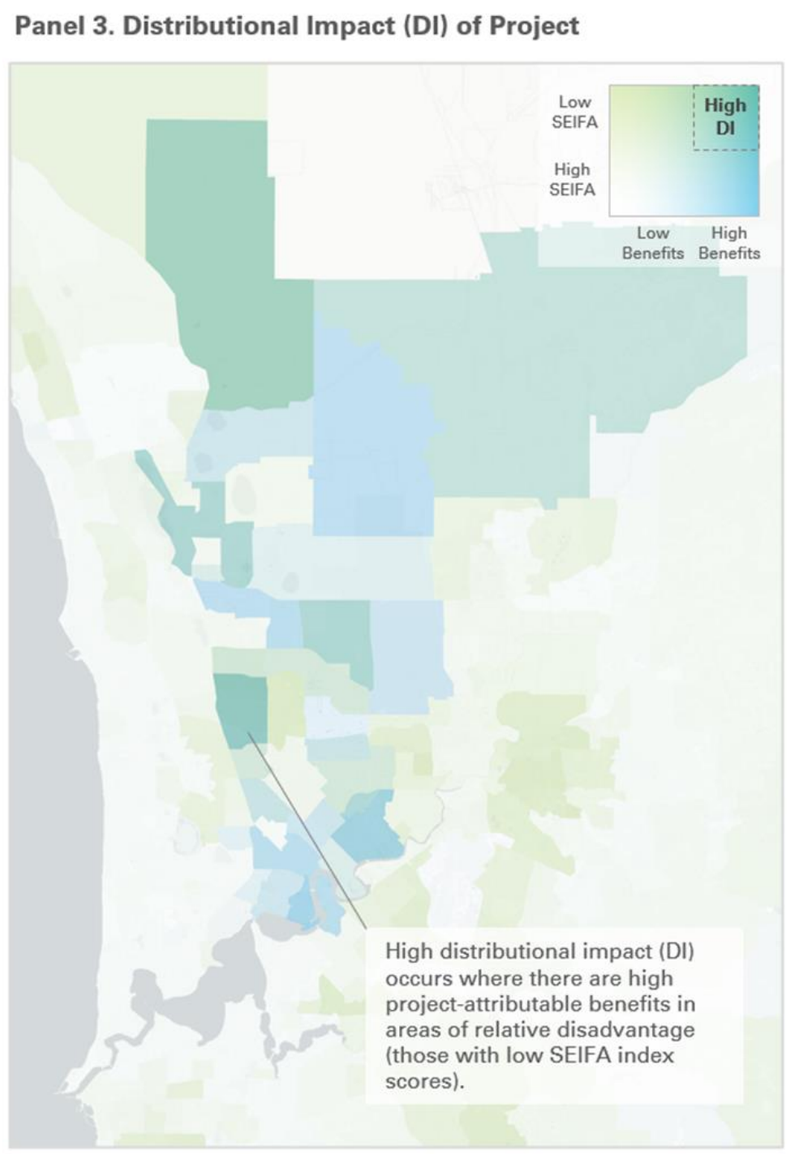
Figure 2 Spatial mapping



Source: Deloitte, DTEM



Source: Deloitte, DTEM



Source: Deloitte, DTEM

The next component of the Initial Assessment, **Step 2c**, uses information about trip attractors and amenities within the impact area that are likely to be used by impacted social groups. Resident populations considered in step 2b are not the only concentrations of social groups in an area. For example, an area containing a school will have children travelling in and out of it from other areas. An understanding of the trip attractors and amenities in an area can add value to the DIA by allowing the assessment to go beyond just the resident population.

For trip attractors and amenities in the impact area likely to be affected by the intervention, a summary table as in Table 4 can show, across different groups and type of amenity, which indicators might be relevant. The table indicates the aspects that may require assessment. The markings in Table 4 are a hypothetical illustration.

The list of types of trip attractors and amenities in Table 4 is not exhaustive. Analysts are free to add and remove rows and change the headings. The rows for tertiary education institutions, shops and other workplaces (offices, factories, farms) do not appear in the UK original.

Table 4 Checklist for socio-demographic analysis: trip attractors and amenities

Trip attractors and amenities present in impact area Cells marked with ■ indicates distributional impact analysis required	User benefits	Noise	Air quality	Safety	Security	Severance	Accessibility	Affordability
Schools, pre-schools		■	■				■	■
Tertiary education institutions	■					■	■	
Playgrounds		■					■	
Parks, open spaces, sporting facilities		■			■	■	■	
Hospitals / health centres					■		■	
Age care facilities			■					■
Community centres						■	■	
Shops							■	
Other workplaces (offices, factories, farms)								

Source: Modified from the UK DfT (2020) lower section of Table 4, p. 12.

The final component, **step 2d**, is not in the UK guidance but is a precursor to constructing the DIA appraisal matrix shown in Table 8 below. It requires consideration of impacts on vulnerable transport users using a template as shown in Table 5. The motor cyclist and young male driver groups shown in Table 5 are relevant for road projects. The groups might be different for a public transport project, but should not repeat groups already listed in Table 3 as resident populations.

