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Addressing current challenges in the economic appraisal of active transport grant programs

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Abstract

Active transport investments can generate significant health, decongestion, safety, and amenity benefits at relatively low cost, particularly where they induce new active transport trips. There are already significant challenges in economic appraisal of active transport projects from limited data and forecasting models to predict changes in route, mode or new/generated trips. These challenges are exacerbated for grant programs where the scope is not known with until submissions are received and assessed. Economic appraisal in this context requires a range of tools and techniques to deal with uncertainty and provide confidence the program will provide value for money. This paper presents examples from recent active transport grant programs in NSW including benchmarking, elasticities, break-even and mode share analysis, and identifies several areas for further refinement.

1 Introduction

Active transport investments[1] can generate significant health, safety, and amenity benefits at relatively low cost, particularly where they generate new active transport trips or replace short car trips. This is because:

- Active transport investments are relatively low cost, ranging from around $1,566 for bicycle hoops to $5.3 million for separated bicycle paths ($June 2024)[2].
- Active transport benefits can be significant, with estimates of up to $3.39/km (cycling)-$5.72/km (walking) from health and decongestion benefits alone[3].

1.1 Challenges in active transport planning and delivery

Despite the apparent benefits, active transport participation rates (particularly cycling) have fallen since 2011[4]. There are many contributing factors driving this trend, including:

- **Fragmentation of active transport planning and delivery** – Active transport investments are often focused on local connections rather than the entire end-to-end journey given the fragmentation of responsibility for planning and delivery between local governments (e.g.. local roads, public spaces and parks), state governments (e.g. public spaces, parks and schools) and businesses (e.g. private end-of-trip facilities).
- **Significant variability in users and scope –** There are several barriers to active transport along the end-to-end journey, including safety, perceptions and awareness, physical challenges, and availability of end-of-trip facilities (Figure 1 below). These challenges will have different or heightened impacts on particular users or in particular locations. This will also influence the scope of investment to address these challenges.

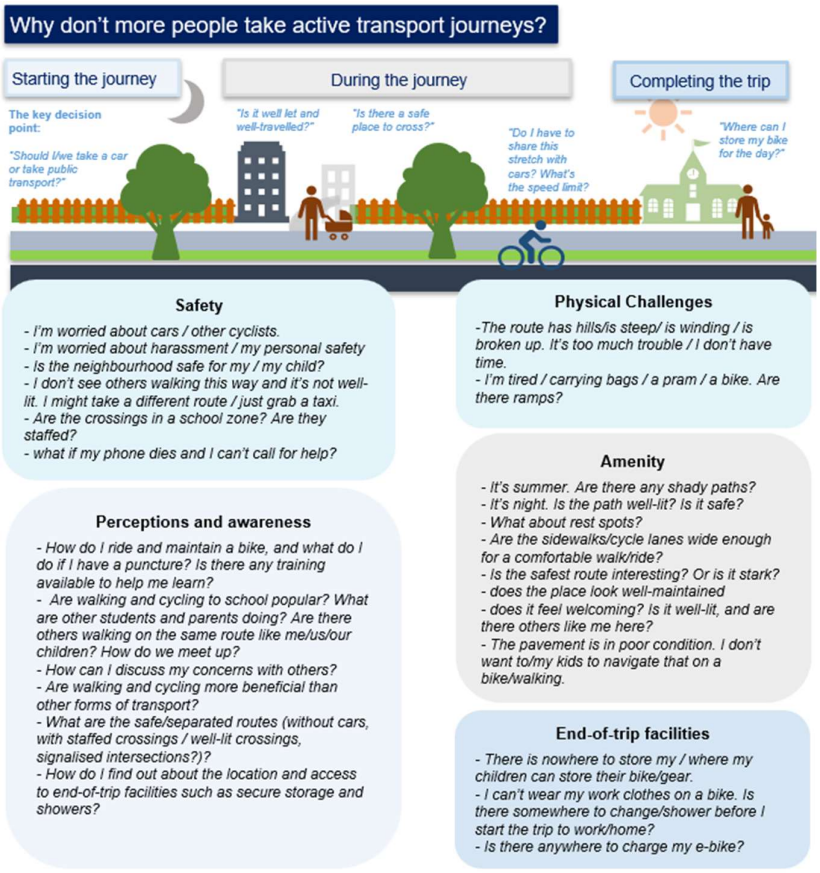
[1] Active transport includes walking and cycling. Micro-mobility modes such as e-scooters and electric bicycles can also be categorised as active transport, but are not the focus of this paper It is noted that e-scooters are not permitted and/or require a license in several jurisdictions.

[2] All values are expressed in June $2024 prices unless otherwise stated. Costs for stainless steel bicycle racks sourced from Transport for NSW (TfNSW) (August 2024), “Economic Parameter Values”, Table 15.8, p73.

[3] TfNSW (Aug 2024), Table 7.1, p49; based on Australian Transport Assessment and Planning (ATAP) M4. Health benefits are compared to insufficient activity and include private (mortality and mortality) and public (heath system costs). Decongestion benefits are applicable to diverted car users and include vehicle operating costs, crashes, environmental externalities, roadway provision and parking costs. TfNSW does not recommend quantifying a travel time cost or saving for active transport projects.

[4] Cycling and Walking Australia and New Zealand (2023), “National Walking and Cycling Participation Survey 2023”, available at: https://www.cwanz.com.au/wp-content/uploads/2023/08/NWCPS_2023_report_v1.3.pdf, accessed: 16/04/2024.

Figure 1: Barriers to active transport throughout the end-to-end journey



1.2 Co-ordination of active transport investment through grant programs

Grant programs are one way that state governments have chosen to address fragmentation challenges, as they enable co-ordination of investments through setting objectives and criteria for assessing submissions including complementarity. However, this also introduces challenges in economic appraisal because of a broad range of investment types and locations. These are not known in advance, until submissions are received and assessed.

1.3 Challenges in economic appraisal of active transport grant programs

Detailed bottom-up assessments considering the existing condition of infrastructure and location-specific data may not be possible or practical given the nature and scale of these grant programs. Economic appraisal of these programs may therefore require benchmark assumptions to deal with uncertainty. Although, assumptions should still be tailored to specific programs to the extent possible. These programs may also require additional sensitivity and scenario testing and a range of additional tools and techniques to deal with uncertainty, including price elasticity of demand, break-even and mode share analysis. Post-completion review may also provide a valuable tool to validate initial estimates.

1.4 Approaches from recent NSW active transport grant programs

This paper presents examples of approaches applied in two recent active transport grant programs in NSW, which included:

- Active transport grant funds administered by Transport for NSW (TfNSW), with individual program budgets of $40 to $60 million over three financial years.
- Some grant programs or components which had already completed previous rounds and others which were new.

