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Australian Transport Assessment and Planning Guidelines

Willingness-to-pay National Survey: Report 3: Final report and survey results

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- Deloitte Access Economics was engaged by Austroads to update the values of travel time savings and risk reduction for car users on Australia's roads and produce a value of reliability based on users' willingness-to-pay (WTP) values. This study seeks to update Australian guidelines from the current approach to a willingness-to-pay approach, in line with international standards.
- The willingness-to-pay values were derived through a nation-wide survey (the National Survey), utilising a discrete choice experiment.
- The project was undertaken between 2018 and 2022, with the timeline being significantly longer than anticipated because of interruptions that occurred due to the COVID-19 pandemic.
- The responses of 3,844 survey respondents were used to develop the final set of WTP values. The groups were weighted to ensure the resulting values and parameter estimates were proportionate to the expected distribution of incomes and trip distances.
- Separate values for travel time savings and reliability improvements were estimated for three trip purposes — commuting, non-work travel and business travel. The travel time saving value was also distinguished by traffic conditions — congested and free-flow — with an additional weighted value being derived for each trip purpose.
- The weighted average values for travel time savings were $31.10/hour for commuting, $33.53/hour for business travellers and $18.81/hour for non-work travellers.
- The value of reliability was measured in dollars per hour of standard deviation of travel time. The values were $35.50/hour for commuting, $36.87 for business travellers and $31.35 for non-work travellers.
- The ratio of the value of reliability to the value of time is known as the reliability ratio. These were 1.1 for commuting, 1.1 for business travellers and 1.7 for non-work travel.
- The value of risk reduction was split into five categories of road crash severity: property damage, minor injury, major injury, incapacitating injury, and fatality.
- The findings for the value of safety were that there is a willingness-to-pay of $16,000 to prevent a crash that only results in property damage, $24,660 per crash to avoid minor injury, $500,010 per crash to avoid major injury, $1.455m per crash to avoid incapacitating injury and $3.664m per crash to avoid a fatality. These do not represent the full social cost of a crash.
- The survey and data analysis have been documented in detail to enable replication of the study in the future.

Transport decisions in Australia are guided by several processes and techniques, including cost-benefit analyses and road transport forecasts. The results from this current study will help better inform assumptions and econometric values used in these assessments, providing a more accurate measure of the economic and social impacts associated with infrastructure projects and regulatory changes. Willingness-to-pay for travel time savings and reliability is also an essential component of travel demand forecasting, which in turn informs the commercial viability of transport networks, and in particular toll roads.

Deloitte Access Economics was engaged by Austroads to update the values of travel time savings and risk reduction for car users on Australia's roads and produce a value of reliability based on users' willingness-to-pay (WTP) values. This study seeks to update Australian guidelines from the current approach to a willingness-to-pay approach, in line with international standards.

The survey was conducted nationally, using a Computer-Assisted Personal Interview (CAPI) with a discrete choice experiment that generated data for the estimation of values for travel time savings, reliability, and safety. The survey was undertaken across 2018 to 2022, with implementation delayed at multiple stages due to unprecedented interruptions caused by COVID-19 (i.e., lockdowns, physical-distancing, working from home). The disruptions impacted the progress of the survey, the ability to fulfil target sample size for some quota segments, and the quality of some survey responses, requiring ongoing reassessment of the most appropriate approach to data gathering and analysis. In the modelling, responses from 3,844 participants were used to develop a robust set of WTP values, which were weighted to ensure they represented the national population in terms of income group and trip distance, as derived from the ABS Census data (2016) and 3-year pooled National Visitor Survey data (2017/18 - 2019/20).

The survey sample was segmented by trip purpose into three segments depending on whether respondents were commuting, travelling for business, or travelling for a non-work purpose. Current practice in cost-benefit analysis of road initiatives is to group commuters and non-work travellers together, applying a single value of travel time savings. Separating them out and applying segment-specific values of time savings should improve the reliability of project appraisal results.

In the survey sampling process, the project team ensured recruiting took place in both urban and regional settings, to ensure travellers outside major cities would also be included. The WTP values estimated from the model were then aggregated to give values that could be used consistently for all travellers in all parts of Australia.

The value of travel time savings represents the amount a traveller would be willing to pay to reduce their trip duration by one hour. The results for travel time savings weighted by congested and free-flow traffic conditions are $31.10/hour for commuting, $33.53/hour for business travellers and $18.81/hour for non-work travellers. These results indicate work commuters and business travellers are willing to pay considerably more than non-work travellers per hour of travel time saved during their journey. These results also indicate that the average values of travel time savings for commuting, and employer-related business trips are almost the same.

The value of reliability, also measured in dollars per hour, can be interpreted as the willingness-to-pay to increase travel time reliability by one hour (reducing the standard deviation of travel time by one unit). This value was estimated at $35.50/hour for commuting, $36.87 for business travellers and $31.35 for non-work travellers. The results generally indicated similar findings across income levels, with a higher value of travel time and value of reliability ascribed to work-related trips. The ratio of the value of reliability to the value of time is known as the reliability ratio. These were 1.13 for commuting, 1.10 for business travellers and 1.67 for non-work travel.

The value of risk reduction was split into five categories of road crash severity: property damage only, minor injury, major injury, incapacitating injury, and fatality. WTP values to avoid a crash, were $5,330/crash for property damage only, $16,000 to prevent a crash that only results in property damage, $24,660 per crash to avoid minor injury, $500,010 per crash to avoid major injury, $1.455m per crash to avoid incapacitating injury and $3.664m per crash to avoid a fatality. The results show WTP increasing with crash severity, which is to be expected. The values do not represent the full social cost of a crash. Survey respondents do not consider costs incurred by governments and other road users from traffic delays and may not be able to estimate the present value of their forgone future consumption. Further detail on the interpretation of WTP values for safety and full cost of crashes is provided in a supplementary report by the ATAP WTP project director.

The results from this study have important implications for conducting cost-benefit analyses across a broad range of areas. The WTP values for time and safety differ significantly from the values currently in use. Reliability benefits from urban road projects are likely to be significant and have rarely been included in cost–benefit analyses to date. For the purpose of estimating time and reliability benefits, commuters will be treated as a separate group from non-work travellers.

This report also provides a baseline against which future estimated WTP values can be compared, providing a useful framework for future iterations and reviews. The survey and data analysis have been documented in detail to enable replication of the study in the future.

List of abbreviations

Acronym	Definition
AADT	Average annual daily traffic
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
ATAP	Australian Transport Assessment and Planning
AWE	Average weekly earnings
B	Business travel
BITRE	Bureau of Infrastructure and Transport Research Economics
C	Commute
CAPI	Computer Assisted Personal Interviewing
CaPPRe	Community and Patient Preference Research
CBA	Cost-benefit analysis
CG	Congested
CHF	Swiss Franc
CI	Confidence Interval
CPI	Consumer price index
DKK	Danish Krone
DOT	Department of Transport
EUR	Euro
FAT	Fatality
FF	Free-flow
GBP	Great Britain Pound
GP	General practitioner
GSMA	Greater Sydney Metropolitan Area
HC	Human capital
INC	Incapacitating injury
ITLS	Institute of Transport and Logistics Studies
JTW	Journey to Work
KPI	Key performance indicators
LCV	Light commercial vehicles
MAJ	Major injury
MIN	Minor injury

MNL	Multinomial logit
N	Non-work commute
NGTSM	National Guidelines for Transport System Management
NOK	Norwegian Krone
NPV	Net present value
NSW	New South Wales
NT	Northern Territory
NZ	New Zealand
OBPR	Office of Best Practice Regulation
PROP	Property damage
QLD	Queensland
RTA	Roads and Traffic Authority
SA	South Australia
SEK	Swedish Krona
SP	Stated preference
SRC	Social Research Centre
SVCR	Subjective value of crash reduction
SVTTS	Subjective value of travel time savings
TfNSW	Transport for NSW
TIC	Transport and Infrastructure Council
TT	Total time
UK	United Kingdom
US	United States
VKT	Vehicle kilometres travelled
VOR	Value of travel time reliability
VRR	Value of risk reductions
VSL	Value of a statistical life
VTTS	Value of travel time savings
WA	Western Australia
WFH	Working from home
WPI	Wage price index
WTP	Willingness-to-pay
WVTTS	Weighted value of travel time savings

1. Introduction and background

This report describes the implementation of a National Willingness-to-pay (WTP) survey to provide estimates of the value of travel time savings and reliability improvements as well as improvements to road safety for drivers and passengers of privately owned motor vehicles.

The report proceeds as follows:

- Chapter 2 provides a summary of the stages leading up to this report.
- Chapter 3 provides an overview of the implementation of the survey and subsequent data analysis.
- Chapter 4 breaks down the various issues faced in sampling and delivery of the survey results, including disruptions caused by COVID-19.
- Chapter 5 details the data handling and modelling techniques applied to the survey results.
- Chapter 6 discusses the results related to the value of travel time saving and reliability, and the value of safety.
- Chapter 7 explores potential future developments in incorporating the National Survey results.

1.1 Background

The study aims to enhance the efficacy of cost-benefit analysis (CBA) in Australia, while also enhancing the accuracy and reliability of road transport forecasting.

1.1.1 Cost-benefit analysis

As discussed in ATAP 'Part T2 Cost Benefit Analysis', transport decisions in Australia are guided by a range of planning and assessment processes in which CBA often plays the central role. CBA is a tool used to determine whether or not the societal costs of an infrastructure project, pricing or a regulatory change are outweighed by the societal benefits. It examines all the monetary and non-monetary or intangible costs and benefits of a policy to society, including economic, social, environmental, and other concerns. CBA aims to identify these impacts, in monetary terms, and produces a single measure of net benefit (benefits minus costs). If the result, expressed as a net present value (NPV), is positive — that is, total benefits exceed total costs — implementation of the initiative will be an economically efficient use of resources and Australia, as a whole, will be better off.