The output of step 2 should be a number of tables along the lines of Tables 3, 4 and 5 above or a single table combining them, accompanied by summary text addressing:

- How the initiative impacts the different social groups (Table 3), groups using amenities (Table 4) and vulnerable transport user groups (Table 5)
- The sources of the information presented, in particular whether it is based on data, modelling, local knowledge or qualitative judgment.

- Sources of any data presented
- Any other aspect of the results to ensure clarity, including maps.

Table 5 Checklist for socio-demographic analysis: Vulnerable transport users

User group Cells marked with ■ indicates distributional impact analysis required	User benefits	Noise	Air quality	Safety	Security	Severance	Accessibility	Affordability
Pedestrians		■	■	■		■	■	
Cyclists			■	■		■	■	
Motor-cyclists	■			■			■	
Young male drivers				■				

Source: Modified from the UK DfT (2020) Table 2, pp. 6-7 and lower section of Table 6, p. 15.

4.4 Step 3: Appraisal

Step 3 involves an appraisal of the impact of the intervention on each social group and road user group for each indicator identified as relevant in step 2.

Step 3a involves scoring the various impacts. Table 6 below provides a scoring guide. The score relates to the impact on the average individual within a social group, The terms 'large', 'moderate' and 'slight' are left to the analyst to interpret. The size of the group, whether in absolute terms or relative to the whole population is irrelevant, only the impact on the average individual member. However, the accompanying qualitative discussion would address the sizes of groups, highlighting cases where larger numbers of people are impacted. Cases where very small numbers of people are affected should not be ignored.

Table 6 Guide for scoring distributional impacts

Impact	Assessment
Beneficial and the impact on the average member of the group is large.	Large beneficial ✓✓✓
Beneficial and the impact on the average member of the group is moderate.	Moderate beneficial ✓✓
Beneficial and the impact on the average member of the group is slight.	Slight beneficial ✓
Neutral and the impact on the average member of the group is not significant.	Neutral 0
Adverse and the impact on the average member of the group is slight.	Slight adverse ✕
Adverse and the impact on the average member of the group is moderate.	Moderate adverse ✕✕
Adverse and the impact on the average member of the group is large.	Large adverse ✕✕✕

Note: To create ticks and crosses in MS Word to the subsequent tables, type the Unicode number 2713 for a tick ✓ or 2715 for a cross ✕, select all four digits, then press the 'Alt' and 'x' keys together. The character can then be copied and pasted as required.

Source: Modified from UK DfT (2020), p. 13.

Using Table 6, an assessment score is determined for each indicator and each demographic group and amenity under consideration. In addition, a qualitative statement should be provided for each indicator to describe the key impacts in each case. The scores and qualitative assessments can be based on data and models or qualitative judgement, depending on size and stage of the CBA and availability of data and model outputs.

Tables 7 and 8 show a way to summarise the core analysis of impacts adapted from UK DfT (2020). Table 7 shows consideration of the impacts on people grouped by income quintiles. Table 7 groups people by income quintiles for each of the eight indicators. Different income splits or SEIFA index bands might be used instead in income quintiles. It is advisable to look at the socio-demographic profile for all indicators unless there is a strong case not to. For example, if the only significant distributional impact is user benefits, it may only be necessary to prepare mapping of the distribution of different income or SEIFA groups in the impact area. If accidents have been identified as being a relevant impact, it may be necessary to prepare mapping of the proportions of children, young adults and older people within the impact area.

Table 8 focuses shows consideration of the eight indicators for disadvantaged or vulnerable groups — social groups and road user groups. A qualitative assessment can be provided for each indicator to describe the key impacts. The matrix can give a detailed picture of the 'winners' (marked by ticks ✓) and 'losers' (marked by crosses, ×) from a transport initiative, and the key issues of relevance.

As noted on the ABS website, SEIFA indices are available for calculating the proportions of people in different social groups across impact areas. If available, local datasets from different official sources can be used to develop a more detailed understanding of the specific local issues within the impact area. The most recent data should be used.

Table 9 sets out an alternative set of variables for socio-demographic analysis from an Australian source. Austroads (2005) notes that 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 impact studies. The major reason for this is that such data are collected regularly, systematically, and are readily available through the Australian Bureau of Statistics which undertakes 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).

If an appraisal summary table (AST) is used (see ATAP Part F3), an overall assessment score for each indicator should be recorded in the AST together with any supporting information the appraisal provides that can be fitted into the AST.

