Projects

Contents

Dive into our world of data wizardry through a selection of our standout projects. Each example is a testament to how Enlightened Data's expertise in analysis and modeling can illuminate the path to strategic decisions and impactful solutions.

Values of Road Safety

2017-11-01 to 2024-02-29 Last compiled: 2024-03-09

Client: Austroads.

Methodology:

- Data collection: Stated Preference Survey.
- Data analysis: Advanced Choice Modelling.

Partners: Deloitte Access Economics and Taverner Research.

Background

Have you ever pondered how the worth of road safety is gauged by economists, or in other words, how they determine the value of a human life in these analyses?

The **Value of Statistical Life** (VSL) is a fascinating concept used to tackle these questions, especially when it comes to making our roads safer. Instead of putting a price tag on life itself, VSL estimates how much people are collectively willing to spend to reduce the risk of fatal accidents. For instance, if a group is ready to pay $50 each for a safety feature that lessens the chance of a fatal car accident by 1 in 100,000, then the VSL is pegged at $5 million ($50 x 100,000). This calculation helps in assessing whether the cost of road safety measures, like new traffic signals or stricter speed enforcement, is justified by the benefits, namely saving lives and preventing injuries. It's a way for decision-makers to prioritise safety measures and make informed choices, ensuring that investments in safety deliver the most *bang for the buck* in protecting our communities.

How could modellers estimate the amount of money that **people are collectively willing to spend to reduce road cashes** and **the chance of involving in a certain type of road crash** such as fatal or major injury that requires hospitalisation? Economists term these concepts a **Willingness To Pay** (WTP) value and a **crash probability**, respectively. These are the two vital inputs for the estimation of the VSL.

What do we need the estimate these values? Two things, really. High quality data and good behavioural models.

Collecting data

Collecting high quality data is time-consuming and this is the reason why this project takes more than 5 years from inception (2017) to completion (2024). Obviously, the Covid-19 pandemic severely delayed and disrupted the study. Not withstanding this, multiple waves of data collection, from pilots in selected states to a national studies, took a lot of time. Multiple survey administration methods, including online self-guided to online-guided and face2face interviews were tested to select the most appropriate method that delivers high quality data within the budget and timeline.