CBA is a widely accepted and well-established tool utilised by government and the private sector across a range of areas. It compares varying options related to the overall project. CBA can be applied to transport, infrastructure, and other non-infrastructure projects such as the introduction of new technologies or changed management practices.

CBA aims to value the impacts of projects based on individual preferences. So, the values used to measure social benefits and costs are obtained from market prices which indicate people's 'willingness-to-pay' for goods and services. For CBAs of road transport projects, benefits of savings in vehicle operating costs can be valued at market prices given by the costs of various inputs consumed. However, there are no market prices for travel time savings or improvements in variability of trip times or safety, so to determine the values, we must look to other sources.

1.1.2 Benefits

Travel time savings comprise the bulk of benefits in CBAs for most road-related projects, so it is important that the values used are robust. Less time travelling in cars can give people more time to spend on more enjoyable or productive activities, which may include travelling further or for longer to undertake work or recreation or provide the ability to commute to and from more affordable housing. Additionally, the value of risk reduction comprises the bulk of benefits in black spot projects and road safety initiatives.

The current practice to measure the value of time for CBAs of road transport projects in Australia is to use average earnings per hour for business time as the value of travel time savings (VTTS). This practice assumes that earnings represent the value of output forgone from time spent travelling. An amount set at around 40% of average earnings is used as the VTTS for commuting and non-work time based on research undertaken in the mid-1990s. The same VTTS values are used for drivers and passengers, with the single VTTS multiplied by average occupancy rates.

WTP unit values represent the full valuation a consumer places on a good or service. While average pre-tax earnings may represent what employers are willing to pay to save time for business travellers, it is not likely to represent the WTP of the business travellers themselves. Furthermore, technology allows people to work while travelling, particularly passengers, questioning the assumption that all time spent travelling is unproductive. The WTP value for non-work time currently in use is highly approximate and based on dated information. Also, it is only an assumption that the VTTS for commuting is the same as for non-work related purposes.

More reliable trip times mean people can more accurately estimate their travel times and hence require shorter ‘buffer’ times. Although it is accepted that reliability improvements are genuine benefits, they are not consistently valued in Australian CBAs of road transport projects. There is currently no agreed method in Australia to measure reliability of trip times, or value of reliability (VOR).

Road safety benefits typically comprise less than 5% of the total benefits for major road projects, however road safety improvements are the primary benefits for projects with a road safety focus, such as black spot projects, and non-infrastructure road safety initiatives. To estimate safety benefits in CBAs, unit values for costs per crash for different severity categories (fatal, serious injury, minor injury, property damage only) are applied to reductions in crash rates estimated to follow from road improvements.

1.1.3 Road Transport Demand Forecasting

Demand forecasting is an essential part in determining the commercial viability in toll roads. Multiple toll roads in the 2000s had over-optimistic patronage forecasts, leading to low returns on investment which threatened investor confidence. Therefore, a report by GHD was commissioned in 2011 which identified that research into WTP values for the VOR and VTTS are priorities to improve road demand forecasting. While average VTTS is required for most road-related CBAs, knowledge about the distribution of values of time is critical for toll road patronage forecasting, due to the fact that road users with relatively high values of time would be prepared to pay more to save time by using a toll road. More generally, information of the distribution of VTTS is valuable for forecasting demand responses for any future or planned road charging scheme.

1.1.4 Response to need to improve CBA and road transport demand forecasting

In 2015, the ATAP Steering Committee commissioned Deloitte Access Economics (Deloitte) to undertake a scoping study (the Scoping Study) to research recommended methodologies to develop updated values of reliability and distribution of travel time savings. This was done to improve the values that are used in CBAs and road demand forecasting.

The scoping study compared two methods to measure reliability — the mean-variance approach and the scheduling approach. The mean-variance approach yields a single VOR value as the marginal value of one standard deviation of travel time. The scheduling approach puts monetary values on minutes early and late relative to preferred arrival times. The scheduling approach is conceptually preferred, but it is quite complex to apply because it demands knowledge of travellers' preferred arrival times and provides more detailed results. The mean-variance approach is the simplest and most feasible way to include VOR in transport appraisals and as such was recommended for use in the ATAP Guidelines for private cars.

For private cars, the Deloitte Scoping Study recommended a stated preference survey methodology for the VTTS and VOR. In parallel, Austroads commissioned a scoping study, 'Social Costs of Road Crashes in Australia: The Case for Willingness-to-pay Values for Road Safety' (AP-R438-15), published in 2015 which also recommended a stated preference survey.

Given both studies recommended stated preference survey approaches, Deloitte was further asked to examine the feasibility using a single WTP stated preference survey instrument to collect data on values of time, reliability, and safety for private car users. They found that it was technically feasible to accommodate the three separate requirements in a single survey. This would require detailed piloting and guidance of respondents to ensure that they understand the questions, which would need a high level of detail to accommodate the requirements.

Based on this outcome, Deloitte began the WTP Survey project to implement a stated preference survey of the drivers and passengers of privately-owned vehicles. The recommended piloting was undertaken and is summarised in the next chapter. This report details the outcomes of the National Survey, which was the final stage of the WTP Survey project.

1.2 Project outline

The ATAP Steering Committee engaged Deloitte to develop updated values relating to WTP to provide estimates of the value of travel time savings and reliability improvements as well as improvements to road safety for drivers and passengers of privately owned motor vehicles.

To assist in this process, Deloitte Access Economics team included academic and survey specialists to support the end-to-end delivery of this study. These include:

- Enlightened Data's Dr Chinh Ho (Senior Lecturer at the University of Sydney) led the econometric modelling for this project and assisted with the survey design.
- Professor David Hensher, of the Hensher Group, assisted with survey design and data analysis for the project.
- Professor John Rose, Dr Edward Wei and Dr Simon Fifer of Community and Patient Preference Research (CaPPRe). Professor Rose conducted survey design and data analysis, Dr Wei conducted survey design and, along with Dr Fifer, survey implementation.
- Taverner Research administered the surveys across the project, through in-person intercept surveys, online self-complete and online guided surveys.

All attributions in this report refer to the joint team led by Deloitte Access Economics.

2. Chapter 2 – Previous stages of the WTP Survey

This study is the first time a WTP approach has been attempted to estimate national values of time, reliability, and safety together for road travel. Due to this study establishing these values for the first time, considerable time and effort has been put into designing, testing, and reviewing prior to undertaking a full large-scale national survey. This was essential to manage the risks involved in creating such a survey and to ensure that survey was able to be validly undertaken by respondents despite the inherent complexity of the survey instrument. The work undertaken prior to the National Survey is summarised in Table 2.1.

2.1 Stage 1: Survey instrument design and test

In 2016-17 Deloitte, in partnership with Professor David Hensher, Professor John Rose and Dr Chinh Ho of the Institute of Transport and Logistics Studies (ITLS), University of Sydney, completed the first stage of this work. Expert advice was also provided by Professor Simon Washington. Professor Juan de Dios Ortuzar peer reviewed this study. This work involved:

- Summarising travel time parameter values and reliability ratio estimates, that were expected to result from a national WTP survey in Australia.
- The drafting of a WTP survey instrument.
- Subjecting the survey instrument to initial statistical quality assurance including testing on two focus groups.
- Administering the survey in a mini-pilot test of 30 people.
- Analysing the results to determine whether parameter values could be derived from the survey instrument.
- Advising on a suggested range of sample sizes and segmentations for the next stage – a Pilot Survey.
- Advising on any additional items that could be considered in progressing the broader study, including recommendations to proceed with a combined (travel time, reliability, and safety) survey.

Table 2.1: Summary of prior actions to national survey

Year	Activity	Respondents
Stage 1: Design		
2017	Focus groups	2 groups with 10 participants
2017	External peer review by Prof. Ortuzar at Pontificia Universidad Católica de Chile	N/A
2017	Test on Deloitte employees	30
Stage 2: Pilot surveys		
2017	Victoria: Melbourne and Bendigo	130
2018	Queensland: Brisbane and Toowoomba	132
2018	WA: Perth and Bunbury	141
Stage 3: National Pilot		
2018-19	NSW: Sydney and Orange	110 surveyed, 105 usable
Stage 3: Independent peer review		
2018-19	Dr Benjamin Phillips, Social Research Centre of the Australian National University	N/A
Stage 3: Cognitive interviews		
2020	Persons interviewed after taking survey to assess comprehension	10
Stage 3: National survey		
2021	Wave 1, Australia: various (Table 3.11)	722 surveyed, 199 usable
2021-2022	Wave 2, Australia: various (Table 3.11)	3,442 surveyed, 3,356 usable

2.2 Stage 2: Pilot survey

In 2017-18 Deloitte, in partnership with Professor David Hensher and Dr Chinh Ho and CaPPRe, completed the second stage of this study, the Pilot Survey.

The Pilot survey was undertaken in three jurisdictions: Victoria (Melbourne and Bendigo), Queensland (Brisbane and Toowoomba) and Western Australia (Perth and Bunbury). The survey was implemented sequentially in each location, through both face-to-face and online methods.

Results were then analysed against the following set of key performance indicators (KPIs):

- That the majority of respondents state neutral, agree or strongly agree for the following questions:
  - Thinking about the scenarios, I could understand the information presented about my different travel options
  - The injury descriptions were easy to understand
  - The injury diagrams were easy to understand
- That all parameter estimates should have the expected sign
- That all parameter estimates should ideally be significant at the 5% level of significance
- That all parameter estimates should be significant at the 10% level of significance
- That parameter estimates should have the correct relative values
  - That marginal WTP for avoiding an injury should be higher for more severe injuries
  - That VTTS for business related travel is expected to be higher than VTTS for non-business travel
  - That VTTS for commuter travel should be within a reasonable range of the relevant average hourly wage (for example, 30%-150%).
    - Based on "Earnings; Persons; Full Time; Adult; Ordinary time earnings; New South Wales"; in May 2017 of $1,545.80. Assuming 40 hours worked per week this gives an hourly value of $38.65.