Table 7 DIA appraisal matrix by income quintile

Impact	Distributional impact by income quintile					Are the impacts distributed evenly? (yes/no)	Key impacts — Qualitative statements (example below)
	0-20%	20-40%	40-60%	60-80%	80-100%		
User benefits	✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓ ✓	no	Although benefits are felt by all income quintiles, the benefits favour those in the least deprived income quintiles. Those in the least deprived income quintile (income quintile 5) experience a considerably higher than expected proportion of benefits, whereas those in the most deprived areas (quintile 1) experience a smaller than expected proportion of benefits.
Noise	✗✗✗	✓	✓ ✓ ✓	✓ ✓	✓ ✓ ✓	no	Noise impacts favour those in the least deprived income quintiles. Those in the most deprived income quintile experience noise disbenefits, whereas all other income quintiles experience benefits of the intervention
Air quality	✓ ✓ ✓	✓ ✓	✓	✗✗	✓	no	Air quality impacts favour residents in the most deprived income quintiles. Those in the most deprived income quintile (quintile 1) that may be considered to be the most vulnerable experience a considerably higher proportion of air quality benefits than may be expected from an even distribution. Residents living in income quintile 4 experience air quality disbenefits
Safety	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	yes	Safety impacts are appraised a moderately beneficial for all of the income deprivation quintiles and therefore the impact is distributed evenly.
Security	0	0	0	0	0	yes	There are no significant security impacts.
Severance	✗	✗	✗	✗	✗	yes	Severance impacts are appraised a slight adverse for all of the income deprivation quintiles and therefore although the impact is adverse the impact is distributed evenly.
Accessibility	✗	✗	✗	✗	✗	Yes	Accessibility impacts are appraised as slight adverse for all of the income deprivation quintiles and therefore although the impact is adverse the impact is distributed evenly.
Affordability	✗✗	✗	✗✗	✓	✓ ✓	No	Personal affordability benefits favour those in the least deprived income quintiles. Those in income quintiles 4 and 5 experience benefits in terms of affordability, whereas those in the least deprived income quintiles (who may be the most vulnerable) experience disbenefits as a result of the intervention.

Table 8 DIA appraisal matrix by social and road user group

Impact	Social groups						Transport user groups				Qualitative statement (including any impact on residential population and identified amenities)
	Children & young people	Older people	Carers	Women	Disabled	First nations	Pedest-rians	Cyclists	Motor-cyclists	Young male drivers	
User benefits		✓	✓	✓	✓				✓		
Noise	××										
Air Quality	✓ ✓										
Safety	✓	✓ ✓ ✓					✓	✓	✓	✓	
Security	✓ ✓	✓		✓ ✓							
Severance	×	×	×		×						
Accessibility	✓	×	×	✓	✓	✓					
Affordability											

Source: Modified from the UK DfT (2020), p. 15.

Table 9 Variables used to define a community social profile

Characteristic	Variable	Examples of measures of variables	Possible data sources
Socioeconomic status	Income	Median income of families and individuals % families below poverty level	Census or local government
	Education	Median years of education completed	
	Employment	% in occupational categories % employment by type and location % unemployment Status of employment (temporary or long term)	Census or Centrelink
	Mobility characteristics	Car ownership and availability Use of alternative and non-motorised modes	Road agency registration data, travel diaries, surveys or focus groups.
Demographic factors	Population	Total population Population density	Census
	Ethnic composition	% of population from different ethnic groups	
	Age composition	% in 10-year age categories	
Housing factors	Homeowner/renter composition	% housing owner occupied % housing renter occupied	Census or local government
	Housing quality	% houses % units/apartments % public housing	
	Housing value	Median house value Median rent	
	Residential stability	% > 5 years in residence % > 10 years in residence	
Family structure	Household size	% single person households Median household size	Census or local government
	Household composition	% households with husband/wife % single parent households with children	
Land use	Nature of land use	Total land area of community % residential % recreational % commercial % industrial % vacant and farm	Local and state government
Community institutions	Religious	Number, type and location of institutions. Patterns of use of institutions.	Local and state government
	Government services including libraries, police stations, etc.		
	Commercial		
	Education, including child care		
	Health facilities		
	Recreation facilities		

Characteristic	Variable	Examples of measures of variables	Possible data sources
Accessibility characteristics	Transport connectivity to region	Type and frequency of services available.	Regional transport planners, travel surveys and focus group
	Efficiency and ease of inter-modal connections	Number of inter-modal connections available.	
Quality of transit service	Level of service	Frequency and hours of service Number of access locations Rates of usage Fare structure	Service providers, local government, focus groups, travel surveys.
Environmental and social stress factors	Existing noise levels	Proximity to major roadways	Local government or road authority
	Existing air pollution levels	Proximity to major roadways and polluting industries	
	Safety	Vehicle and pedestrian accident rates	
Community goals and public attitudes	Goals, aesthetics, health, safety, security, preservation of tax base, attitudes towards development and specific alignments necessary.	Residents' attitudes.	Attitudinal surveys

Source: Austroads (2005), p. 10.

4.5 Cumulative distributional impacts

Peoples' wellbeing can change over time and through the cumulative effects of successive initiatives. Transport practitioners involved in distributional impact assessment should therefore be aware of cumulative impacts.

A cumulative impact on an individual, group or resource is one that results from the incremental impact of an action when added to other past, present and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Cumulative impacts can include the effects of natural processes and events (FHWA, undated) and can apply to the environment as well as distribution.

Analysis of cumulative impacts is specific to an individual, group or resource. It is more often undertaken for environmental resources directly impacted by an initiative under study but can be directed towards distributional impacts.