- Program objectives targeting specific impacted groups with varying needs, such as primary school children; women, girls and gender-diverse users; and train commuters impacted by the shut-down of services and replacement bus during construction.
- A broad range of investment types (see Table 1) including education and behavioural change, kerbs and crossings, paths and separated street space, and end-of-trip facilities.

Table 1: Overview of the scope of the example NSW active transport grant programs

Category	Scope examples
Education & behaviour	Signposting, wayfinding
	Research, engagement, media campaigns or digital education platforms.
Kerbs & crossings	Pedestrian fencing, tactile markers, "zebra" crossing, kerb ramps, signal phasing, kerb extensions, signal phasing, raised "wombat" crossings/pedestrian thresholds, new signalised crossing/intersection.
Paths & separated street space	Footpath 1.8m wide, line-marking, continuous footpath treatments or footpath widening (3m), tree canopy (shelter).
	Pop-up or semi-permanent cycling paths, quietways, separated bicycle paths, speed zone reduction, road closures, place-based pilots (lighting, activation, landscaping, public art) and shared zones.
End-of-trip facilities	Station bicycle parking, bicycle shed, pump and maintenance station, school bicycle parking or bicycle pump track.

1.5 Structure of this paper

The remainder of this paper addresses scope uncertainty in grant programs (Chapter 2) and data and forecasting limitations (Chapter 3). It presents the benchmark assumptions and additional tools and techniques applied in the example active transport grant programs (Chapter 4), noting assumptions should always be tailored to the individual characteristics of the project or program where possible. It concludes by presenting the combined demand, benefit and induced demand benchmarks applied in the example programs and identifying several key areas for further research and refinement.

2 Addressing scope uncertainty in grant programs

Grant programs provide a degree of certainty around capital costs given program budgets are fixed. However, the final scope is not known until submissions are received and assessed. Previous rounds of grants can provide an indication of likely scope where available, but not for new grant funds of components. The example programs included:

- Tailoring the objectives and relevant scope items to the particular user group(s) and geographies being targeted by the program, as part of investment logic mapping (ILM).
- Developing a representative distribution of scope considering the objectives, user groups, previous rounds of grant funding, unit cost reconciliation and location.
- Allowance for ongoing operating and maintenance costs which will be borne by the party delivering the active transport scope (e.g. local governments).

2.1 Tailoring objectives and scope to targeted user groups

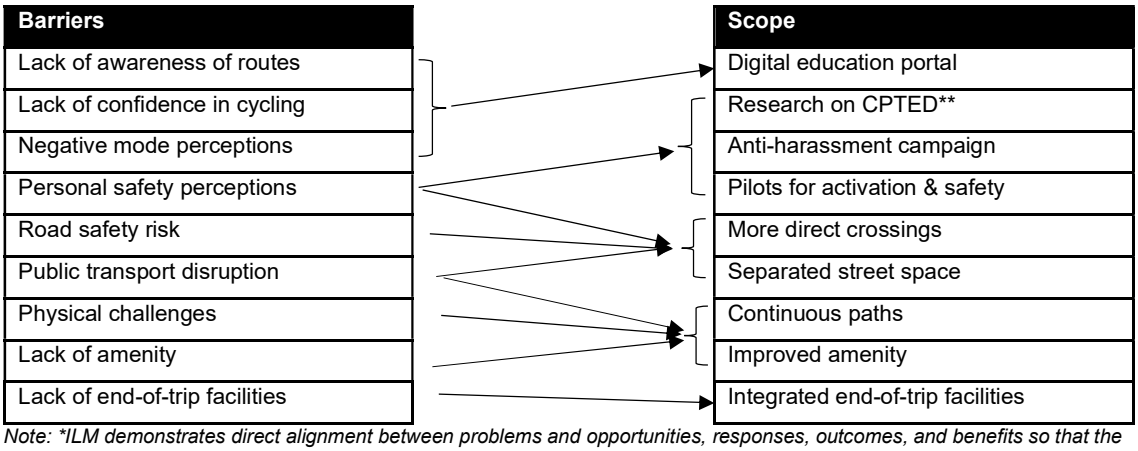
Table 2 provides examples of how scope may vary for different user groups.

Table 2: Examples of scope tailored to different user groups

Users	Primary school children	Women & gender-diverse	Train commuters
Barriers ↓	Road safety, education, physical challenges, and end-of-trip facilities.	Behavioural change, personal safety, and amenity.	Route identification, amenity, and end-of trip facilities.
Scope	Digital education and rewards portal, raised "wombat" crossings and continuous paths within 500m of schools, bicycle parking/pump and maintenance stations.	Research, engagement and anti-harassment campaign, and place-based pilots (lighting, activation, landscaping, public art).	Route maps, amenity and safety in underpasses, pedestrian tunnels and station areas, bicycle facilities at stations.

Figure 2 presents a simplified ILM demonstrating how different barriers and opportunities (see Figure 1 above) are aligned with different active transport responses more generally.

Figure 2: Mapping active transport responses to barriers and opportunities*



*Note: *ILM demonstrates direct alignment between problems and opportunities, responses, outcomes, and benefits so that the scope is directly aligned with the specific problems and opportunities identified. This figure should be considered as an indicative extract only and excludes additional ILM components such as outcomes and benefits. ** Crime Prevention Through Environmental Design (CPTED) is a multi-disciplinary approach to crime prevention that uses urban and architectural design and the management of built and natural environments.*

2.2 Converting program budgets to scope by reconciling to unit costs

Program scope should be aligned with the objectives and benchmarked against previous rounds of grant funding where available. Where uncertain, it may be practical to group similar types of infrastructure and use cost benchmarks to reconcile scope to budgets[5], as per the example below in Table 3 developed with TfNSW subject matter experts (SMEs).

Table 3: Indicative unit cost rates by category and scope items (June $2024)

Category	Scope examples	$ per unit
Education & behaviour	Signposting, wayfinding	$3,100-$6,100
	Research, campaigns, digital education and rewards portal	$380,000-$2,550,000
Kerbs & crossings	Fencing, markers, zebra crossing, kerb ramps, phasing	$5,100-$21,300[1]
	Kerb extension, wombat crossing, traffic signals, raised pedestrian threshold, signalised crossing leg	$306,000-$510,000
Paths & separated street space	Line marking, speed zone reduction, tree canopy	$30,600-$133,000[2]
	Place-based pilots (lighting, activation, landscaping, public art), continuous footpaths/widening (3.0m), shared zone	$102,000-$266,000[3]
	Footpaths (1.8m), pop-up/semi-permanent cycle paths	$255,000-$530,000[3]
	Footpath (3m), quietways, separated bicycle paths	$1,020,000-$5,300,000[3]
End-of-trip	Bicycle hoops or shed, pump and maintenance station	$1,600-$10,200[4]

Note: 1. TfNSW (Aug 2024), Table 15.8, p73 including costs of includes $7,670 (Jun $2024) for a crossing spanning 2 lanes including a pedestrian refuse. 2. Per tree rate converted to per unit assuming 500m length, planting on both sides and 8m^2 per medium tree (DPHI 2023). 3. There can be significant variation in the costs of paths depending on the specification. TfNSW (Aug 2024),Table 15.8, p73 includes $327,000 per km for 2.2m on-road cycleway without separation $415,000 with separation and $935,000 per km for a 2.5m concrete path (June $2024). 4. TfNSW (Aug 2024) includes $1,566 for stainless steel bicycle racks. 5. Other cost benchmarks were sourced from TfNSW SMEs and inflated to $June 2024 based on Sydney CPI.