The primary results from the Pilot were broadly consistent with the results seen in the literature. The results also demonstrated good performance in terms of how parameter estimates aligned with the hypothesised expectations, previous experience, and statistical significance.

Overall, the Pilot indicated that:

- There was strong performance relating to the KPIs, with the only unachieved KPI, minor injuries being statistically insignificant at the 5% level, likely to be satisfied by a larger sample.
- In general, respondents found the information about crashes and injuries reasonably easy to understand.
- Reliability proved to be a challenging issue for design and for communicating with respondents.
- The parameter values achieved are within the range of values seen in previous studies and also show good performance in terms of comparability– particularly for injuries.
- Deloitte recommended that ATAP undertake a well-structured National Survey, preceded by a National pilot, to confirm the Pilot results.

2.3 Stage 3: Peer review and response

In 2018, the ATAP WTP Working Group engaged the Social Research Centre (SRC) of Australian National University to review the survey instrument. This review, carried out by Dr Benjamin Phillips, was in response to concerns regarding the relative complexity of the choice task in the survey instrument. The review sought to determine whether respondents understood what was being asked of them and to ensure that the quantitative results from the survey were not the product of survey design and statistical modelling but were a true representation of the preferences of survey respondents.

The principal recommendation of the Peer Review Report was to conduct a rapid round of 8 to 12 ‘cognitive interviews’ to determine empirically whether respondents understand the travel time and reliability information presented to them and whether they consider all the information presented to them in the choice tasks.

The SRC also provided the WTP Working Group with a number of suggested simplifications to the survey instrument.

Deloitte, Hensher, Enlightened Data and CaPPRe reviewed the SRC’s recommendations, conducted the recommended cognitive interviews and considered a specific query relating to the presentation of injury categories. They were also asked to consider some further suggestions for simplification from the ATAP WTP Working Group.

As a result of the SRC peer review and associated consideration, the survey instrument was adjusted to include:

- Provide survey respondents with a single sum of ‘travel costs’ in place of separate toll and running costs.
- Add a statement that made it clear that the crash/injury profile of the two routes in each choice task are directly comparable.
- Remove identified unnecessary icons through the SRC peer review.
- Show all injury categories even if the occurrence level is 0.

The peer review report is summarised in Appendix B.1 and the report on the cognitive interviews is attached in appendix B.2.

2.4 National Pilot

Deloitte, again in partnership with the Hensher Group and CaPPRe, were engaged in November 2018 to undertake a National Pilot. This survey was undertaken in Sydney and Orange in New South Wales and consisted of 105 face-to-face interviews with drivers and passengers of privately owned vehicles. Respondents were presented with a series of five choice experiments that were used for estimating WTP values for VTTS, VOR and road safety. The choice experiment design was identical to that used in the Western Australian pilot survey, so it was possible to pool data from NSW with WA if needed.

The value of travel time savings, reliability and willingness-to-pay for damage from this survey were generally consistent with those seen in previous pilots. Most results, with the exception of the WTP value for a major injury, were statistically significant.

Results and recorded participant understanding indicated that the surveys conducted both in this stage and in the Pilot could be incorporated into the National Survey and thus potentially reduce the number of respondents required to achieve sound results.

2.5 Cognitive interviews

After the National Pilot and following the recommendation of Dr Benjamin Phillips from the Social Research Centre of the Australian National University, Taverner conducted cognitive interviews with ten participants to test the responses on cognition, wording, interpretation, and the ability to engage with the questionnaire. The feedback from these interviews was used to inform adjustments to the survey instrument where appropriate for the next stage of the National Survey.

Respondents generally found the survey user-friendly and easy to answer, with some confusion surrounding certain topics. The injury classifications had to be further explained and clarified for a few of the respondents, while some respondents provided incorrect answers despite seemingly having understood the questions. Some participants had also experienced a change in circumstances since their initial recruitment, which changed their responses.

Based on the interviews, there were a number of recommendations made, largely around clarifying the injury classification question to ensure respondents would understand what was being asked of them. There was also a recommendation to explain the distinction between different trip types and purposes, to ensure respondents would clearly understand the journey purpose for which they had been recruited.

3. Chapter 3 – WTP Survey Implementation Details

3.1 Survey Instrument

The survey instrument (screen captures of the survey are displayed in Appendix A) consisted of four parts:

- An introduction – to outline the purpose of the survey
- Questions regarding recent trips for the purposes of business, commuting, and shopping, and then regarding details of the last trip taken — origin/destination, time taken, time in congested conditions, urban/non-urban, tolls, number of passengers
- The stated preference (SP) experiment in which each respondent faced five choice scenarios, all for the same trip purpose with trip attribute levels which 'pivoted' around the characteristics of the trip reported by the respondent
- Socio-demographic questions to assess the representativeness of the survey sample to the Australian population and to indicate the requirement for potential weighting

The survey instrument began with an introduction that was read out by the facilitator of the survey. The introduction contextualised the choice experiment. The purpose was to communicate what the questions meant, to assist respondents to make their choices based on their own personal values relating to the three assessed metrics of time, reliability, and safety.

The prompts in the second part of the survey instrument were used to determine the dollar figures and context given in the choice experiment. Respondents' choices were expected to vary with their income, the purpose of their trip and whether they were a driver or passenger. Values for cost were then given as a reasonable estimate based on their income and costs for different trip types. The outcome of the responses, such as income and current spending, helped determine price sensitivities, so each respondent was shown dollar figures relevant to their individual price sensitivities rather than general streamlined amounts.

The time spent in congested conditions and the proportion of travel undertaken in built up areas (speed limits of under 80kph) was noted for each individual to differentiate between those predominantly driving in rural and urban areas. This was particularly important for those in regional large towns and highly rural areas, and when compared with the respondent's address could ensure travel accurately reflected rural status. The urban/rural distinction was important for the project team to track the in-field data collection progress against targeted quotas and to develop expansion factors (i.e., weight) for aggregating the modelling results to obtain representative values for the population.

In the survey, congested conditions were defined as "conditions where you are consistently braking and accelerating and can only change lanes if others let you in", with an example image (Figure 3.1) shown to respondents. Respondents must then interpret what "consistently" means in terms of braking and their interpretation does not necessarily align with any speed profiles. Each respondent may have a different interpretation of congestion, for example, a respondent in a rural area that rarely experiences levels of congestion in urban areas, may have a looser definition of "consistently breaking", and therefore report congestion where a respondent in a metropolitan location may not.

Caution should therefore be taken when aligning the subjective definition of congested conditions with quantitative definitions of congestion. As such, it has been recommended that VTTS is not split by congested and free-flow conditions in the final guidelines.

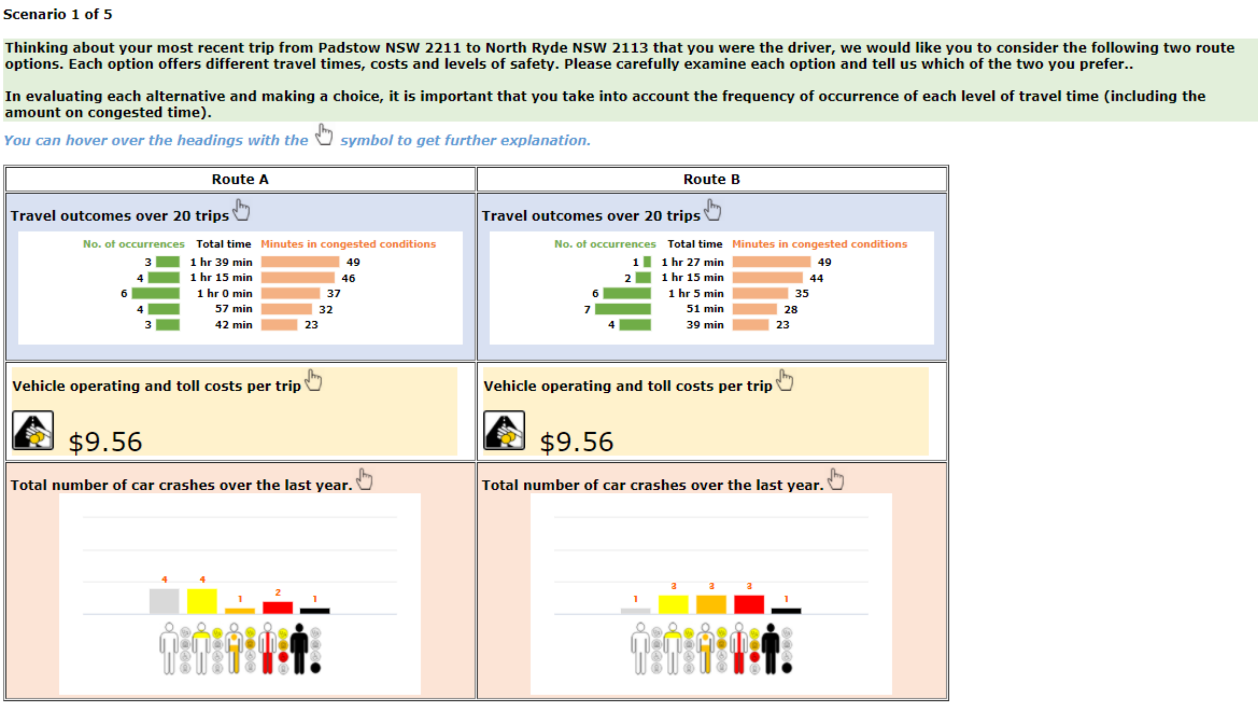
Figure 3.1 The image shown to respondents to describe congested conditions.

Source: Deloitte Access Economics

The third part of the survey instrument was the stated preference experiment. Participants were presented with 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 3.2 below).