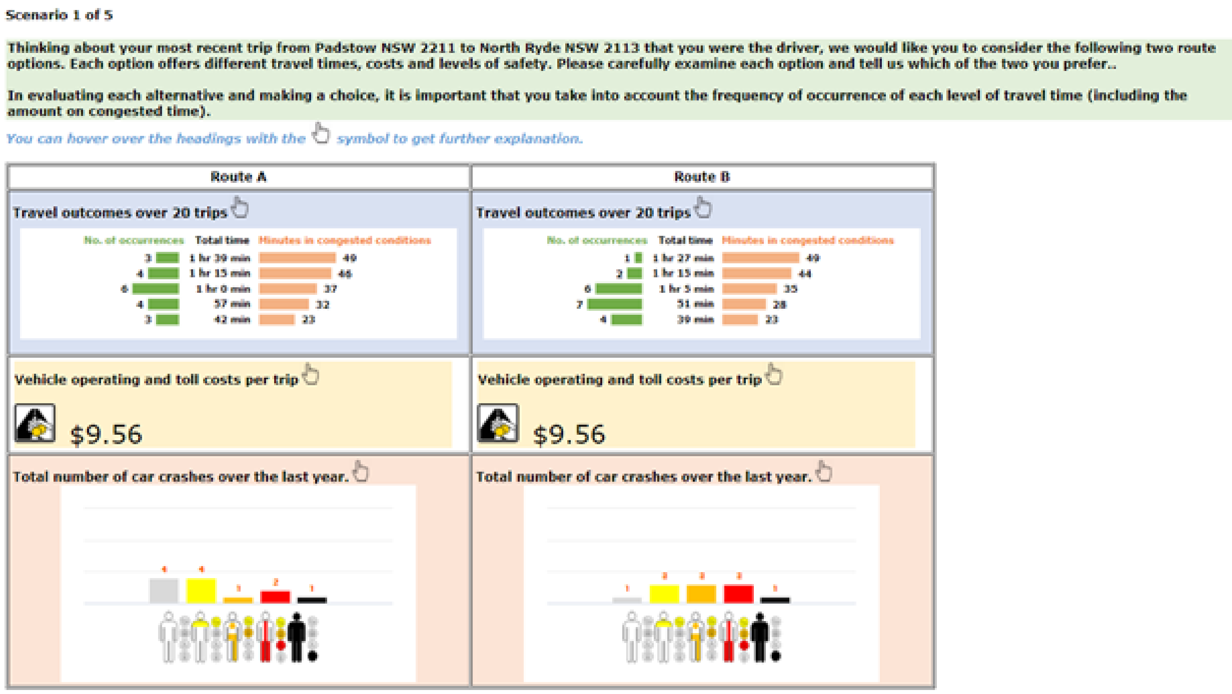
Survey administration methods

This study marks the first attempt to use a WTP (Willingness to Pay) approach to simultaneously estimate national values for time, reliability, and safety in road travel. As these values are being determined for the first time, significant time and effort were invested in the design, testing, and review phases before launching a comprehensive national survey.

The survey comprises three phases: design, pilots, and national survey (wave 1 and wave 2) with cognitive interviews and feedback between phases to improve the survey instruments. Overall, nothing beats face2face interviews, which had to be replaced with online-guided interviews in Wave 2 of the national survey due to *physical distancing* measures imposed by Covid-19.

The Stated Choice Experiment

Centred to this national study of WTP is a SP experiment that face the participants five sets of route choices, each choice consisted of two options. The two options had varying estimates of safety, cost, and travel time, where travel time was given as a range to reflect differing reliabilities (see Figure below).



The attribute levels (cost, time, reliability, and safety) of the choice experiments were chosen using *Bayesian efficient designs*. These optimise the attribute levels based on each respondent's reported trip details obtained from the background questions that preceed the SP experiment. The aim of the *Bayesian efficient designs* is to minimise the standard deviations of errors in the model coefficient estimates.