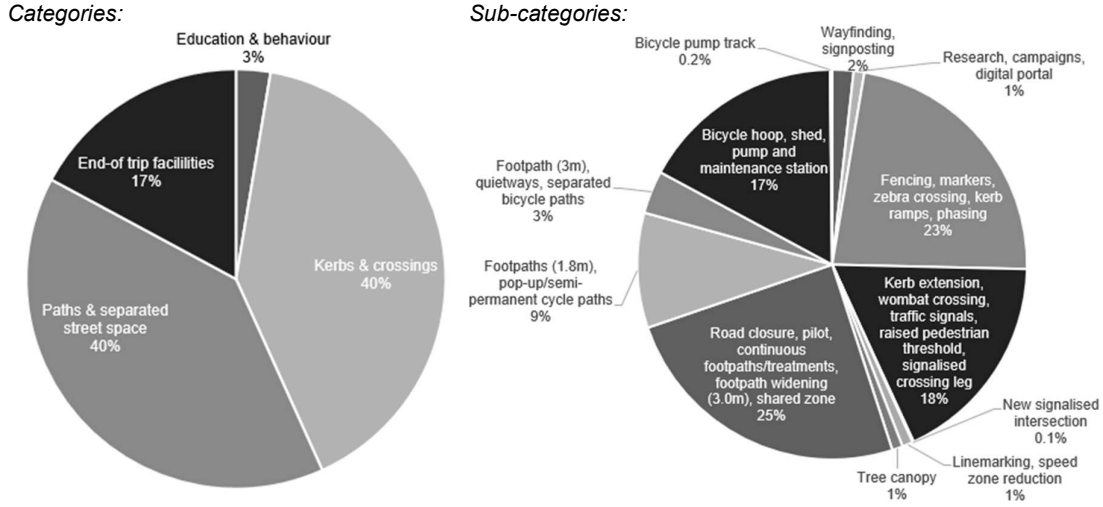
Figure 3 provides an indicative breakdown of scope from the example programs noting:

- Kerbs and crossings (40%) and paths and separated spaces (40%) were the most significant categories driven by signal phasing improvements near stations, wombat crossings around schools, place-based pilots (lighting, activation, landscaping, public art) footpaths around schools and pop-up/temporary cycle paths near train stations.
- Education and behavioural change programs make up a small proportion in terms of the number of units (3%) but are more significant in terms of cost per unit and are critical enablers expanding the reach of the program beyond the direct infrastructure[6].

[5] This may include redistribution to ensure whole units and/or equal distribution where there is remaining uncertainty.

[6] However, care must be taken to ensure that there is not double counting of induced demand from direct program benefits.

Figure 3: Indicative scope breakdown for NSW active transport programs (no. units)



2.3 Developing benefit assumptions based on benchmarks

A benchmarking approach to benefits may be appropriate for active transport grant programs given scope uncertainty, substantial number of scope items and broad geographical coverage which makes detailed bottom-up estimates challenging. As summarised in Table 4, the example active transport grant programs included scenarios for the degree of improvement (e.g., low, medium, high) applied to different scope categories:

- High scenario (+40%) based on train station amenity parameters in TfNSW guidelines which are based on a maximum 40% improvement[7] (road closures, quietways and shared zones).
- Medium (+20%) and low benefit benchmarks (+10%) were defined relative to the maximum improvement based on the characteristics of the scope categories.

Table 4: Benefit benchmark assumptions from the example active transport grant programs

Category[1]	Scope items	Safety	Amenity	Info.
Education & behaviour	Signposting, wayfinding	-	-	10%-20%
	Campaigns, digital portal	-	-	40%
Kerbs & crossings	Kerbs, pedestrian thresholds, zebra crossings	10%		
	Wombat crossings, signalised crossing legs		20%	
	Signal changes			
Paths & separated street space	Continuous footpaths/treatments		10%	
	Footpaths 1.8m wide, widening		20%	
	Pop-up/temporary cycle paths	10%-20%	10%	
	Shared paths 3.0m	20%	20%	
	Place-based pilots (lighting, activation, landscaping and public art)	20%-40%	10%-20%	
	Road closures	40%	20%	
	Quietways, shared zones	40%	40%	

Notes: Bespoke approaches were used for tree canopy (1), wait time savings (2) and end-of-trip facilities (3) as follows: 1. Tree canopy benefits were based on Walk Environment Quality parameters from TfNSW (Aug 2024), Table 16.4 Value of Walk Environment Attributes Cents Per Minute, p80; and greenhouse gas emission savings parameters from NSW Department of Planning, Housing and Infrastructure (DPHI) (October 2023),"Framework for Valuing Green Infrastructure and Public Spaces", Section 5.1.7.2.2 Canopy cover, p45. Assumes medium tree; 2. Wait time benefits assumed 30 second improvement. The National Association of City Transportation Officials "Urban Street Design Guide" indicates cycle lengths are between 60-90 seconds and balanced signal timing with shorter cycles would result in a 60 second reduction. The Sydney CBD has a 90 second SCAT2S maximum cycle time, having reduced from 120 seconds a few years ago. As such, a 30 second reduction is consistently applied to signal phasing inclusion; 3. End-of-trip facility benefits were based on UK WebTAG Data Book (Nov 2023) values for secure parking facilities and changing and shower facilities, multiplied by 50% to reflect overseas willingness to pay values and potential differences in specification in the grant programs (e.g. bicycle hoops).

[7] The values represent a quality improvement from a rating score of 40% to 80%. TfNSW (Aug 2024), Table 11.4 Value of bus stop/station quality attributes, p59.

Accounting for the broad range of benefits provided by an active transport grant program may require reconciling the following differences:

- **Different units for personal safety and amenity ($ per unit increase in rating)** – Australian Pedestrian Environment Review System (PERS) values are relatively new (September 2023) and are based on a unit increase in PERS rating[8] rather than 40% customer satisfaction.
- **Health and decongestion ($ per km)** – Distance-based parameters require assumptions for average trip distances, which vary for different user groups. For example school children were assumed to travel shorter distances of 0.5km (walking) to 0.9km (cycling) at lower speeds of 4km/hr (walking) and 14km/hr (cycling)[9]. Train station access typically involves longer distances of 0.8km (walking) to 2.5km (cycling) at higher speeds of 6km/hr (walking) and 16km/hr (cycling)[10]. Other local trips may have longer distances of 1.5km (walking) to 4km (cycling) for a 15-minute neighbourhood[11].
- **Tree canopy ($ per location or m2)** – Tree canopy benefits are measured by location (amenity) or per square metre (greenhouse gas emissions). The example active transport grant programs assumed 8m^2 per medium tree[12] and planting on both sides of a 500 metre length path or separated street space.
- **Benefit decay** – Some infrastructure may be temporary, although there is the potential for these to be retained permanently if successful[13].