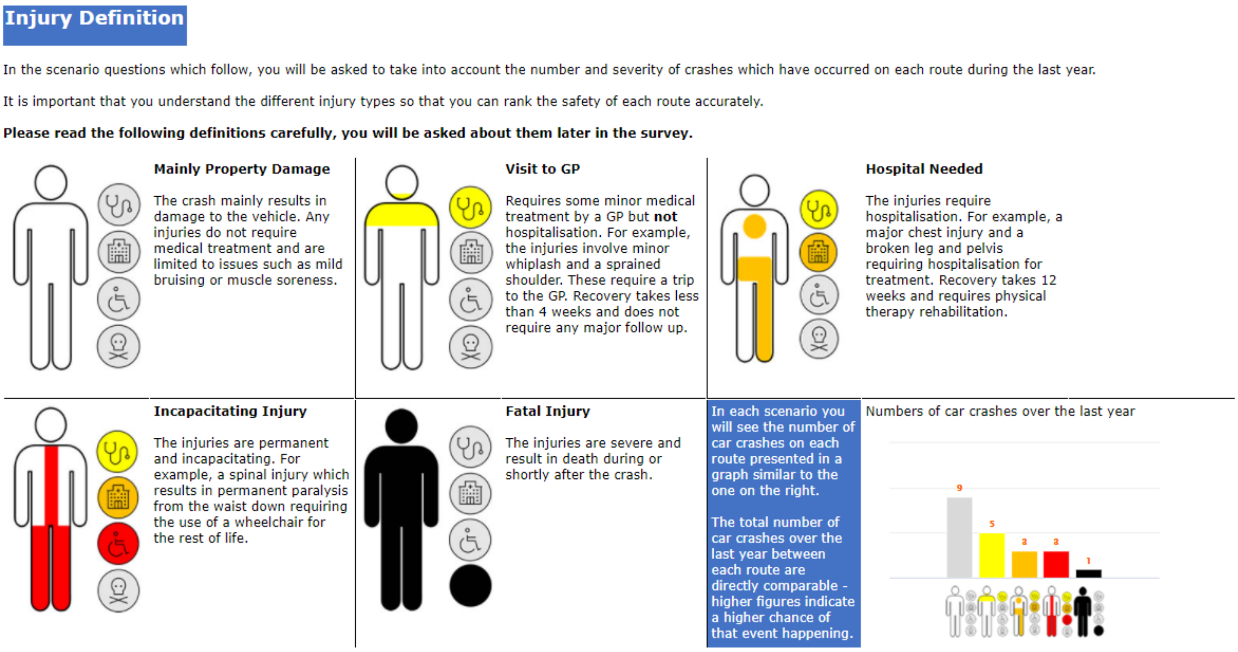
The attribute levels (cost, time, reliability, and safety) of the choice experiments were chosen using Bayesian efficient designs. These optimise the attribute levels based on each respondent's experiences, given in the preliminary questions, with the aim of minimising the standard deviations of errors in the model coefficient estimates.

Figure 3.2: Online survey example



Source: Deloitte Access Economics

Figure 3.3: Crash severity categories used in the survey



Source: Deloitte Access Economics

Crash frequencies in the survey were presented for five severity levels shown in Figure 3.3 above — no injury (mainly property damage), minor injury (GP visit), major injury (hospitalisation), incapacitating injury and fatal injury. Each severity category was accompanied by a description of a specific incident shown above in Figure 3.3. To assess the survey respondents' understanding of the categories, a test was provided at the start of the survey, asking participants to assign a category to each scenario in a list of incidents.

The final part of the survey asked questions regarding socio-economic and risk preferences. This data was used to understand how the characteristics of respondents altered their WTP. It then assessed whether these results varied across the population, testing the sample to confirm the accuracy or establish a basis for weighting, to better represent the characteristics of the national population.

The socio-economic factors explored relating to transport included a respondent's car insurances, whether the respondent had experienced a car crash and whether the respondent knew someone who had been in a car crash. The measures of risk presented specifically related to the context of driving, with a lengthy typical risk aversion study being avoided to reduce cognitive load. The survey asked participants to respond to scenarios about driving, and considering safety, such as road rule perceptions and focus on the road.

It would be expected that there is a level of preference heterogeneity of respondents about their WTP values, particularly that those with higher incomes would be able and willing to pay more. As such further analysis would be needed to test heterogeneity of willingness-to-pay values by income, which is reported in Appendix A.3. The survey instrument is likely to not capture the exact willingness-to-pay of each respondent, and should not be used on an individual level, but can capture the average willingness-to-pay of the population in aggregate using a mixed logit model, as discussed in 3.4.

3.2 Survey design and sampling

Constructing the survey was a complex procedure, since it was necessary to develop an underlying experimental design, requiring either specific code or specialised software.

- The survey was administered using Confirmit, an online survey platform capable of handling complex experimental designs.

- The experiment was designed using NGENE, a package specifically built for the purpose of generating experimental designs for stated preference experiments.
- The analysis of survey data was undertaken using NLOGIT, a software made for statistical analysis of choice models.

The experiment was unlabelled, meaning that at each choice participants were presented with two choices called Route A and B, which did not have any further contextual information beyond the given names. In contrast, as an example, a labelled experiment could specify the specific road that a route between the two suburbs take, such as a specific toll vs free road.

In a labelled choice experiment, respondents may project their own perceptions of the routes onto the task, and therefore the experiment may capture features that are not described, such as road quality or views, which cannot be quantified in the modelling of the survey data. Labelled choice experiments may also require routes between each origin-destination suburb pair to be manually entered or shown in a map so that the respondent can take the information presented in the choice task at face value and accurately make choices in accordance with their preferences. Labelled choice experiments therefore would add complexity to the survey, increasing the cognitive burden for the respondent. Keeping the information presented to the participant unlabelled and non-specific is required to only reflect travel time, safety, and reliability in their responses and for effective communication of the choice experiment the respondent faces.

Table 3.1: Factors considered in the design of the stated preference survey

Issue	Approach
Whether to have a labelled or unlabelled choice experiment	An unlabelled approach for a single or repeated trip choice was used for this experiment. It was not feasible to use a labelled approach without naming specific contexts, and the unlabelled approach allows for an estimation of all effects.
What attributes to include in the experiment, whether all three WTPs could be estimated using a single experiment	Considering the trade-offs between realism, the ability to measure aspects independently, and the cognitive burden on respondents, this experiment included the following attributes: Travel time in free-flow conditions; Travel time in congested conditions; Distribution of travel time (free-flow and congested conditions); Total costs (combined operating and toll costs); Crash profile, described by average annual crashes, by level of severity. To estimate WTP for reducing number of crashes by severity classes, the survey utilised the following five injury classes: 1. Fatal injury 2. Incapacitating injury 3. Major injury requiring hospitalisation or extensive follow up care 4. Minor injury requiring medical treatment but not hospitalisation 5. No injury / property damage only.
How to make the choice task as realistic as possible	The survey employed a pivot design approach to construct the SP experiment which varied attribute levels around a recent journey the respondent made in order to make the task realistic.
What type of response mechanism and the number of alternatives to include	This experiment used a binary choice response mechanism where respondents selected their preferred option from two available options.
Whether to frame the choice task as the single trip choice or repeat trip choice	Use single trip choice to keep the survey as simple as possible.
How to manage trip purposes	The scope of travel purposes for this study were: commute, non-commute and employee business travel for both drivers and passengers. the survey instituted quota sampling by trip purpose to ensure all travel purposes were appropriately covered.
What method should be used to generate the experimental design	For this study, the assumptions used by Hensher et al. (2011) were utilised to generate the survey design. The precise assumptions used were intended to minimise parameter standard errors, and to provide greater certainty around the population estimates obtained.

Source: Deloitte Access Economics

The survey used quota sampling for ‘trip purpose’ due to the requirement of separate WTP values for time and reliability for commuting, business, and non-work trip purposes. 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 survey sampling process, it was ensured that recruiting took place in both urban and regional settings, to ensure travellers outside major 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.

3.3 Survey Administration

In December 2020, Deloitte, in partnership with Enlightened Data, the Hensher Group, CaPPRe and Taverner Research, were engaged to conduct the National WTP Survey (the National Survey) and develop parameter values from statistical analysis of the results. At commencement, the following key features of the National Survey were decided upon:

- There would be a target of 4,500 completed useable surveys across all states and territories of Australia.
- The surveys, and subsequent statistical analysis, were to be completed in two separate waves with a pause between Wave 1 and Wave 2 for data analysis and modelling.
- Surveys were to be conducted online and face-to-face.
- There would be a disaggregation of the sample collected by:
  - Drivers and passengers
  - Urban and non-urban locations of travel
  - Travel purpose (commuting, business and non-work)
- Resultant parameter value development and analysis, was required to test for statistically significant differences in the VTTS, VOR and value of risk reduction (considering all five crash severity levels together) between:
  - Trip duration
  - Traffic conditions: free-flow and congested
  - Population income bands.

3.3.1 Wave 1

Wave 1 of the National Survey was designed to meet three criteria. Firstly, Wave 1 would be used to determine whether the revised survey instrument could deliver more reliable estimates for the WTP parameters than the pilot, through incorporating the changes informed by the peer review and the cognitive interviews. Second, the survey allowed for the testing of multiple models using data gathered in the pilot stages. Third, the parameter estimates that were calculated using Wave 1 data were able to be used to make small changes to the survey to improve the effectiveness of the survey instrument.

Wave 1 was administered in New South Wales, Queensland, Western Australia and Victoria, to make results comparable with the results of the Pilot and National Pilot results. As part of this, there was a target quota of 720 respondents, with an actual response rate of 722 respondents.

The target sample size for each state was determined as a proportion of each state’s share of national population (Table 3.2). The state samples were proportioned to represent the regional / urban split in each state - with built up areas around state capitals designated as urban. Four regional locations were selected for Wave 1: Lithgow in NSW, Kingaroy in Queensland, Warragul-Drouin in Victoria and Busselton in WA.