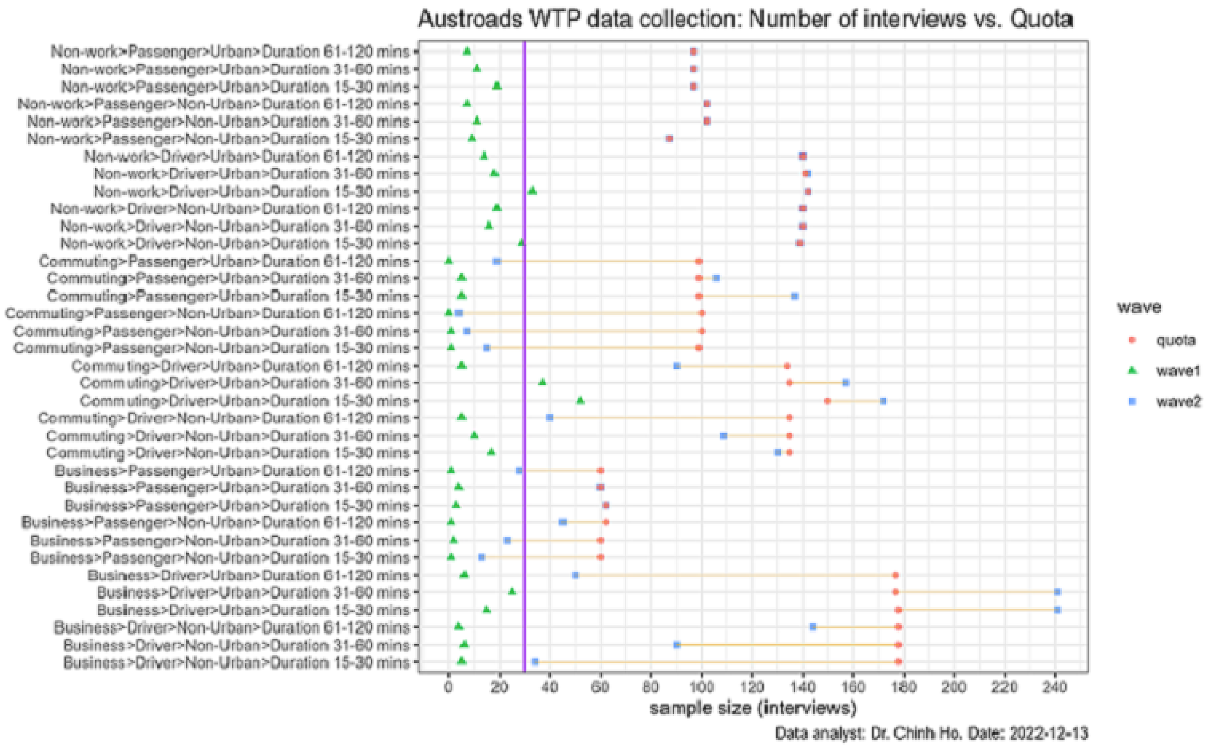
Survey sampling

The survey used a **stratification sampling with quota** to obtain enough sampels for the requirement of separate WTP values for different travel purposes. Samples are proportionate to the population of each State/Territory. Quotas were also employed for jurisdictions, drivers and passengers, and metropolitan and regional locations to ensure the survey results accurately represented nationwide averages.

In the field work, recruitment took place in both urban and regional settings so that travellers outside major (capital) cities would also be included. The split of the samples (i.e., respondents) between urban vs. rural location was matched with corresponding statistics derived from the ABS 2016 Census Journey to Work (JTW) to obtain an expansion factor (i.e., weight) for each observation. In the absence of reliable statistics on urban/rural split for business and non-work trip purpose, the matching process used statistics for the Census JTW data for all trip purposes. The WTP values estimated from the model were then aggregated using the expansion factors to give weighted average values that could be used consistently for all travellers in all parts of Australia.

Final sample size

The National Survey captured a large sample of respondents and provided enough variation to ensure reliable and statistically significant results. However, the sample for the National Survey had approximately 650 fewer participants than initially planned, as some segments such as business travel and passenger trips in regional areas were extremely difficult to find post Covid-19. The figure below shows the shortfall of the final sample vs. targeted number.



Thus, we make efforts to use the pilot samples as much as possible. This brings the total sample closer to the target number.