For a given transport initiative, the cumulative impacts of past, committed and potential future initiatives elsewhere in the network are part of the base case (see ATAP Part T2 on the base case). The initiative being assessed will have further incremental effects. Identification of cumulative impacts requires historical knowledge of past initiatives and their impacts, and of committed and planned future initiatives and their impacts. Cumulative impacts may be missed when appraising a single initiative in isolation. Analysts should be alert for cumulative impacts and point them out in SMTs, DIAs and business cases. Decision-makers may then take them into account and possibly commission further investigative work.

4.6 Sources of information on distributional impacts of large transport projects

Larger projects will have more detailed CBAs, which will provide greater detail to support DIAs. CBAs of the largest projects may be supported by strategic transport models, estimation of wider economic benefits, analysis of land-use changes and use of computable general equilibrium models. Note that the great majority of transport initiatives will not generate wider economic benefits or land use changes, or require the use of computable general equilibrium models.

Strategic transport models: Benefit estimates for CBAs of major urban road, public transport and light rail CBAs will be made using strategic transport models. They divide a city into small zones linked by a multi-modal transport network and feature origin–destination matrixes of numbers of trips between each zone and every other zone. Further detail is available in ATAP Part T1 Travel demand modelling. Since a transport model estimates benefits by origin–destination pair and contains demographic information about each zone, it can be a rich source of quantitative information on how the benefits are split between people in different locations and the socio-economic/demographic characteristics of those locations. The use of outputs from transport models to provide information to support DIAs was illustrated above in Figures 1 and 2.

Wider economic benefits (WEBs): If WEBs have been estimated, the intermediate outputs from the process can provide information on how they are distributed. For example, the geographical distribution of forecast productivity changes can support observations about the location and industries that may gain or lose. ATAP Part T3 addresses estimation of three type of WEBs.

- WB1: Agglomeration economies, which are productivity gains arising from clustering by firms, will be shared among large numbers of firms' shareholders, employees and customers. As such, they are likely to be spread widely and thinly and so not likely to be of interest in a DIA.
- WB2: Tax impacts of changes in the labour market accrue to governments, and so are not of interest in a DIA. However, the changes in wages estimated in the process of estimating WB2 might be relevant for understanding the occupations and income levels of some beneficiaries from an initiative, though it may point more to benefits accruing to higher income earners.
- WB3: Output changes in imperfectively competitive markets due to reductions in business car and freight costs accrue as higher profits to firms. This may be a distributional impact of interest, albeit as a benefit to the better-off in society. From information on the locations of industries and benefits to business cars and freight, it may be possible to say something about the particular industries and locations involved.

There may be overlap between the WEBs 'narrative' and the distributional impact assessment, so material from the former can be repeated or summarised in the latter. Note that WEBs tend to be small for individual firms but become large when aggregated over whole or parts of cities and whole industries.

Land-use change benefits: If land-use change benefits have been included in the CBA, there should be detailed information available on benefits to land owners and developers. If land-use modelling for the CBA includes making forecasts of locations and sizes of changes in property values, information on benefits passed on to property owners will be available for the DIA. Forecast land-use changes, in base and project cases can provide information about demographic changes in the future that could be relevant for a DIA where they involve social groups, amenities and trip attractors, for example, the proportion of older people in an area, construction of new schools and age care facilities. 'Gentrification' of an area, pricing out low-income earners, would be noteworthy for a DIA. See ATAP O8 for discussion and guidance on land-use benefits of transport initiatives.

Computable general equilibrium (CGE) models: For some major projects, economy-wide impact models (CGE or input-output (IO) analysis) may be used in the appraisal. Where this is the case, they can assist in DIA by allowing tracking of full flow-on effects by industries and regions to their final incidence. They can provide impacts on groups of consumers, workers and industries by regions in terms of changes in prices,

wages and outputs. See ATAP T4 for discussion and guidance on CGE and IO models. Where a spatial CGE model has been used, a wide range of impacts will be available at a detailed spatial level. T4 discusses how CGE models can aid distributional analysis including estimating changes in income by income bands, relevant for completing the above tables, however, this requires post-modelling work. IO analysis is addressed in T4 but comes with warnings. Analysts should note that IO analysis can produce highly unrealistic results because of its assumption of perfectly elastic supplies of inputs and factors of production (see T4 for more detail).

5. Equity considerations

Consideration of the equity implications of initiatives by decision-makers determines the normative desirability of distributional impacts identified by the DIA. There is no formal equity assessment process that an analyst can conduct in the same way as for the DIA just discussed. However, DIAs can support decision making by presenting information in a way that highlights impacts that might raise equity concerns based on explicit jurisdictional goals and objectives and on widely-accepted notions of equity.

To best support the decision-makers, the CBA practitioner or business case author needs to be able to identify potential equity issues in order to bring them to the attention of decision-makers along with relevant information. In many cases, there will be stated goals or objectives related to equity in jurisdictional policy or strategy documents or in the problem statement or project specification. These may not be comprehensive so analysts should also bear in the mind the commonly accepted notions of equity.