Table 3.2: Proposed sample breakdown for Wave 1 by jurisdiction

Jurisdiction	Target number of respondents	Locality		Target Regional Location for physical recruiting	
		Metro	Regional	National Survey	Pilot Survey
NSW	259	159	100	Lithgow	Wagga Wagga
QLD	164	77	87	Kingaroy	Toowoomba
VIC	213	158	54	Warragul-Drouin	Ballarat
WA	84	66	19	Busselton	Bunbury
Total	**720**	**460**	**260**		

Source: Deloitte Access Economics

The survey recruitment for Wave 1 was conducted by individually screening and recruiting 25% of participants (intercept recruitment), while the remaining 75% were recruited through an online panel. The survey implementation involved online self-complete and online guided (video conference) surveys, with a 50:50 split between self-complete and guided surveys. Wave 1 had to change methodology compared to the National Pilot due to manage the risks from COVID-19, which required the use of online surveys for physical distancing as opposed to the recommended face-to-face sample in the National Pilot. The internet-based survey panel was managed by CaPPRe, drawing on panels from Dynata, while the guided survey participants were preselected by Taverner, drawing on panels from Cint, to be well-suited to undertaking longer surveys with facilitator guidance.

In total, 722 respondents were surveyed during Wave 1 across the period 1 April to 25 May 2021. The results from Wave 1 for regional representation (Table 3.3) and trip purpose distribution (Table 3.4) were used to inform the survey process for Wave 2. The proportion of respondents surveyed from each state/territory roughly aligned with the target quotas, with sampling in Wave 2 subsequently adjusted to account for under-represented and over-represented samples (Table 3.5).

Table 3.3: Breakdown of participants by state and regional status in Wave 1

Jurisdiction	Total number of respondents	Share of Total		Locality	
	Total	Planned	Metro	Regional	Actual
NSW	292	36%	201	91	40%
QLD	148	23%	80	68	20%
VIC	221	30%	171	50	31%
WA	61	12%	56	5	8%
Total	**722**	**100%**	**508**	**214**	**100%**

Source: Deloitte Access Economics

Table 3.4: Participants by trip purpose given in choice experiment in Wave 1

Occupant type	Trip Purpose			
	Commuting	Business	Non-work	Total
Driver	173	132	180	485
Passenger	52	48	137	237
Total	**225**	**180**	**317**	**722**

Source: Deloitte Access Economics

Table 3.5: Deviation of actual from planned respondent groups for Wave 1

Occupant type	Trip Purpose			
	Commuting	Business	Non-work	Total
Driver	44%	10%	50%	**35%**
Passenger	-57%	-60%	14%	**-34%**
Total	**-6%**	**-25%**	**32%**	**0%**

Source: Deloitte Access Economics

In early 2022, the report outlining Wave 1 outcomes and proposed delivery of Wave 2 was finalised. The report highlighted that there were significant issues with the data quality obtained through the self-completed online surveys. It was found that respondents completing the complex choice survey online and unsupervised did not properly consider the choice tasks presented. The performance of survey respondents was evaluated by assessing three metrics: the speed of the responses, completion of knowledge tests placed throughout the survey, and the prevalence of straight lining occurring through the survey. After consideration of these data quality issues, it was determined to exclude the self-complete survey responses collected through Wave 1, meaning the respondent count then failed to meet the target of 720 responses (Table 3.7).

Table 3.6: Breakdown by respondent group with removal of self-led participants and addition of valid national pilot data for Wave 1

Occupant type	Trip Purpose			Total
	Commuting	Business	Non-work	
Driver	128	116	95	**339**
Passenger	39	46	64	**149**
Total	**167**	**162**	**159**	**488**

Source: Deloitte Access Economics

Table 3.7: Effect of excluding online self-complete respondents from Wave 1

Jurisdiction	Total			Metro			Regional		
	Wave 1	Online Self-complete	Remaining	Wave 1	Online Self-complete	Remaining	Wave 1	Online Self-complete	Remaining
NSW	292	182	110	201	131	70	91	50	40
QLD	148	103	45	80	65	15	68	38	30
VIC	221	179	42	171	143	28	50	36	14
WA	61	59	2	56	54	2	5	5	0
Total	**722**	**523**	**199**	**508**	**393**	**115**	**214**	**129**	**84**

Source: Deloitte Access Economics

To address the lost responses outlined previously (due to data quality for online unguided surveys) it was decided to use valid data from the National Pilot Survey, to increase the total number of usable responses up to 488, as detailed in Table 3.8. This meant that the usable set of data from 488 respondents, surveyed through guided-online or face-to face intercept surveys, across Wave 1 or the National Pilot Survey was used to estimate the range of WTP parameters that were reported at the end of phase 1.

Table 3.8: The composition of the recommended sample at the end of Wave 1, excluding unguided responses

Jurisdiction	Wave 1 Remaining	Pilot surveys guided	Final Sample at the end of Wave 1
NSW	110	186	296
QLD	45	80	125
VIC	42	22	64
WA	2	0	2
Total	**199**	**288**	**488**

Source: Deloitte Access Economics

From the newly pooled data, models were estimated for all respondents, the three trip purposes, drivers, passengers, urban, and rural. Almost all estimated parameters in the models were of the correct sign, highly statistically significant, within the expected magnitudes and had sensible relative values. These interim results were presented for the purpose of project decision making and have been included in Appendix A.10.

As a result of the poor outcomes from the online self-guided surveys it was agreed, at the end of Wave 1, that Wave 2 would not use an unguided survey method and that online self-guided surveys would be removed from Wave 2 data analysis and modelling.

3.3.2 Pooling data from national and pilot surveys

Prior to undertaking the National Survey, a key consideration was whether data from the National Pilot Survey would be usable, because if it was a usable dataset then the number of respondents required for the National Survey could be reduced.

After the significant concerns with the online self-completed responses in Wave 1, it was recognised there was a need to incorporate data from the National Pilot surveys to create a larger final sample size to be used for the survey results. Data from the guided surveys, both face-to-face and online guided, in the National Pilot were successfully combined with Wave 1 data. This was achieved by using a scale parameter in the generalised mixed logit form to control for potential differences in survey experiments.

Pooling data from different surveys introduces new issues to the dataset, which was exacerbated by the shift to working-from-home in 2020. The inverse relationship between the model scale and error term initially prevented data from being pooled since it would change the model scale and affect the model's utility function. The effect is demonstrated below, using utility functions estimated for two models: with utility (U) calculated using the model scale (μ), vector of parameter estimates (β), error term (ε) and a vector of the variables (x):

$$U_1 = \mu_1\beta_1 x + \varepsilon_1 \quad (1)$$

$$U_2 = \mu_2\beta_2 x + \varepsilon_2 \quad (2)$$

Changing the model scale to $\mu_1 = 1$ for a single survey requires the model scale for the second be set as a relative scale of $\mu = \frac{\mu_2}{\mu_1}$, meaning different parameter estimates cause the preferences to become unstable, or necessitate a different error term, changing the model scale:

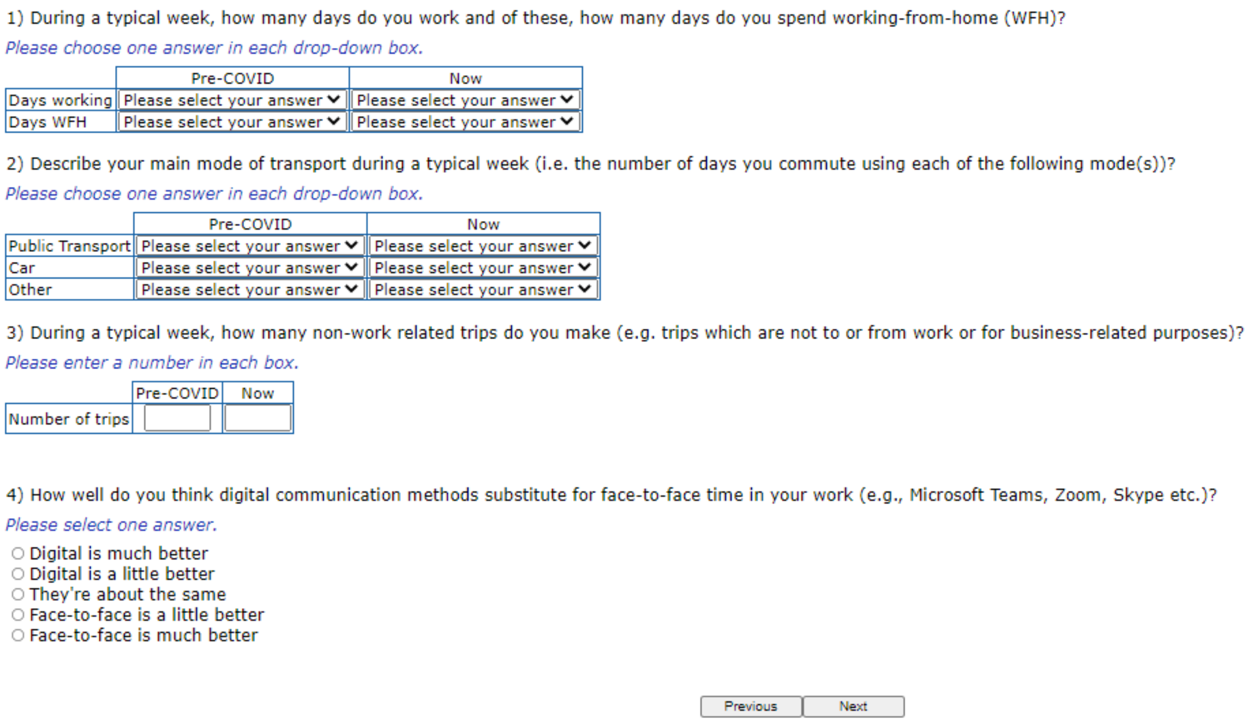
$$U_1 = \beta x + \varepsilon_1 \quad (3)$$

$$U_2 = \mu\beta x + \varepsilon_2 \quad (4)$$

To pool the estimates, parameter estimates would be assumed as constant, changing only the error term, which was unlikely to succeed due to COVID-19 impacting traditional commutes and working-from-home arrangements and respondents' choices around travel time. This could have been addressed by making the error term a function of data collection or time, but such an approach would have still resulted in different parameter estimates and may not always solve the problem in practice.