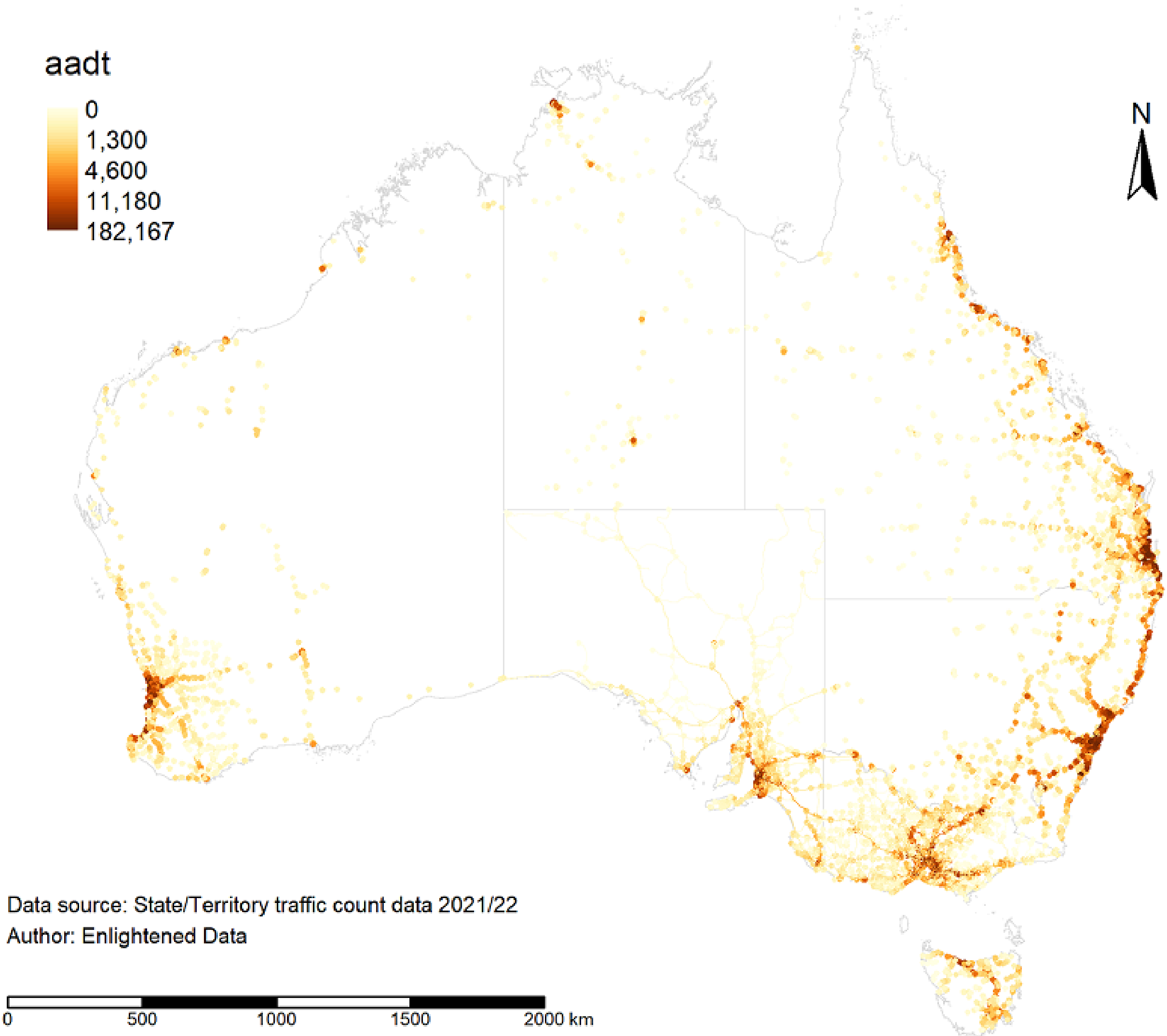
Collecting crash probability data

The crash probability, measuring the risk of exposing to road crashes is needed to estimate the WTP for reducing the number of crashes by one, for each severity class. Five severity classifications were represented in the survey. They correspond with fatal, incapacitating, major, minor injury and property damage only. Comparing to the classifications used by Australian jurisdictions, the study introduced the incapacitating injury which was considered necessary because the range of severities for hospitalised injuries is very large, ranging from an overnight stay to life-long incapacity.