3 Addressing data and forecasting limitations in active transport

Unlike other motorised transport modes, active transport programs cannot typically rely on state government strategic transport demand models (or other mesoscopic or simulation models), to accurately forecast demand. There are also data and forecasting limitations which mean a benchmark approach may be warranted. This is explored further below.

3.1 Addressing limitations in walking and cycling data

3.1.1 Limited coverage of walking and cycle counts and fitness applications

Active transport counts are generally static, providing data on the number of pedestrians and cyclists passing a particular point. However, they are geographically limited as shown in Figure 4 below for the Sydney Greater Metropolitan Area. There is also significant variability between and within locations, as shown in below, which makes tailoring benchmarks to the specific program context critical.

Compared to these static counts, several fitness applications record additional information include origins, destinations, distance, time, and purpose. However, these are opt-in covering only part of the market (e.g., 3% to 30%)[14].

[8] PERS are based on a rating scale between -3 to +3 but the published parameter corresponds to a unit change (e.g. from 2 to 3), or a 16.7% improvement. As such, further adjustments are required for 10%, 20% and 40% improvements.

[9] Merom, D., Tudor-Locke, C., Bauman, A., and Rissel, C. (2006), "Active commuting to school among NSW primary school children: implications for public health.

[10] TfNSW (2014) "Train Statistics 2014", Table 6 Trips by distance to station by access mode, p20; and Fosgerau, M., Lukawaska, M., Paulsen, M. and Rasmussen, T. (2023) "Bikeability and the induced demand for cycling".

[11] This is a planning principle that most services should be within 15 minutes by active transport. See TfNSW, "Future Transport – Thriving places", available at: https://www.future.transport.nsw.gov.au/strategy-highlights/thriving-places, accessed: 29th August 2024.

[12] NSW Department of Planning, Housing and Infrastructure (DPHI) (October 2023), " Framework for Valuing Green Infrastructure and Public Spaces", Section 5.1.7.2.2 Canopy cover, p45.

[13] In the example active transport grant programs, pilot program benefits were reduced to 75% after 5 years, and 50% after 10 years. Temporary and semi-permanent cycling infrastructure were reduced to 0% after 10 years. The education and behavioural change program was delivered through a digital portal which could be accessed by all NSW school students, of which 10% were assumed to access each year. There would also be a cycle of students progressing through primary school and being replaced by new students. As such, information benefits from the digital portal were not capped in the same way.

[14] Colorado Department of Transportation (Jun 2018) "Strava Metro Data Analysis Summary", p29.

Figure 4: Active transport count locations in NSW (TfNSW, 2023)

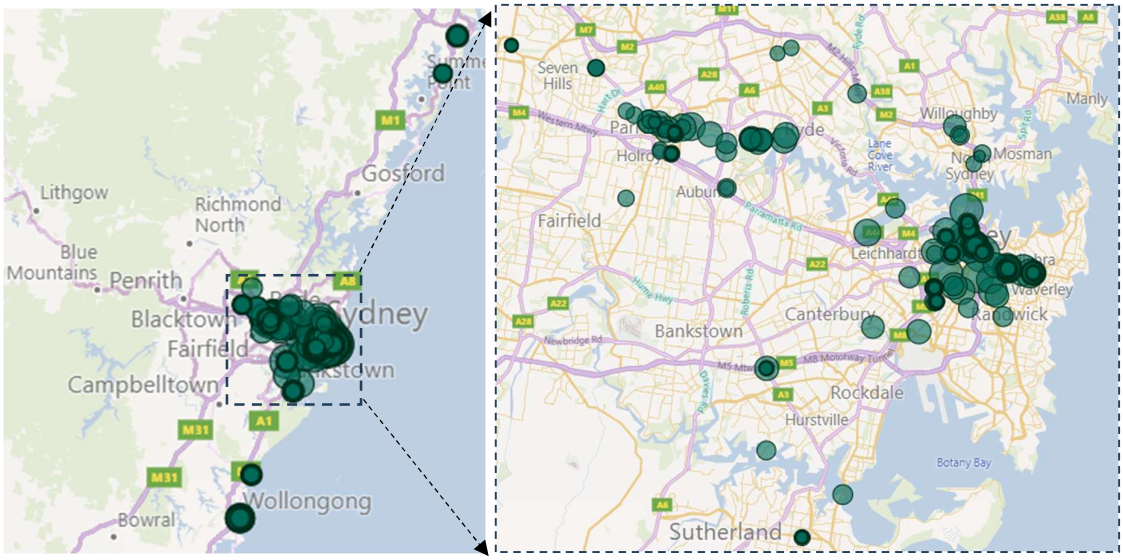


Table 5: Variability in average daily demand by source

Type	Source	Average	Minimum	Maximum
Walking	**NSW (TfNSW)**	**1,209**	**6**	**9,968**
	City of Parramatta	441	49	2,000
	City of Sydney	13,689	243	104,660
	Blacktown LGA	528	387	594
Cycling	**NSW (TfNSW)**	**151**	**1**	**1,302**
	City of Parramatta	264	2	523
	City of Sydney	647	55	2,450
	Blacktown LGA	11	8	14

*Note: *TfNSW publishes an online dashboard of all walking and cycling count locations in NSW. **Includes 144 walk counter sites across 14 LGAs (11% of NSW total) and 249 cycle counter sites across 19 LGAs (15% of NSW total). **Figure 4 based on cycle count locations, given they provide greater coverage than walk counters.*
Source (Figure 4 and Table 2): *TfNSW (2024), "Walking and cycling counts", available at: https://www.transport.nsw.gov.au/projects/programs/walking-and-cycling-program/walking-and-cycling-counts.*

3.1.2 Categorise infrastructure to enable benchmark demand assumptions

In the example active transport programs a benchmark approach to demand was used, as summarised in Table 6 below. This included:

- Average path demand (for the geographic coverage of the program[15]) was applied to signposting, wayfinding, paths and tree canopy. Demand for higher-specification paths was only applied to quietways and shared zones[16].
- Kerbs and crossings assumed 25% of average path demand reflecting multiple potential access points (generally four-way intersections)[17].