Including the pilot data limits the ability to use the findings to assess changes impacted by COVID-19, as the pilot stages were pre-COVID-19 so the questions about work from home and digital communication methods were not asked in the pilot stages. Final modelling did not significantly differ from the preliminary modelling undertaken using the data from the pilot stages, indicating that there was not a major difference in WTP across the two samples. This analysed changes and perceptions of workers towards working from home and how transport methods have changed after COVID-19, as shown in Figure 3.4.

Figure 3.4: The four questions added to the survey after the pilot phases



1) During a typical week, how many days do you work and of these, how many days do you spend working-from-home (WFH)?

Please choose one answer in each drop-down box.

	Pre-COVID	Now
Days working	Please select your answer	Please select your answer
Days WFH	Please select your answer	Please select your answer

2) Describe your main mode of transport during a typical week (i.e. the number of days you commute using each of the following mode(s))?

Please choose one answer in each drop-down box.

	Pre-COVID	Now
Public Transport	Please select your answer	Please select your answer
Car	Please select your answer	Please select your answer
Other	Please select your answer	Please select your answer

3) During a typical week, how many non-work related trips do you make (e.g. trips which are not to or from work or for business-related purposes)?

Please enter a number in each box.

	Pre-COVID	Now
Number of trips		

4) How well do you think digital communication methods substitute for face-to-face time in your work (e.g., Microsoft Teams, Zoom, Skype etc.)?

Please select one answer.

- Digital is much better
- Digital is a little better
- They're about the same
- Face-to-face is a little better
- Face-to-face is much better

Previous Next

Source: Deloitte Access Economics

The results from these questions have been included in appendix A.11.

3.3.3 Wave 2

The implementation of Wave 2 was delayed by the spread of the Delta COVID-19 variant and subsequent lockdowns in in Australia, with the project team delaying the rollout of Wave 2 to late 2021. The survey delivery was also split into sections 2a and 2b, coordinated around lockdown timings, and concluded in August 2022. The agreed approach to Wave 2 maintained the planned sample size for the National Survey by converting all planned online self-complete responses into online-guided responses, to replace all 497 of the invalid Wave 1 responses.

In formulating the updated sampling plan, location quotas were set to maintain an overall representative sample based on population across each jurisdiction. The sample size was cross-checked against the statistical analysis to ensure that a minimum sample would be exceeded for each group where a model was fitted. This was done with the aim of maximising the chance of statistically significant results given the performance of the survey.

The survey sought to obtain a broad distribution of respondents with sufficient coverage of geographically remote areas, covering any journeys which may take place entirely outside built-up areas. The study mapped postcodes to Remoteness Areas and Statistical Area 2 (SA2) regions, verifying the distribution of survey respondents across regional and remote Australia. To capture regional intrastate trips, a soft quota was put in place based on trip distance, with intercept recruitment methods targeting specific samples.

Respondent samples were also redistributed across the six travel segments to achieve a 60:40 driver to passenger split of the non-business samples. It was expected that, after combining Wave 1 and Wave 2 data, the responses would reach a 75:25 driver to passenger split for business travel. The proportion of drivers was increased to better reflect actual occupancy rates and increase the accuracy of the weighted VTTS estimates for whole vehicles. Since travel time savings are typically estimated for whole vehicles in CBAs, improving the accuracy of VTTS estimates without changing the sample size allowed for a more efficient implementation of the survey.

The target split of respondents by travel segment for Wave 2 is shown in Table 3.9 below.

Table 3.9: Proposed trip purpose breakdown for drivers and passengers for Wave 2

Occupant type	Trip Purpose – Wave 2			Total
	Commuting	Business	Non-work	
Driver	824	1066	843	2,733
Passenger	596	364	582	1,542
Total	**1,420**	**1,430**	**1,425**	**4,275**

Source: Deloitte Access Economics

There were a number of difficulties in fulfilling certain quotas in Wave 2 (Table 3.10), with a considerably lower number of passengers than expected. The non-work trips were the only segment which saw the expected number of responses, with an equivalent split across both the driver and passenger categories. As in Wave 1, the low number of passenger responses likely reflected the reality of the travel segments at a national level with many journeys being completed by a single driver. After a detailed analysis and review by the project team, it was determined that a sample size of 3,300 would be sufficient to yield robust parameter values for use in CBA and other applications.

Table 3.10: Actual trip purpose breakdown for drivers and passengers for Wave 2

Occupant type	Trip purpose - Wave 2			
	Commuting	Business	Non-work	Total
Driver	698	800	843	2,341
Passenger	288	231	582	1,101
Total	**986**	**1,031**	**1,425**	**3,442**

Source: Deloitte Access Economics

Of the 3,442 responses collected as part of Wave 2, 86 were found to be unusable, due to a variety of factors, such as speed of responses and unreasonably high toll costs. This means that 3,356 responses from Wave 2 were used in the final modelling.

3.3.4 Combined sample size and final model

After combining the data from both waves and the national pilot, shows the final distribution of survey responses across segments. The final ratio of drivers to passengers was higher than expected, with passengers making up 31% of the total responses, higher than the 75:25 ratio initially expected. The quality of responses was reviewed in the final modelling process, and one additional response from the pilot surveys was found to be usable, hence the difference between the 288 and 289 numbers of pilot surveys in Table 3.8 and Table 3.11 respectively. This brought the combined sample size to 3,844.

Table 3.11 Breakdown of the sample size used in modelling by stage of surveying

Phase	Number of interviews (people)
Pilot	289
National Survey – Wave 1	199
National Survey – Wave 2	3,356
Total	**3,844**

Source: Deloitte Access Economics

Table 3.12: Trip purpose breakdown for drivers and passengers for pooled data used in the modelling after combining waves 1, 2 and pilot surveys

Occupant type	Trip purpose - Combined			
	Commuting	Business	Non-work	Total
Driver	808	914	906	2,628
Passenger	320	629	267	1,216
Total	**1,128**	**1,543**	**1,173**	**3,844**

Source: Deloitte Access Economics

Table 3.13: Breakdown of the sample size used in the modelling after combining waves 1 and 2 and pooled data from the pilot by jurisdiction and trip origin.

Jurisdiction	Trip origin		
	Metro	Regional	Total
NSW	857	259	1,116
QLD	433	485	918
VIC	768	235	1,003
WA	272	106	378
SA	229	68	297
Tas	28	33	61
ACT	41	0	41
NT	22	8	30
Total	**2,650**	**1,194**	**3,844**

Source: Deloitte Access Economics

3.4 Data analysis and modelling

3.4.1 Willingness-to-pay methodology

The survey design process was complex, due to the requirement to balance simplicity for respondents against the need for gathering detailed information and accounting for statistical issues.

An extensive effort was made to remove poor quality data such as unsatisfactory responses, ‘speeders’, data with missing items, and outliers. The model estimated delivers mean values for the different WTP parameters which also provides additional information to check that the data was clean and meaningful. After the data had been cleaned, a mixed logit model was estimated to accommodate for preference heterogeneity. The model behavioural parameters were then used to estimate the WTP values. All modelling was done using NLOGIT, a multinomial choice modelling program.

The simplest functional form that this model seeks to estimate is the observed utility, expressed as follows, with utility expressed as U:

Equation 3.1: The simplest utility that reflects the WTP

$$U = \beta_c trip\ cost + \beta_t trip\ time + \beta_r variability\ of\ trip\ time + \sum_{i=1}^{5} \beta_i\ probability\ of\ a\ crash\ of\ severity_i$$

Source: Deloitte Access Economics

The VTTS results was given in dollars per hour and varied depending on the travel conditions (free-flow and congestion), trip length (log transformation of travel time) and trip purpose (commuting, business and non-work). The VOR was also presented in dollars per hour of standard deviation of total travel time but varied only by travel purpose. The value of risk reduction (VRR) was measured in millions of dollars per crash, and varied by crash type (property damage, minor injuries, major injuries, incapacitating injuries and fatality). Numerous iterations of testing and refining the model were undertaken. The final version is presented in equation 3.1, with two components: free-flow (FF) and congestion time (CG).

Equation 3.2: The observed utility used to estimate the willingness-to-pay

$$\begin{aligned} U_j = {} & \beta_{fft}^{BIS} * FF_{BIS} + \beta_{fft}^{WK} * FF_{WK} + \beta_{fft}^{NW} * FF_{NW} + \\ & \beta_{cgt}^{BIS} * CG_{BIS} + \beta_{cgt}^{WK} * CG_{WK} + \beta_{cgt}^{NW} * CG_{NW} + \\ & \beta_{ffsr}^{BIS} * log(FF_{BIS}) + \beta_{ffsr}^{WK} * log(FF_{WK}) + \beta_{ffsr}^{NW} * log(FF_{NW}) + \\ & \beta_{cgsr}^{BIS} * log(CG_{BIS}) + \beta_{cgsr}^{WK} * log(CG_{WK}) + \beta_{cgsr}^{NW} * log(CG_{NW}) + \\ & \beta_c * cost + \beta_{cpinc} * cost * pinc + \\ & \beta_r^{BIS} * WSDOT_{BIS} + \beta_r^{WK} * WSDOT_{WK} + \beta_r^{NW} * WSDOT_{NW} + \\ & \beta_{pty} * Property + \beta_{min} * Minor + \beta_{maj} * Major + \beta_{incap} * Incap + \beta_{fat} * Fatal \end{aligned} \quad Eq[3.1]$$

Source: Deloitte Access Economics

Where superscripts/subscripts:

BIS denotes a coefficient employer-related business trips

WK denotes work commutes

NW denotes non-work commutes

fft is used as a coefficient for variables that are free-flow time

cgt is for variables that are measuring congested time, as the log variables have different coefficients, this is reported as $ffsr$ and $cgsr$

FF and CG represent the travel time in Free-Flow and Congested conditions, respectively for each travel purpose

Property, *Minor*, *Major*, *Incap* and *Fatal* represent the VRR for the 5 injury categories

$cost$ represents travel cost

$pinc$ represents personal weekly income

$WSDOT$ is the weighted standard deviation of total travel time, which is used as a measure of reliability. Noted that all components of travel time, including FF, CG, total time and reliability, were presented in the choice experiment as a range of (5 – 7) discrete values, each with a frequency of occurrence over 20 trips. Thus, the final data weighs these discrete values using their frequency of occurrence to obtain the weighted times for use in modelling.

r denotes a reliability coefficient

Not all parameters are reported in the final results, as some variables, such as model constant are not consequential to any WTP outcomes and are only required for model estimation (see Appendix A.1 and A.2 for the model as originally presented).