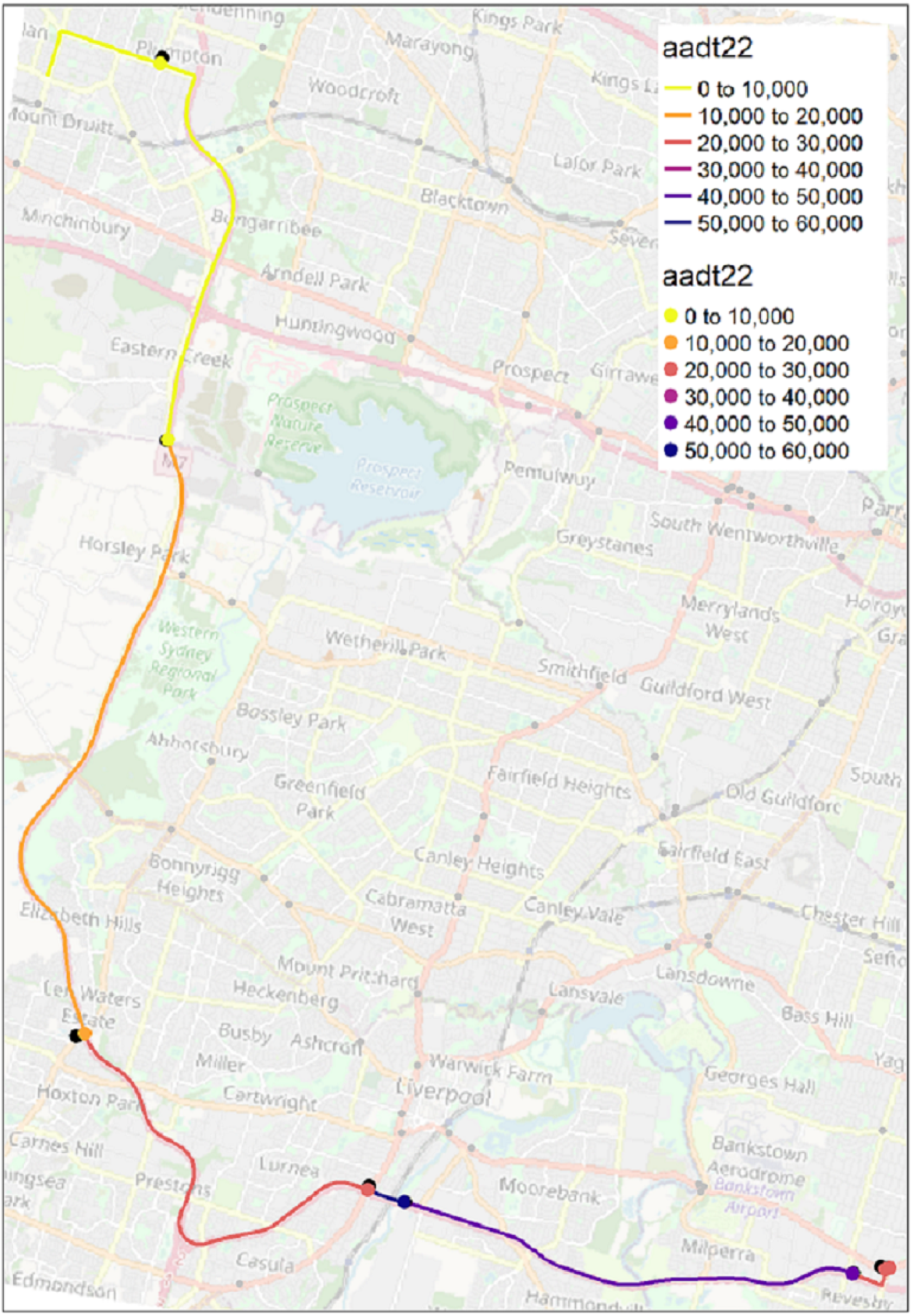
The survey instrument presented the numbers of crashes in each severity category along the route of the trip over a period of a year. If the modelling was undertaken using SP data alone, the WTP value obtained would be WTP per trip for a reduction in the number of crashes, in a given severity category by one per year. This is termed the **subjective value of crash risk reduction** (SVCR).

For a given crash severity, the **Value of Risk Reduction** (VRR) is obtained by multiplying the SVCR by the level of crash exposure (number of opportunities for a crash) in a year. The exposure measure for each trip per annum was taken as the distance-weighted **average annual daily traffic (AADT)** level times 365 along the route of the trip. As the level of crash exposure varies between trips, the conversion was undertaken at the individual trip level. The number of crashes in each survey response was divided by the distance-weighted AADT times 365 for the trip to convert it to the annual probability of a crash occurring. The WTP value estimated from data expressed in crash probabilities is then the required VRR.

Transport authorities from various states and territories provided AADT data, which was standardised and indexed by year. Transport authorities in Australia estimate the AADT using traffic count data obtained from counters placed at various points/stations across the road networks. The location of these counters, and hence data coverage of the AADT, is shown in the Figure below.