This chapter aims to explain the widely-accepted notions of equity relevant to transport initiatives to help analysts identify potentially sensitive issues. These may or may not overlap with the stated goals and objectives relevant for strategic merit tests. An understanding of these concepts of equity will help analysts determine what impacts identified in the DIA are important and otherwise in order to better meet the informational needs of decision-makers.

5.1 What is equity?

Equity in the context of transport initiatives refers to the fairness with which impacts (benefits and costs) are distributed (Litman 2022). It relates to the distribution of income and wealth in society, questions of equality of opportunity and outcomes, and the rights of individuals. What is equitable and what is not can only be decided by making value judgments and is therefore subjective. It is not something that can be determined by applying a methodology to data such as estimating a net present value to predict the economic efficiency outcome of a proposal.

Note that positive equity impacts are of interest to decision-makers as well as negative impacts. Following Litman (2022), equity issues are categorised into vertical and horizontal.

5.2 Vertical equity

Vertical equity is concerned with improving the situation of disadvantaged people. Disadvantages extend to the economic, physical and social sides of the human condition. In essence, vertical equity requires that people who have more should pay more, and conversely.

In the economic sphere, vertical equity broadly relates to achieving greater equality in the distribution of income and wealth. Justifications include:

- High levels of inequality are more likely to result in crime and social instability
- A minimum threshold of income is necessary to preserve human dignity
- Some upper- and middle-income people may gain utility from seeing improvement in the circumstances of the less well off, which is the rationale for charitable giving
- Some people prefer to live in a more equal society. (Boardman et al. 2018, p. 540)

In the transport context, “vertical equity refers to the distribution of transportation impacts among sub-populations that differ in ability and need, such as different social income classes, age groups, and disabled or special needs groups” (Bills and Walker 2017, p. 62). Many of these groups were mentioned in the previous chapter on DIA.

Transport initiatives can give rise to vertical equity issues where they impact on

- Lower-income people — including renters and home owners with mortgage stress
  - as recipients of user benefits or not receiving any significant share of user benefits
  - excluded by fares or levels of charges at unaffordable levels
  - bearing a disproportionate share of externality costs.
- Transport-disadvantaged people — people with disabilities, special mobility needs, youth and seniors unable to drive, people unable to afford a car
  - levels of user benefits, fares and charges, externalities as per low-income people
  - design features of transport infrastructure and vehicles to ensure accessibility
- Socially disadvantaged groups — first nations, recent migrants, unemployed, students, seniors, homeless
- Vulnerable transport users — pedestrians, cyclists, motor cyclists and inexperienced drivers.

These categories are not mutually exclusive.

Public transport services and regional roads are often seen as necessary to meet basic needs of users. They could be considered to be ‘merit goods’. Merit goods are goods that, in the opinion of the decision-maker, would be under-consumed in a free market economy because, they create positive externalities or individuals do not recognise the full benefit to themselves from consuming the good. (Musgrave 1957, pp. 12-15) The merit good concept might be seen as overriding the concept of consumer sovereignty whereby the consumer is considered to be the best judge of their own welfare, a fundamental principle of welfare economics.

5.3 Horizontal equity

Horizontal equity is concerned with perceived human rights, property rights and entitlements of individuals and groups. People can feel unfairly treated if perceived entitlements are not fulfilled, or if the entitlements of others are exceeded. If someone purchases a good or service of a certain quality and quantity, they feel entitled to receive the quality and quantity they paid for. They feel entitled to certain levels of clean air, peace and quiet, safety, reliable transport times, and feel aggrieved if deprived of these without fair compensation.

Equity in the form of entitlements or property rights obtained in exchange for money are referred to by Bills and Walker (2017, p. 65) as ‘market-based’ equity. People should ‘get what they pay for and pay for what they get’ (Litman 2022, p. 3). Prices charged above costs and taxation without corresponding benefits to the payees can be seen as unfair violations of peoples’ property rights. Positive externalities, infrastructure not charged for and subsidies, can be seen as undeserved gifts. Studies are sometimes undertaken that assess whether the amount a group pays in taxes and fees corresponds with the levels of benefit received or the costs incurred to provide those benefits.

If a person has purchased a house with the expectation of a certain level of ambience and a freeway is built nearby causing noise, pollution, severance and visual ugliness, this might be considered unfair regardless of the economic circumstances of the houseowner. It would result in a fall in property values and there would be a case for compensation if the freeway proceeded. However, if a person purchased a house already exposed to these externalities at a market-determined price that reflected the disutility of living in the property caused by the externalities, the ongoing existence of the externalities might be considered equitable.

If a public transport improvement led to a rise in land values for nearby properties, the windfall gain accruing to landowners might been seen as inequitable. In such a case, 'value capture', for example through a surcharge on rates or a developer contribution, would be considered equitable.

Some minimum levels of entitlement are seen to exist, which ought not to be taken away in exchange for monetary compensation. Externalities above expected levels that affect physical and mental wellbeing such as air pollution, noise and road safety are examples. While less serious, road users feel entitled to reasonable standards of reliable trip times, average speeds and road pavement condition. Public transport users feel entitled to reasonable standards of punctuality, safety, cleanliness, comfort and freedom from over-crowding.