Table 6: Demand benchmark assumptions from the example active transport grant programs

Category	Scope items	Demand benchmark
Education & behaviour	Signposting, wayfinding	Avg. path
	Campaigns, digital portal	Website visits
Kerbs & crossings	Kerbs, pedestrian thresholds, zebra crossings, wombat crossings, signalised crossing legs, signal changes	25% of path

[15] In the example active transport programs which were largely focused on Greater Sydney, the City of Parramatta was chosen as a central location in Greater Sydney assuming the average daily demand across all locations but excluding higher-specification paths below in footnote 16. Daily demand assumed: 446 (walk) and 236 (cycle).

[16] In the example active transport programs, average daily demand was based on higher specification separated paths around the Parramatta River. Daily demand assumed:1,158 (walk) and 462 (cycle).

[17] In the active transport programs average daily demand was multiplied by 25%, resulting in: 112 (walk) and 59 (cycle) per day.

Category	Scope items	Demand benchmark
Paths & separated street space	Continuous footpaths/treatments, footpaths 1.8m wide, footpath widening, pop-up/temporary cycle paths, shared paths 3.0m, road closures, tree canopy	Avg. path
	Quietways, shared zones	High path

Bespoke approaches were used for education and behaviour (campaigns and digital portal)[18], end-of-trip facilities (bicycle hoops, sheds, pump and maintenance stations)[19] and bicycle pump tracks[20]. Differences between user groups and locations are reflected where possible, for example, school children and commuters travel during weekdays for non-business purposes, but with a shorter year for school children (40-week term) than commuters (48-weeks for full time after accounting for annual leave). Weather may also be a consideration, with groups such as school children less likely to travel during heavy rain[21].

3.2 Addressing limitations in forecasting induced active transport demand

3.2.1 Limitations in current active transport appraisal tools

There are also limitations in current active transport appraisal tools which do not overcome the shortcomings with forecasting induced demand. For example, TMR provides a comprehensive online tool for active transport economic appraisal tool[22]. However, this still requires current or forecast average daily counts as an input. Applying this tool at a program-level may also be challenging as project location, length and type are also inputs.

3.2.2 Significance of induced active transport demand

Economic appraisals based on existing counts alone are likely to significantly understate benefits given health and decongestion benefits are based in new and diverted car trips. In the example active transport programs, these accounted for around 70% of the total (see Figure 5 below) because growing the active transport share was a primary objective and direct infrastructure investment was supported broader research, engagement, education and awareness campaigns, and place-based pilots to maximise induced demand.

[18] Digital education portal visitation of 1,500 per day estimated based on ABS Schools, 2023 assuming 10% of all NSW public school students, carers and teachers accessing the portal 4 times per year. Total 550,000 per year is consistent with benchmarks from government websites/campaigns. For example, the Department of Immigration and Border Protection's "Live the Life Australia" campaign had around 660,000 unique views. More highly utilised Qld government web pages can receive between 10,000 to 130,000 visits per year, and there are generally numerous web pages per site. Sources: 1. Gov tech view, "Government social media: The power of 'like'", available at: https://www.govtechreview.com.au/content/gov-tech/article/government-social-media-the-power-of-like-1-2--1298357730, accessed 10th May 2024; 2. Qld Government Open Data Portal, "January 2017 – Page views by title", available at: https://www.data.qld.gov.au/dataset/web-stats-for-government/resource/72c098a0-4377-437d-9585-85a87a3d4b10, accessed 10th May 2024.

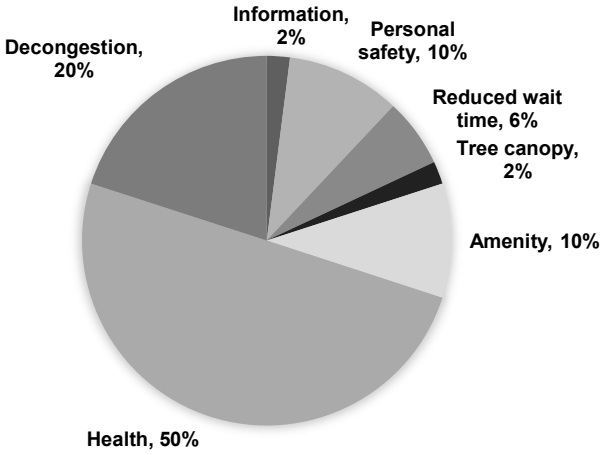
[19] Bicycle parking assumed 15 hoops per location based on cost benchmarks.

[20] Bicycle pump tracks proxied based on household willingness to pay for skateparks applied to relevant Local Government Areas. See DPHI (Oct 2023) "Framework for Valuing Green Infrastructure and Public Spaces", Table 5.1 Household WTP by characteristic at an urban park or sports field and Table 5.2 Defining the 'nearest' catchment for characteristics at urban parks or sports fields, pp27-28.

[21] The Bureau of Meteorology provides data on the average number of rainy days per year to assist with this adjustment if required.

[22] TMR, "Active Transport Economic Appraisal Tool", available at: https://www.tmr.qld.gov.au/Travel-and-transport/Cycling/Cycling-investment-in-Queensland/Active-transport-economic-appraisal-tool, accessed 13th May 2024.

Figure 5: Indicative benefit break-down for active transport programs (PV, 20-year appraisal)



3.2.3 Limited induced demand benchmarking is publicly available

Limited project or program-specific data has been published on active transport demand forecasts, particularly demand analysis before and after an investment that isolates all the components of induced demand (i.e., new/generated trips, diverted car or public transport trips, or route switching)[23]. This break-down is important because of the relationship between the type of induced demand and the applicable benefits.[24]. Table 7 presents a high-level literature review supporting induced demand of up to 60% considering new/active transport and diverted car trips which contribute to health and decongestion benefits.

Table 7: High-level literature review of induced active transport demand

Source	Description
AECOM (2010)	13% new cycling trips and 10% diverted car trips for a public bicycle scheme in Sydney based on evidence from the City of Portland.
Transport and Main Roads (TMR) (2011)	Intercept surveys at four locations in Brisbane[25], with new/generated active transport trips ranging from 5% to 40% and diverted car trips ranging from 5% to 15%. See Table 8 below for a more detailed breakdown of the intercept survey results and Table 9 for additional Brisbane case studies applying these assumptions.
Sahlqvist et al (2019)	VicHealth Walk to School 2015 campaign participants had a 60% greater chance of participating in any active school travel post-campaign and engaged in school active travel for 1.4 trips per week more than non-participating students.
Kraus & Koch (2021)	48% more cycling trips in major European cities with bicycle lanes.
Fosgerau et al (2023)	60% increase in cycling trips from the Copenhagen cycling network.