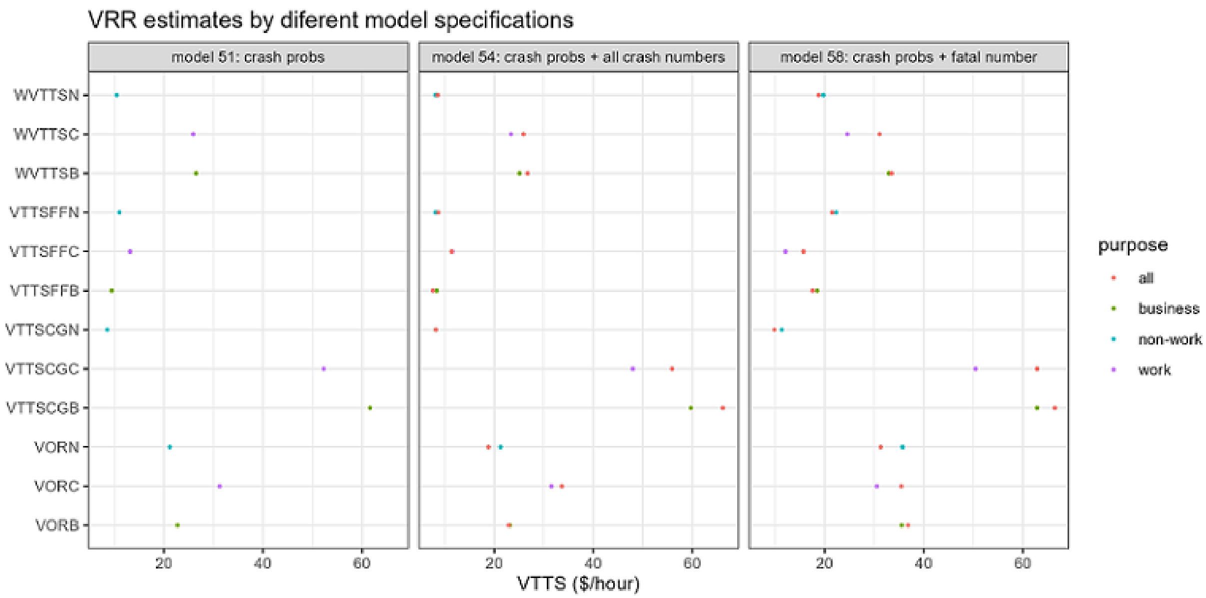


Survey respondents were asked to provide the suburb of origin and destination of their trips, allowing for an optimal route (shortest time) to be determined through Google Maps. There were 3,885 unique routes identified for all origin-destination pairs, across all surveyed people, excluding intra-zonal trips. The reported trips span a wide geographical area of Australia and spread between urban and regional areas. AADTs for segments along the route for each trip were estimated for all identified routes across the entire survey sample. Since the AADT varies over the length of the route for each trip, the distance-weighted average was taken after snapping the traffic count data to each route and split it up to segments. The Figure below shows an example route between Bankstown and Mount Druitt in Sydney which went through a few traffic counters that provide the AADT data.


aadt22
0 to 10,000
10,000 to 20,000
20,000 to 30,000
30,000 to 40,000
40,000 to 50,000
50,000 to 60,000
aadt22
0 to 10,000
10,000 to 20,000
20,000 to 30,000
30,000 to 40,000
40,000 to 50,000
50,000 to 60,000

Developing behavioural models

When it comes to model development, there is no shortcut. It is an interactively process of testing different model specifications, validating the results, and selecting the best models based firstly on their *behavioural outputs* (elasticity, willingness to pay, marginal rate of substitution) and secondly on statistical tests such as model *goodness of fit*. Literal, hundreds of models have been estimated such that the best one can be found. While automation and programming help us make this process a bit less daunting, there is really no shortcut.



Estimating the VSL

Once the best model has been found, we can use it to derive the economic values, which in this case, are the willingness to pay for time saving and risk reduction. ATAP will publish these values in due course for the estimation of benefits of transport and safety projects.

Valuing Urban Realm

2023-05-20

Client: Sydney Metro

Methodology:

- Data collection: Stated Preference Survey
- Data analysis: Best-Worst Choice Modelling

Partners: Deloitte Access Economics and Taverner Research

Objectives

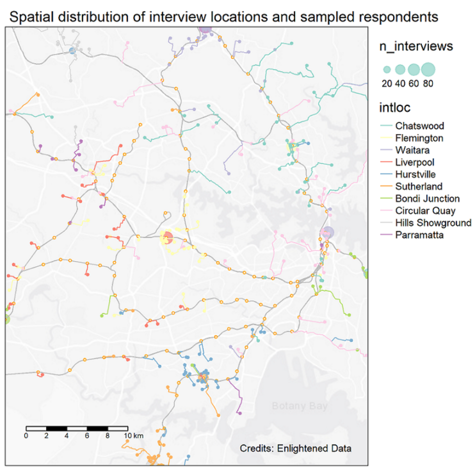
The amenity benefits from improved urban realm in station precincts are increasingly being recognised as a critical part of a transport project's development and are receiving more focus from project teams. However, the approaches to value and incorporate these considerations into project option design and business cases are not appropriate for the modern-day Australian context.