Transport options may need to be designed to reduce or minimise these externalities, for example, noise barriers and pedestrian under- or over-passes to address severance. Without such measures, a transport option might fail the strategic merit test (see Section 3.5.2).

Raux and Souche (2004) use the term 'spatial equity' to refer to rights of people is all locations to have comparable access to jobs, goods and services. Accessibility inevitably becomes poorer in less densely populated areas and for place more remote from major centres, but spatial equity may demand greater levels government spending on a per capita basis compared with major centres to reduce the size of the disadvantage that would otherwise occur. This can lead to infrastructure being provided at above economically warranted levels in less populated rural and remote areas. Public transport fares are usually heavily subsidised.

Inter-generational equity refers to the incidence or degree to which benefits and costs fall on different generations and generational periods (Bills and Walker 2017). Future generations are seen as having rights and entitlements. Emissions of greenhouse gases, damage to the environment, loss of biodiversity and loss of heritage infringe on the entitlements of future generations. Environmental impacts on future generations would be addressed in the Environmental Impact Statement and, monetised in the CBA where parameter values are available, such as those in ATAP Part PV5 Environment. Heritage impacts would be addressed in the SMT. As such, DIA does not need to address equity issues relating to future generations.

Note that Raux and Souche consider spatial equity to be a third category of equity distinct from Litman's vertical–horizontal categorisation. In line with Bills and Walker (2017), ATAP T5 groups spatial and inter-generation equity with horizontal equity because they relate to rights and entitlements.

5.4 Trade-offs and conflicts

The different types of equity often overlap or conflict. As an example of conflict, horizontal equity requires users to bear the costs of transport facilities and services, but vertical equity may justify subsidies for disadvantaged people. Improving spatial equity through cross-subsidisation in transport charges or investment in poorly utilised infrastructure in rural areas can conflict with market equity. Rights to freedom from externalities above acceptable levels and compensation for resultant losses of property values applies to rich and poor alike. Promotion of spatial equity can channel government funds towards high-income people in less populated areas at the expense of low-income people in densely populated urban areas.

Then there are conflicts between equity and economic efficiency. Achieving greater equality in the division of the pie can come at the expense of the size of the pie. Taxes, subsidies and welfare payments can affect incentives to work and consume, have transactions costs, and so cause losses in economic efficiency. Rawls' (1999) theory of justice is interesting because it is equalitarian to the maximum possible extent but allows departures from equality where they improve the welfare of the most disadvantaged members of society. Efforts to improve the welfare of the most disadvantaged are likely to also improve the welfare of others along the continuum, a property Rawls calls, 'chain-connectedness'.

Investing in infrastructure options with lower negative net present values compared with other options to achieve equity objectives sacrifices some economic efficiency for the sake of equity. Transport projects are generally not a good way to redistribute income. This is usually better done through the tax system and provision of social services or directing greater resources to education, health and other services in locations of need. However, it is acknowledged that government budgetary systems make it difficult to shift funds between portfolios depending on what best achieves objectives. While an affluent society can afford a number of less economically efficient initiatives to meet other objectives, if done too often or on too large a scale, the combined cost can mount up and have a significant negative impact on the economic wellbeing of citizens. An example is Pickford (2013).

The cost of mitigating an externality to an acceptable standard can exceed the willingness-to-pay of the beneficiaries. Even achievement of market equity can conflict with economic efficiency, for example, in the case of uncongested roads, the economically optimal user charge is the marginal cost of damage to pavements which is zero for cars (Harvey 2015). The Mohring effect and lack of congestion pricing for cars justify a certain level of subsidisation for public transport on economic efficiency grounds, though usually nowhere near the actual levels of subsidy provided. In both cases, economically efficient pricing is incompatible with full cost recovery from users and hence with market equity.

CBAs and business cases should point out situations where selecting one option over another (including the base case) involves trade-offs between economic efficiency and equity or between different equity considerations. CBA results will enable any sacrifices of economic efficiency to be expressed as monetary amounts.

5.5 Embedding equity in CBAs

Judgements about equity can be embedded in CBAs by adjusting the numbers. Distributional weights can be attached to costs incurred by and benefits received by different groups. Typically, grouping is by income level so that the benefits accruing to low-income groups receive a higher weight than the same dollar impact on high-income groups. Note that the approach addresses only vertical equity. The distributional weights can be derived from an assumed utility function that expresses utility as function of income and features diminishing marginal utility with respect to income. Setting the distributional weight for the highest-income group to one, the weight for each successive group below is given by the ratio of the marginal utility of income for the lower income group to the marginal utility for the highest income group. Typically, an iso-elastic utility function is chosen. A numerical example is given in Box 2. There are other ways to determine distributional weights as well. (Boardman et al. 2018, chapter 19).