Sources: AECOM (2010) "Inner Sydney Regional Bicycle Network – Demand Assessment and Economic Appraisal"; TMR (2011) "Benefits of the inclusion of active transport in infrastructure project"; Salqvist, S., Veitch, J., Abbott, G., Salmon, J., Garrard, J., Acker, F., Hartman, K., and Timperio, A. (2019) "Impact of an Australian state-wide active travel campaign targeting primary schools; Kraus, K., and Koch, K. (2021) "Provisional COVID-19 infrastructure induces large, rapid increases in cycling"; Fosgerau, M., Lukawaska, M., Paulsen, M. and Rasmussen, T. (2023) "Bikeability and the induced demand for cycling".

3.2.4 Additional breakdown of induced demand components

The most comprehensive source of induced demand benchmarks appears to be TMR (2011), which includes a more detailed breakdown of induced demand based on interception surveys at four locations (see Table 8 below). In the example active transport grant programs which targeted locations outside the Sydney CBD, these surveys support

[23] Active transport projects often include information about their objectives and expected benefits (e.g. Get NSW Active Program (TfNSW, 2024), and sometimes about current demand (e.g. Sydney Harbour Bridge Cycleway Access Program (TfNSW, 2022) and Oxford Street East Cycleway (TfNSW, 2024)), but rarely induced demand.

[24] The type of induced demand may impact the rule of a half (i.e. if route switching is not observed in the demand model or survey, then amenity and safety benefits should be estimated as half the average benefit to continuing users).

[25] Go-Between Bridge, Normanby Cycleway and Pedestrian Link, Ted Smout Bridge and Sir Leo Hielscher Bridge.

new/generated trips of between 30% (cycling) to 40% (walking) and car diversion of between 10% (walking) to 15% (cycling). They also demonstrate that route diversion can be significant (50%-70%) so care should be taken when attributing induced demand to health and decongestion benefits which are not applicable to changing routes.

Table 8: TMR (2011) induced demand intercept survey results

Source	Cycling		Walking	
Induced from:	Inner city	Other areas	Inner city	Other areas
Car	10%	15%	5%	10%
Public transport	20%	0%	15%	0%
Route switching	65%	55%	70%	50%
New/generated	5%	30%	10%	40%

Source: TMR (2011) "Benefits of the inclusion of active transport in infrastructure project"; Table 4.2 Suggested diversion rates by mode and project location, p33; cited in ATAP M4.

TMR (2011) also presents nine Brisbane case studies applying these assumptions, which are summarised in Table 9 below. Some of these case studies include even higher levels of new/generated demand (e.g., up to 52% for cycling and 50% for walking).

Table 9: TMR (2011) induced demand project examples

Source	Cycling			Walking		
	Daily Trips*	**Car%**	**New %**	**Daily trips***	**Car %**	**New %**
Centenary Motorway (Wacol to Darra)	68	10%	5%	50	5%	10%
Darra to Springfield Transport Corridor	164	25%	37%	30	0%	50%
Dinmore to Goodna Transport Corridor	970	5%	33%	261	8%	40%
Houghton Hwy Duplication (Ted Smout Bridge)	970	5%	33%	261	8%	40%
Gateway Upgrade Project	164	25%	37%	30	0%	50%
Normanby Cycleway and Pedestrian Link	440	10%	10%	228	1%	29%
Go-Between Bridge	1,079	5%	5%	495	3%	15%
Moreton Bay Rail Link	970	5%	52%	261	8%	40%
North Brisbane Cycleway	3,500	10%	5%	261	5%	10%

*Note: *Average daily demand, opening year. Source: TMR (2011) "Benefits of the inclusion of active transport in infrastructure project"; Table 6.1 Scenario assumptions, p38.*

3.2.5 Addressing induced demand uncertainty through price elasticity of demand

It is possible to estimate induced demand "bottom-up" based on the estimates of demand elasticity to changes in underlying factors[26]. However, there is significant variability in both values and units for these demand elasticities (below), and no consensus on the preferred approach. As a result, ATAP M4 guidelines suggest that practitioners estimate active travel demand changes using generalised cost elasticity values of -0.5, -1.0 and –1.5[27]

Table 10: Comparison of active transport demand elasticity estimates

Parameter	Measure	Elasticity	Change
Walking			
Cervero and Kockelman (1997)	Non-private vehicle choice for non-work trips	0.09 / 0.12-0.18	Avg. path width / walking quality factor
Rodrıguez and Joo (2004)	Walk mode choice (commute)	1.23	Path m^2
Fan (2007)	Daily walking time per person	0.12	Footpath length
Ewing et al. (2009)	Walk mode choice	0.27	Path m^2
Douglas, Jones and Whatley (2022)	Walking trips	0.78	Walk environ. rating

[26] Demand elasticity measures the change in active transport trips in response to a change in another variable. An elasticity of 1.0 means there is a 1% increase in demand for every 1% increase in the other variable.

[27] ATAP M4, p47.

Parameter	Measure	Elasticity	Change
Cycling			
Marshall and Garrick (2010)	Bicycle commuting %	0.34 – 0.36	% streets with bike lanes
Dill and Carr (2003)	Bicycle commuting %	0.32	Bike lanes/km^2
Fosgerau et al. (2023)	Bicycle induced %	0 to -6.5*	Generalised costs
Active transport			
ATAP M4	Active transport demand %	-0.5, -1.0, -1.5	Generalised costs

Source: Infrastructure and Planning Ministers (2023), "M4 Active Travel – Background Report"; ATAP M4, p47; Fosgerau et al. (2023) "Bikeability and the induced demand for cycling", Figure 2.
Note: Fosgerau et al. (2023) estimate a price elasticity of demand function for cycling where elasticity decreases almost linearly from 0 to −6.5 as generalised increase from $0 to $7 per trip. This implies that a 10% reduction in generalised costs for longer cycling trips would result in a 65% increase in demand.

3.2.6 A benchmark approach to induced demand

In the example active transport grant programs, induced demand benchmarks of between 10% to 40% were developed for each group of similar scope items considering the type and scale of infrastructure and whether it is likely to induce behavioural change. These were also compared to bottom-up estimates of induced demand based on ATAP M4 price elasticity of demand with respect to generalised costs of travel (see Section 4.1 below).The maximum induced demand uplift of 40% was only applied to quietways and shared zones, while the medium scenario of 20% was only applied to shared paths 3.0m and road closures. A bespoke approach was developed for place-based pilots[28].

Table 11: Induced demand benchmarks from the example active transport grant programs

Category	Scope items	Induced
Education & behaviour	Signposting, wayfinding	-
	Campaigns, digital portal	10%
Kerbs & crossings	Kerbs, pedestrian thresholds, zebra crossings	
	Wombat crossings, signalised crossing legs	10%
	Signal changes	-
Paths & separated street space	Continuous footpaths/treatments	-
	Footpaths 1.8m wide, widening	10%
	Pop-up/temporary cycle paths	10%
	Shared paths 3.0m	20%
	Place-based pilots (lighting, activation, landscaping)	14%
	Road closures	20%
	Quietways, shared zones	40%
	Tree canopy	-
End-of-trip	Bicycle hoops, sheds, pump and maintenance station	-

4 Additional tools and techniques to address uncertainty

Economic appraisals of active transport should include rigorous sensitivity and scenario testing of the impact of changes to benchmarks and other assumptions. Additional tools and techniques to address uncertainty in economic appraisal of active transport grant programs include price elasticity of demand, break-even and mode share analyses. Post-completion review may also provide a valuable tool to validate initial estimates, providing a feedback loop to inform assumptions for future grant programs. However, this was not a part of economic appraisal of the example active transport programs being profiled in this paper.