The effect of income on WTP was tested by interacting travel cost with personal income and various forms of non-linearity in travel time such as log, exponential, square root, etc. were tested. The log transformation of travel times was selected for the utility function alongside the linear effects because these delivered the most behaviourally meaningful model with the best statistical fit. This combination of linear and log form accounts for the diminishing value of travel time savings with respect to trip time.

A large amount of modelling was undertaken on the final data set with variables, such as age, education, income, driving conditions and passenger status being tested for inclusion in the model, and modelling techniques being varied. These rounds of testing lead to removal of variables found to be statistically insignificant, leading to the core and final model that is presented in this report. Factors that were considered when choosing models were the significance of variables, usefulness of the variables in CBA, whether the modelling led to expected results, and the preferred units of output. In the end, statistically insignificant variables, such as age and education were not included, and crashes were represented as both numbers per year and probabilities.

3.4.2 Crash risk exposure methodology

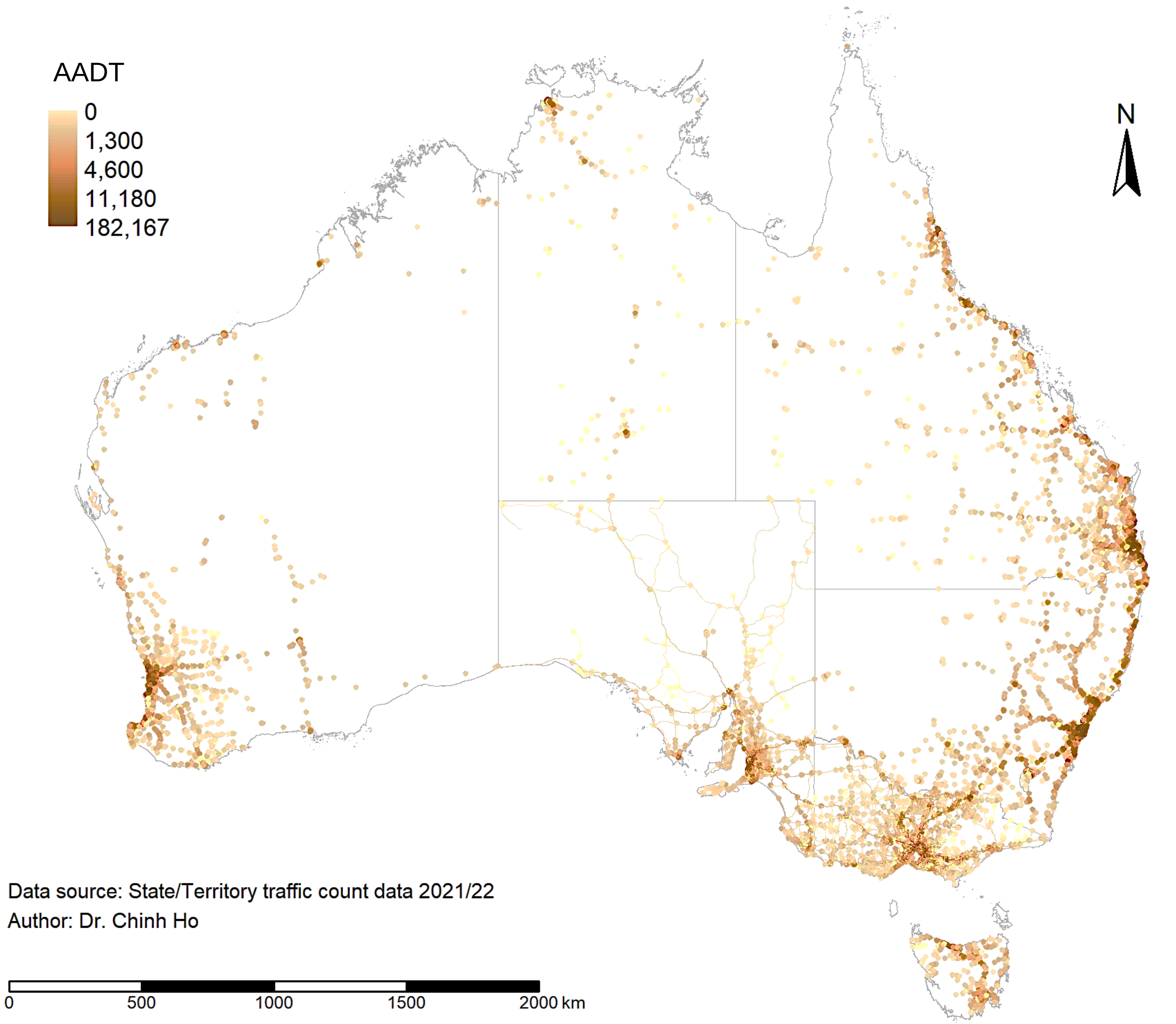
The crash risk exposure methodology sought to estimate the WTP for reducing the number of crashes by one, for each severity class. Five severity classifications were represented in the survey. They correspond with fatal, serious/major/hospitalised injury, minor injury and property damage only classifications used by Australian jurisdictions, with the exception that the survey presented two serious injury crash severities. This 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 this data, 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 the purposes of valuing reductions in crashes in CBA, the required value relates to a single crash avoided. In the case of fatal crashes, the value of a statistical life (VSL) is the willingness-to-pay *'for improvements in safety (that is, reductions in risks) that, in the aggregate, reduce the expected number of fatalities by one'*. (US DOT 2021, p. 1). The term 'value of risk reduction' (VRR) is conceptually equal to VSL but extends to all risk types including injury and property damage only crashes.

For a given crash severity, the 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. The supplementary report provides a detailed explanation of this.

Transport agencies from various states and territories provided AADT data, which was standardised and indexed by year. Transport agencies 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 Figure 3.5 overleaf.

Figure 3.5: AADT data coverage



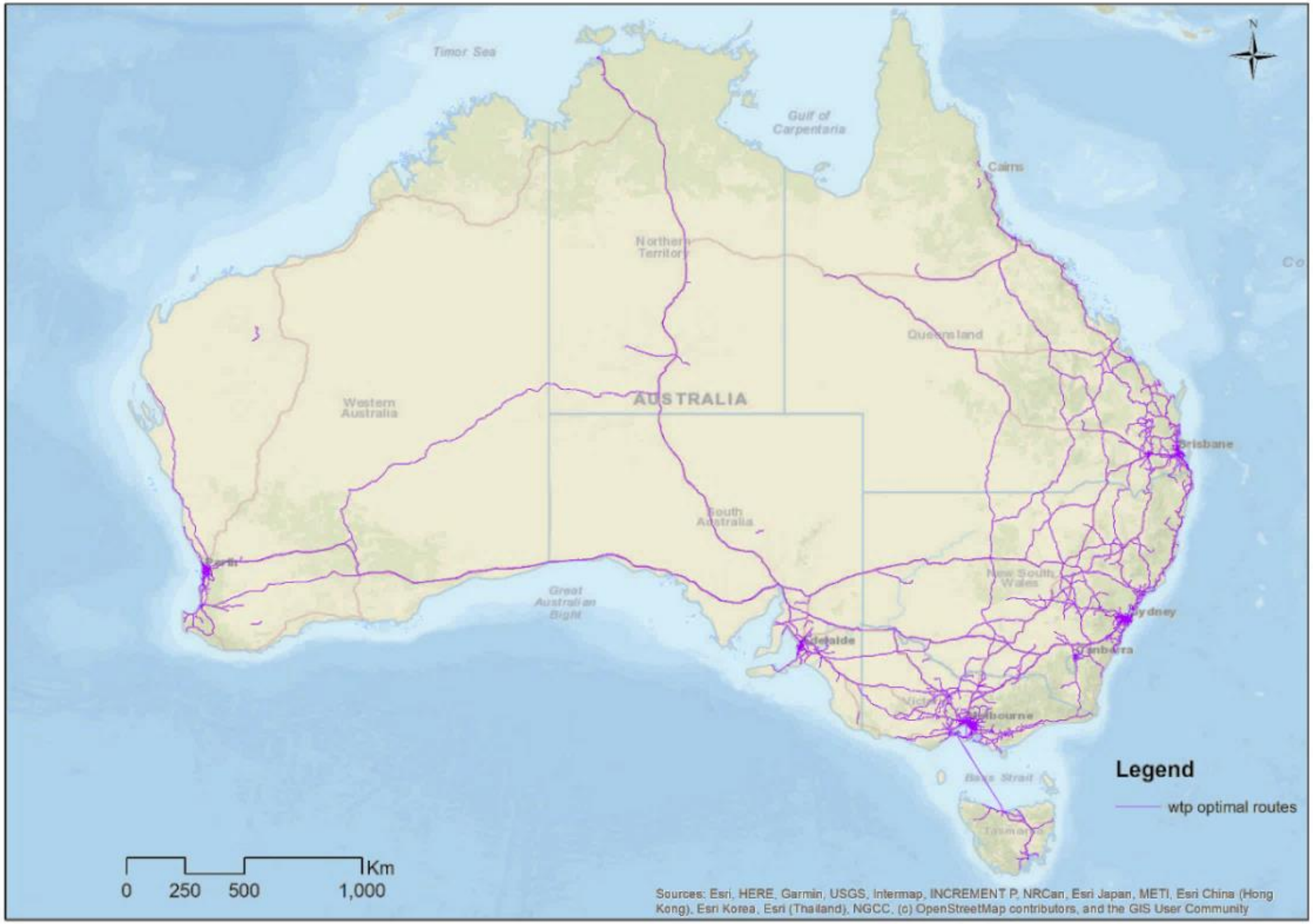
Source: Deloitte Access Economics from state/territory traffic count data 2021/22

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, spanning a wide geographical area of Australia, and spread between urban and regional areas. There was an additional number of routes identified through surveys that were incomplete and therefore invalid for inclusion. 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. The average AADT, across all trips in the data, was 21,846 vehicles per day, with a standard deviation of 20,024. The minimum AADT was 228. The maximum AADT was 182,167. The average trip distance was 40 kilometres with a standard deviation of 43 kilometres. (Figure 3.6 overleaf).