Distributional weights are discussed in ATAP Part T2, Chapter 12 as part of 'adjusted CBA'. T2 recommends that adjusted CBA results never be reported separately from the results of the corresponding unadjusted CBA. If decision-makers select options or prioritise initiatives on the basis of adjusted CBA results, it is important that they are aware of the trade-offs, that is, the amount of economic efficiency gains forgone in order to promote other objectives.

The consensus in Australia to date has been not to use distributional weights, but rather to convey information about distributional impacts to decision-makers and leave it to them to weigh up efficiency and equity impacts on a case-by-case basis.

Box 2 How to apply distributional weights from an assumed utility function

Say that a particular initiative provides benefits for two different population groups, high income, *H*, and low income, *L*. The benefit to each group is given by B_H and B_L respectively. The combined benefit is:

$B = W_H \cdot B_H + W_L \cdot B_L$, where W_H and W_L are the distributional weights.

The iso-elastic utility function is given by $U = \frac{y^{1-\eta}}{1-\eta}$ if $\eta \neq 1$ and $U = \log y$ if $\eta = 1$, where $1 - \eta$ is the elasticity of marginal utility with respect to income. Given this utility function, marginal utility is $\frac{dU}{dy} = \frac{1}{y^{\eta}}$.

Setting the weight for the high-income group to one, the weight for the low-income group is given by the ratio of the marginal utility of income for the low-income group to the marginal utility for the high-income group.

$$W_L = \frac{dU_L}{dy_L} \Big/ \frac{dU_H}{dy_H} = \left(\frac{1}{y_L^{\eta}}\right) \Big/ \left(\frac{1}{y_H^{\eta}}\right) = \left(\frac{y_H}{y_L}\right)^{\eta}$$

Estimates of the parameter η from a number of countries range between 1.19 and 1.34 (Boardman et al. p. 546). Say the value of η is 1.2, the high-income group has an average income of $80,000 per year, and the low-income group of $40,000 per year. The distributional weight for the low-income group is then

$$\left(\frac{\$80{,}000}{\$40{,}000}\right)^{1.2} \approx 2.3$$

The combined benefit equation becomes: $B = 1.0 \cdot B_H + 2.3 \cdot B_L$

Setting the weight for the high-income group to one and the weights to other income groups above one, will inflate project benefits, raising NPVs and BCRs. Income weighted CBA results for different projects therefore should only be compared with results for other projects adjusted using the same weights. The absolute values of NPVs and BCRs from income weighted CBA cannot be interpreted in the same way as for unweighted CBAs as indicating whether or not the project increases economic efficiency.

There is an exception in the use of 'equity values' of time. People with higher incomes are willing to pay more to save time. ATAP Part M1 Public transport distinguishes between behavioural and equity values of time:

- *Behavioural values* are used for use in demand modelling. They are the willingness-to pay (WTP) values observed in surveys. They tend to vary between transport modes and across travellers with different income levels. Understanding the different values of time by people with different income levels can be important for demand forecasting in some cases. In the case of toll roads, people with higher values time will be more willing to pay the toll to save time. Low-income people will be more willing to switch from car to a public transport service with a longer door-to-door trip time.
- *Equity values* are used for estimating benefits in CBAs. The equity value is a population average value used consistently across all transport modes in appraisal. Common practice in Australia and around the world has been to use 'equity' values of time in transport appraisals because it is considered unfair to value peoples time differently based on income. WTP for safety would also vary with income, but population averages of WTP to reduce crash risk are used in practice to value changes in transport safety. In effect, travel time and safety benefits are weighted inversely with income.

Appendix A Distributional impact and equity assessment in other guidelines

This section summarises how various other key guidelines interpret the need and role of assessment of distributional impact and assessment. It provides context for the approach recommended in section 3.5.

Australian Government 2006: Handbook of cost–benefit analysis

The Handbook was first published in 1991, and was updated in 2006 (Department of Finance and Administration 2006). Since 1991, it has a been a central guidance document to guide the use CBA across the Australian Federal Government.

The Handbook notes the importance of distributional impact assessment. It advises that:

- Decision-makers need information about the distributional impacts of initiatives where they are significant
- Gains and losses by the relevant groups can be displayed in chart or tabular form as an adjunct to the CBA
- As a general rule, the use of distributional weights in CBA is not advised, leaving distributional judgments to be made at the political level
- Where an option is selected on equity grounds, the decision-maker should be advised of the efficiency cost (in terms of loss net benefits compared to the option with the greatest net benefits).

Australian Government 2020: Distributional analysis guidance note

The Australian Government's Office of Best Practice Regulation (Department of Prime Minister and Cabinet 2020) discusses the importance of distributional impact assessment in assessing regulatory proposals. It advises that distributional analysis is necessary when an intervention is likely to have a significant impact on different groups or when the proposed policy has an explicitly redistributive objective.

Assessment of distributional impacts could range from a simple quantitative or descriptive approach where the scale of the effect is relatively low, to an in-depth appraisal and detailed calculation of distributional impacts where the scale is relatively high. OBPR's advice is:

- Decision-makers need information about the distributional impacts of initiatives where they are significant
- Gains and losses by the relevant groups can be displayed in chart or tabular form as an adjunct to the CBA
- Where an option is selected on equity grounds, the decision-maker should be advised of the efficiency cost (in terms of loss net benefits compared to the option with the greatest net benefits).