To address these limitations, Sydney Metro engaged Deloitte Access Economics and Englightened Data to develop contemporary WTP values for amenity benefits from improved public realm attributes in station precincts. The WTP values were to be derived in units that were more appropriate for their intended purpose such as on a per householder or per trip basis

Data collection

We use SP surveys to understand how people might behave in different environments of a station precinct. In these experiments, respondents are asked to choose between different options that have both desirable and undesirable characteristics. We design a Best-Worst experiment based on the review of similar studies and input from the clients.

We work with Taverner who recruited and conducted face2face survey across 10 stations in Sydney. The interview locations and repsondents' are shown in the Figure below. These locations were selected to cover the geography of greater Sydney as well different types of station users such as residents, visitors and non-rail users.



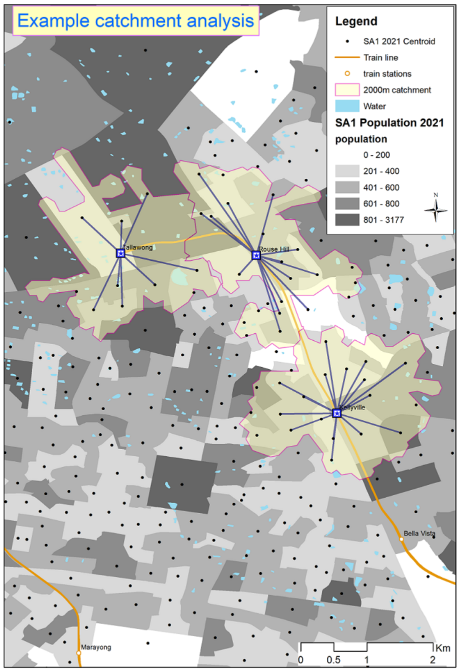
Analysis method

Best-Worst model

Numerous models were tested and estimated. The best model, identified via log-likelihood ratio tests, took the form of a Best-Worst Generalised Mixed Logit model type II, also known as a hybrid model of scaled MNL and mixed logit. With a sample size of 400+ respondents, the Best-Worst survey and modelling technique helps us double the number of observations, which in turn deliver more reliable parameters and hence WTP values.

Catchment analysis

Once the WTP were estimated, we need to apply the value to the case of Sydney. To this end, a catchment analysis is deployed to estimate monthly numbers of train trips per visitor and per resident, respectively. An example is shown in the Figure below.



Outcomes

For application of these WTP values in business cases and economic appraisal, it is necessary to convert the WTP estimates delivered by the best model to the value per use (i.e., $/train trip). Catchment analyses were conducted, using four alternative catchments of 500m, 800m, 1000m, 1200m walking distance from each of the 10 interview locations. The resulting catchments were then intersected with the Sydney HTS data to estimate the average train trips per household per month. The 500m catchment results in the highest average number of monthly train trips per household (31.72). The average number of monthly train trips per household appears to be stable at around 27 trips/household/month for catchments between 800m and 1200m. Using this average, we calculate the average WTP per use for rail users. To estimate annual non-use value in business cases, we can just multiply the $/household/month with 12 months and the total number of non-rail households residing in the station precinct (e.g., 1km).

WTP per trip for every 1 unit improvement to a PERS theme (e.g., - 2 to 1, or 1- 2, or 2-3)						
user group	**Sense**	**Safe**	**Opp**	**Move**	**Comfort**	**Inter**
rail user ($/trip)	$0.03	$0.08	$0.07	$0.06	$0.09	$0.06
non-rail user ($/hh/month)	$0.00	$1.06	$0.43	$0.40	$0.50	$0.26

For more information, please see our paper published in Australasian Transport Research Forum (ATRF)