4.1 Price elasticity of demand with respect to generalised costs

Analysis of price elasticity of demand with respect to generalised costs was used as an additional check on the induced demand benchmarks. This provides confidence in the relationship between the benefit benchmarks and induced demand benchmarks because a

[28] Place-based pilots targeted personal safety of women, girls and gender diverse users travelling near train stations late at night or early in the morning. Induced demand benchmarking assumed a 50% reduction in the gap between female and male active transport participation over 10 years. Based on Cycling and Walking Australia and New Zealand (2023) "National Walking and Cycling Participation Survey" which estimates 59% of females currently feel unsafe in public places compared to 31% of males. Halving this gap was equivalent to a 14% reduction, falling between the low and medium scenario.

40% improvement in personal safety and amenity is estimated to result in induced demand of up to 27% to 37% (walking) and 30% to 45% (cycling). These estimates are likely understated for several reasons[29].

Table 12: Analysis of elasticity of demand with respect to generalised costs

Input	Walking	Cycling
Distance[1]	0.65km (0.5-0.8km)	1.7km (0.9-2.5km)
Speed[1]	5km/hr (4-6km/hr)	15km.hr (14-16km/hr)
Time[1]	8.5 mins (5-12 mins)	7 mins (4-9 mins)
Generalised costs – time only[2]	$2.93 ($1.72-$4.13)	$2.43 ($1.16-$3.69)
Generalised costs – time + crashes[2]	$3.94 ($2.22-$5.83)	$3.66 ($1.81-$5.50)
Benefits (personal safety + amenity)	$0.18, $0.36, $0.72 (10%, 20%, 40%)	$0.18, $0.36, $0.72 (10%, 20%, 40%)
% change generalised costs – time only[3]	-6%, -12%, -25%	-7%, -15%, -30%
% change generalised costs – time + crashes[3]	-5%, -9%, -30%	-5%, -10%, -20%
Demand elasticity (ATAP, M4)	-0.5.-1.0,-1.5	-0.5.-1.0,-1.5
% induced demand – time only[4]	3%, 12%, 37%	4%, 15%, 45%
% induced demand – time + crashes[4]	2%, 9%, 27%	2%, 10%, 30%

Notes and sources:

1. Distance and speed assumptions are from Section 2.3 above. Speed is equal to distance divided by time.

2. Generalised costs including travel time are based on a private value of time of $20.62 ($June 2024) sourced from TfNSW (Aug 2024), p12. Crash costs of $0.99/km to $4.11/km (walking) and $0.72 to $1.82 (cycling) were sourced from ATAP M4, Table 2 Crash costs by mod per vehicle km (Dec 2022 dollars) and inflated to $June 2024 based on Sydney CPI. The range of crash costs reflects a hybrid human capital (lower bound) versus inclusive willingness to pay (upper bound). Crash costs are significant and not representative of all users in the example active transport programs (e.g. school children are permitted to cycle on footpaths), and so generalised costs have been estimated as a range, including and excluding crash costs. ATAP M4, p13 notes that bike maintenance and repair costs are unperceived and are expected to be small and so were not included in generalised costs.

3. Calculated as low, medium and high benefit scenarios divided by the mid-point of the range of generalised costs.

4. Lower bound estimates are likely understated as the low benefit scenario has been applied to the low elasticity.

4.2 Break-even analysis

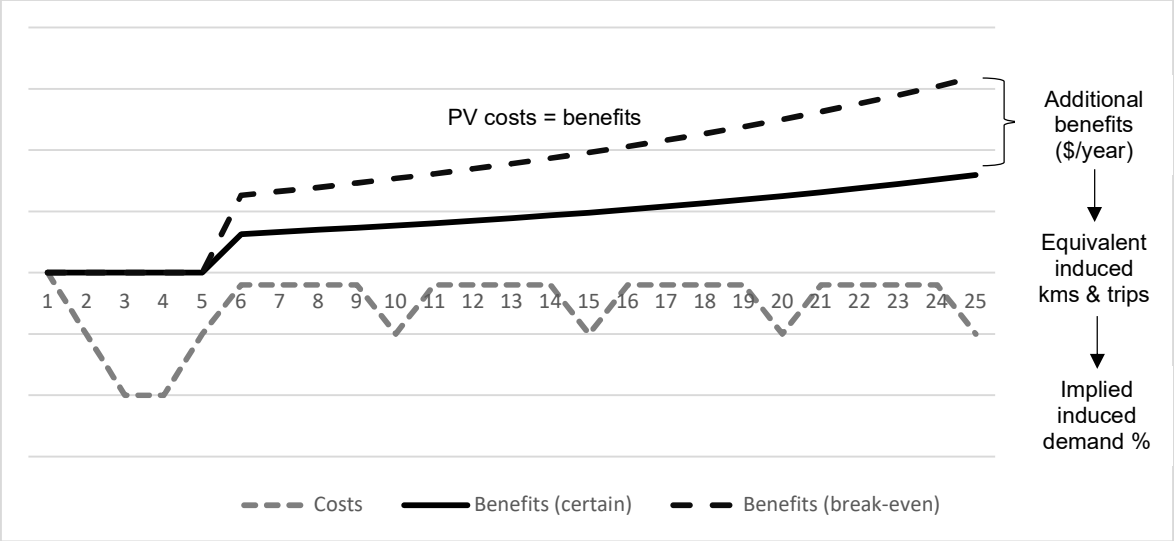
Break-even analysis is a valuable tool where costs and some benefits are known with relative certainty, but there are significant unquantified benefits or uncertainty as to their magnitude. Key steps are outlined in the stylised example in Figure 6 below and include:

- Develop a discounted cash flow model that includes costs and benefits where there is a relative degree of certainty and excludes those that are uncertain and need to be tested. In the example active transport programs this included lifecycle costs and personal safety and amenity benefit for continuing users but excluded health and decongestion benefits based on induced demand.
- Back solve the annual benefits required for discounted benefits to equal costs (i.e. a benefit cost ratio of 1.0, or neutral NPV) and converting it to an equivalent metric such as average user benefit ($ per trip) or induced trips. In the example active transport programs, this was based on calculating the implied percentage uplift[30] which was then compared to available benchmarks (Section 3.2 above).