Infrastructure Australia (2021a): Guide to economic appraisal

The benefits of proposals are often not uniformly distributed across the population. CBA does not explicitly take this into account, as it is generally conducted from the perspective of society as a whole. For some projects, understanding the distribution of costs and benefits may be critical to their economic analysis. Among other reasons, understanding how the project affects different groups is useful to measure performance against stated strategic objectives for equity, such as improving economic and social development, or levelling-up of disadvantaged areas or communities.

You should describe and analyse as best as possible the distributional impacts of the change resulting from your proposal. An indication of the scale of those effects is also desirable at both a spatial and temporal level. We recommend the use of maps, diagrams and charts to help illustrate the scale of those effects.

Distributional analysis is the favoured method to analyse the distributional impacts of a project. The key steps in undertaking a distributional analysis are:

1. Identify the key groups of interest for the analysis
2. Allocate costs and benefits from the CBA to the identified groups
3. Consider whether any of these costs or benefits may be shifted to another group
4. Include any transfer payments that have not been included in the CBA, and consider which groups are impacted.

Consider whether the impacts not monetised in the CBA are likely to affect groups in different ways.

For items that cannot be monetised and included in a CBA or a distributional analysis, completing a descriptive analysis can demonstrate a project's differential effects. Stages 1 and 2 of the Assessment Framework provide advice on how to best complete this analysis. The key steps to complete a descriptive analysis are:

1. Describe the benefit or cost related to the overarching problem or opportunity identified in Stage 1 of the Assessment Framework
2. Establish the link from the service and infrastructure to the identified benefit or cost
3. Determine the anticipated magnitude of the benefit or cost, using quantitative indicators where possible. Where impacts are not able to be quantified, you should describe relevant benchmarks (such as relevant regional or national comparisons) and government objectives for comparison
4. Provide evidence of the anticipated impact, which could involve reporting on survey outcomes or insight from relevant academic literature.

United Kingdom

In the UK, the analysis of distributional impacts is mandatory in the appraisal process, and is reported through the Appraisal Summary Table, the formal mechanism in the UK for reporting appraisal results. To facilitate this, the UK Government publishes formal guidance on undertaking distributional impact appraisal (UK DfT 2020). It uses eight distributional impact indicators, and measures those across different groups of people.

In the absence of detailed Australian guidance, the UK guidance provides a useful approach for Australian practitioners to use. A modified version of the approach is provided in Chapter 4 above.

New Zealand Government, 2021

In the New Zealand guidelines (Waka Kotahi NZTA 2021), equity refers to the ethical desirability of distributional impacts among groups of individuals

While an analysis of the distribution of benefits and costs among different groups is not required for economic efficiency analysis, evaluations of an activity should report the distribution of benefits and costs, particularly where they relate to the needs of transport disadvantaged populations. This reporting forms a part of the funding allocation process

Distributional impacts should be reported separately from, but alongside, the CBA results.

United States

US Department of Transportation (2022) notes the interest of policy makers in how the resulting benefits of an initiative are distributed among different parties or groups.

A project may result in some parties being made worse off, irrespective of whether there are positive net benefits in the aggregate.

Project benefits may be widely shared among the general public, or conversely concentrated among private parties (e.g. private transport operators, or landowners and commercial enterprises directly served by a new or improved transport facility).

Where an initiative is targeted to meet the needs of traditionally underserved or disadvantaged population groups, policy makers may be interested in understanding how benefits are shared between those groups.

Proponents of an initiative are encouraged to provide relevant information (such as the demographics of the expected users, or by distinguishing between public and private benefits) to assist the funder better understand how a project may contribute to the range of associated public policy goals.

European Union

The European Union funded the European Cooperation in Science and Technology (COST) project, Transport Equity Analysis (TEA): Assessment and Integration of Equity Criteria in Transportation Planning (Di Ciommo 2018) aims to provide a practical guideline for assessing the equity impacts of transportation policies and projects.

The Guidelines list criteria and stratifications of populations for equity analysis, such as gender, age and lifecycle stage (e.g. children, elderly), health and well-being, special needs groups (mobility, physical, cognitive difficulties, etc.), ethnicity, cultural context, language barriers (e.g. not speaking the local language), educational level, employment status, work-hour flexibility, financial security, personal income (quintiles, poverty line, lower income areas), household income, household composition (e.g. single parents, caregivers: responsible for dependent child or disabled adult, etc.), housing security (tenure), mode availability, car ownership, driving license ownership, size of social capital network, residential location with specific characteristics/urbanisation levels.

For bringing equity into the CBA, they use shadow values (method recommended by the European Commission, Di Ciommo, 2018). Shadow values, which may be higher or lower than the corresponding market price can be used for promoting equal opportunities (e.g. single social value for travel time savings, in order to ignore higher willingness-to-pay for high-income groups, and use of labour costs below the real wages in order to induce labour-intensive solutions).

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