[29] There are significant ranges in some assumptions, but the central estimate is generally taken forward to subsequent steps. In the final steps of the calculations, low benefit benchmarks are also applied to the low-price elasticity, and alternative sources to ATAM M4 include significantly higher price elasticity benchmarks (e.g., Fosgerau et al (2023) for cycling).

[30] Note that care must be taken in interpreting results that include broad education and behavioural change programs as there may not be a direct relationship between direct users of the infrastructure being funded and the induced demand uplift. It is also important to ensure there is not double counting of induced demand from the infrastructure and the broader program.

Figure 6: Break-even analysis (stylised example)

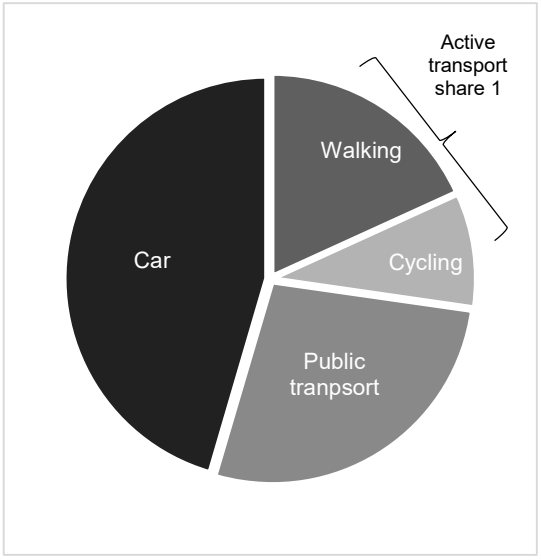


4.3 Mode share analysis

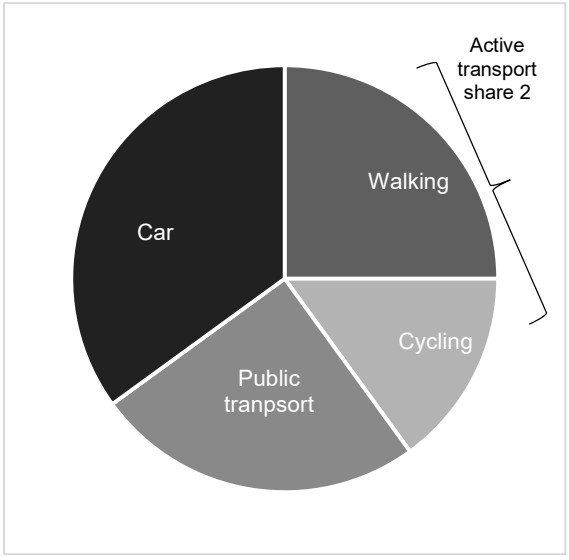
Mode share analysis provides an additional check on the reasonableness of induced demand forecasts where investments are focused around a common trip destination (e.g., schools or train stations). Comparison of mode share before and after the investment can be compared to benchmarks from comparable locations and/or tested with SMEs.

Figure 7: Mode share analysis (stylised example)

a. Baseline mode share



b. Implied mode share (incl. induced demand)



Note: In the example active transport grant program, train station mode shares were available from TfNSW (e.g. TfNSW (2013) "Train Statistics") and school mode shares were calculated based on average students per NSW primary school (i.e. 299 based on ABS 2023), total schools targeted by the program, and train the current active transport mode share (15%[31]).

5 Conclusion

There are several approaches available to address limitations in the economic appraisal of active transport grant program because of uncertainty around scope, demand data and

[31] Although, it should be noted that mode share change may be misleading if induced demand includes parents, carers or the local community who also benefit from active transport infrastructure around schools. For example, education and behavioural change campaigns will have broader impact than the direct users of infrastructure.

forecasts of induced demand. These include categorising similar scope items and benchmarking unit costs, benefits, demand and induced demand. The following approach summarised in Table 13 was applied to estimate benefits in the example programs:

- **Existing user benefits** – Units of Scope (B) x Annual Demand (C) x Benefit parameters (D, E, F) x Growth Rate (% per annum)[32].
- **New (induced) user benefit** – Units of Scope (B) x Annual Demand (C) x Induced Demand % (G) x New User Parameters (H) x Growth Rate (% per annum).

Table 3: Integrated active transport appraisal framework

Category	Scope items (A) & units (B)	Demand (C)	Safety (D)	Amenity (E)	Other[1] (F)	Induced[2] (G)
Education & behaviour	Signposting, wayfinding	Avg. path	-	-	Info. (10%-20%	-
	Campaigns, digital portal	Website	-	-	Info (40%)	10%
Kerbs & crossings	Kerbs, pedestrian thresholds, zebra crossings	25% of path	10%			
	Wombat crossings, signalised crossing legs			20%		10%
	Signal changes				Wait time (30s)	
Paths & separated street space	Continuous footpaths/treatments	Avg. path		10%		
	Footpaths 1.8m wide, widening			20%		10%
	Pop-up/temporary cycle paths		10%-20%	10%		10%
	Shared paths 3.0m		20%	20%		20%
	Place-based pilots (lighting, activation, landscaping and public art)	25% station access	20%-40%	10%-20%		14%
	Road closures	Avg. path	40%	20%		20%
	Quietways, shared zones	High path	40%	40%		40%
	Tree canopy	Avg. path			Walk Environ.& Climate[3]	
End-of-trip	Bicycle hoops, sheds, pump and maintenance station	15 per location			Cycling facility[4]	

Notes: 1. Other category includes information, wait time (from signal phasing), tree canopy amenity and greenhouse gas emissions and end-of-trip cycling facilities. 2. Health and decongestion benefits are only applied where there are new active transport trips, and decongestion is only applicable where there is diversion from car.3. Tree canopy benefits include amenity based on Walk Environment Quality parameters from TfNSW (Aug 2024), and greenhouse gas emission savings parameters from NSW Department of Planning, Housing and Infrastructure (DPHI) (October 2023) assuming medium trees. 4. End-of-trip facility benefits were based on UK WebTAG Data Book (Nov 2023) values for secure parking facilities and changing and shower facilities, multiplied by 50% to reflect overseas willingness to pay values and potential differences in specification in the grant programs (e.g., bicycle hoops).

This paper also identified additional tools and techniques to deal with uncertainty price elasticity of demand, break-even and mode share analyses can provide more confidence that the program as a whole will provide value for money despite other limitations. However, three areas have been identified that would benefit from further consideration:

- Publication of project or program-specific active transport data that shows active transport demand before and after investment, the results of intercept surveys and/or benchmark assumptions from other active transport economic appraisals.
- Refinement of price elasticity of demand estimates with respect to generalised costs, and more certainty in guidelines around their application.
- Post-completion reviews that compare active transport investment outcomes with assumptions in the economic appraisal and using these as a feedback loop to improve benchmark assumptions on future appraisals.

[32] In the NSW active transport program assumed to be the long-term population growth rate.

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