To estimate the distance-weighted AADT for the trip in each survey response, the AADT data had to be mapped to each optimal route. Each optimal route was then split into road segments, before being matched to a traffic count station using a tolerance of 200m – up to a distance of 2km, to account for ‘gap’ between different coordinate reference systems used across spatial dataset, which was gradually increased until a match was found. For each route, the weighted average of the AADTs was estimated using segment length divided by trip length as the weights.

For intra-zonal trips and for the three trips that did not have any traffic count station within the 2-kilometre buffer around the optimal route, AADT was calculated by identifying the nearest three traffic count stations and using the distance-weighted average AADT of these stations as the route AADT.

Figure 3.6: Estimated optimal routes for willingness-to-pay data using reported trip origin and destination



Source: Deloitte Access Economics

4. Issues faced and how they were addressed

Throughout the course of the project a number of issues were faced, particularly during the survey implementation and analysis stages. Many of the issues arose from the significant disruption caused by the COVID-19 pandemic that were unprecedented and unexpected, and created issues that required unique solutions.

4.1 Sample composition

The initial sampling plan was to obtain survey responses from an equal number of participants across all categories, with the full breadth of geographic, regional and travel purpose diversity. There were six distinct groups of travellers, consisting of drivers and passengers commuting, a business purpose or a non-business trip. It was determined through the Pilot Survey, that a large sample size was important for addressing issues of statistical significance, which were present in smaller jurisdictional samples. Unfortunately, the issues relating to COVID-19 restricted the availability of survey respondents, and the sample sizes were smaller than initially planned. That said, results achieved are still statistically significant and robust.

The sample size was expanded to reduce the possibility of over or under-representation of specific groups within the population. Despite these changes passengers remained underrepresented in the sample relative to the initial plan, with a particularly low number of business passengers – which was deemed to be related to the reduction in business travel due to lockdowns and working from home. The challenge in recruiting passengers was likely to be a result of the lower instance of these types of trips in general and this was further compounded due to COVID-19 travel impacts. The sampling plan for Wave 2 attempted to account for this discrepancy by increasing target quotas for under-represented groups and decreasing targets for over-represented groups. However, it was ultimately decided to accept a lower proportion of passengers in the survey responses, due to a low incidence of car passenger trips, particularly for business and commuting purposes in rural areas.

Table 4.1: Sample used in modelling by trip purpose

Passenger type	Trip purpose - Total			
	Commuting	Business	Non-work	Total
Driver	808	906	914	2,628
Passenger	320	267	629	1,216
Total	**1,128**	**1,173**	**1,543**	**3,844**

Source: Deloitte Access Economics

Low-income groups and those undertaking short trips were similarly underrepresented in the final sample (see chapter 5.3.) The observed samples for these groups were weighted to account for the reduced representation of respondents who take short trips and are low-income. The weighted sample was found to match the population in terms of income, trip length, location of residence, and the interaction of trip length with different environmental settings.

In the sample of pooled data from Wave 1 and the pilot, there was an underrepresentation of passengers in the business and commuting segments, compared to the initial survey plan, which aimed for an equal number of passengers and drivers in this segment. This deviation was within the scope of the National Survey.

Of all groups, business travel was the most affected by COVID-19 as mandatory lockdowns and working from home arrangements dramatically impacted movement and reduced all non-essential travel. Consequently, there was a reduction in the overall number of people who needed to travel to work or for business (Hensher, 2022). VTTS and VOR were lower in Wave 1 than the pilot surveys, with the most notable change seen as a reduction in the value of reliability.

4.2 Quality of online survey results

In the National Pilot survey, data collected through the online self-complete surveys had large differences in the estimated parameter values when compared to the face-to-face sample. Overall, the performance of the self-completed online survey responses was significantly worse in several areas:

- Of the 18 respondents in Wave 1 who miscategorised every injury statement included in the injury classification task, 17 were from online self-completes, while only one was from the face-to-face group.
- Of the 14 results with problematic data such as incorrect travel times, distances, and toll costs, 13 were from online self-completes and one was from the face-to-face group.
- The average ‘overall experience rating’ for face-to-face surveys was 8.6, however this was 7.6 for online.
- The average of other ratings of the face-to-face survey was approximately 4.5 (between Agree and Strongly Agree), while for online it was 4.1 (indicating Agree).

These results indicated that despite the speed and efficiency of online self-complete surveys, they were ineffective at delivering high quality data.

The early performance of online respondents in Wave 1 of the National Survey was closely monitored. Given the difficulty in sampling trips for non-built up areas, online recruitment and screening questions were utilised to ensure good population coverage across these areas. Several issues arose during the survey monitoring process, which led to the elimination of all online self-completed responses from Wave 1 data analysis, and a revision of the Wave 2 approach to include only face-to-face surveys or online guided interviews.

The quality of online self-complete survey data significantly deteriorated in Wave 1, compared to the performance of online self-complete responses in the pilot surveys. Issues included respondents completing the survey at an exceptionally fast speed, large gaps in the time taken to answer questions, and low scores on in-built knowledge tests which were aimed at assessing and self-reporting a respondent’s understanding of the questions. The poor results were expected to have caused unexpected WTP estimates and higher standard errors in the results, and there was a concern that similar issues would arise in the Wave 2 analysis if online self-complete responses were included.

It is uncertain exactly why the response quality deteriorated to this extent; however, it is likely COVID-19 was a major contributing factor. The disruptions from the pandemic were likely to have impacted the composition of the online panels, with a noticeable drop in performance seen across results from both the Dynata and Cint panels. Given COVID-19 related lockdowns, specifically those for the Delta variant, were ongoing during the implementation of Wave 2 of the survey, it was expected that the panel composition would be similarly impacted if self-complete online surveys were undertaken. Although in-person and face-to-face intercept surveys were difficult to organise through the lockdowns, these remained the preferable alternative in fielding the Wave 2 surveys. This was particularly important when considering the three key issues observed in the Wave 1 self-complete online surveys, outlined below:

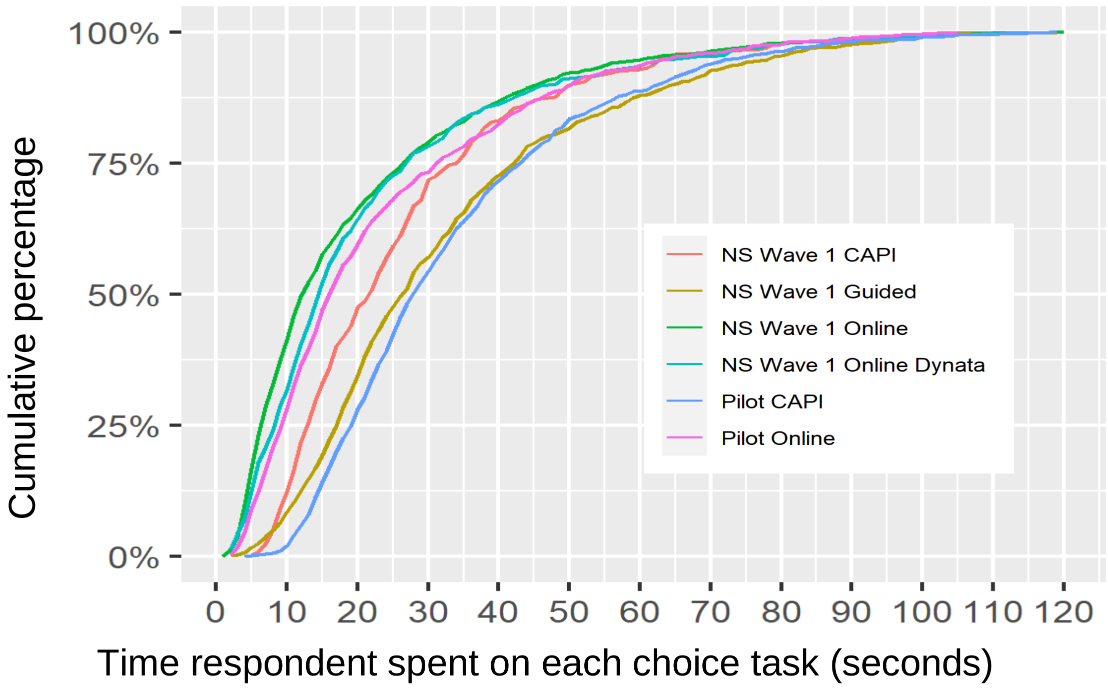
- The speed of online respondents

- The performance of respondents in knowledge tests
- The prevalence of straight-lining behaviour among respondents.

4.2.1 Speed of online respondents

Online self-complete survey respondents generally completed the survey faster than the guided online and face-to-face groups, and this effect was accentuated in the Wave 1 online survey. When respondents are self-completing online complex choice surveys, there is a concern that the respondent may not have properly considered all aspects of the tasks presented to them, this was noted in the National Pilot, however in the Wave 1 results, this issue was obvious. Including this data may create issues in the modelling by increasing the standard error of the parameter estimates. In Wave 1, online self-complete survey respondents were not only faster than the guided and face-to-face intercept groups but were also completed significantly faster than self-completed online survey respondents in the National Pilot, as seen below in Figure 4.1. This increased the risk of issues with the parameter estimates for the Wave 1 results.

Figure 4.1: Comparison of time spent on choice tasks by survey method and phase



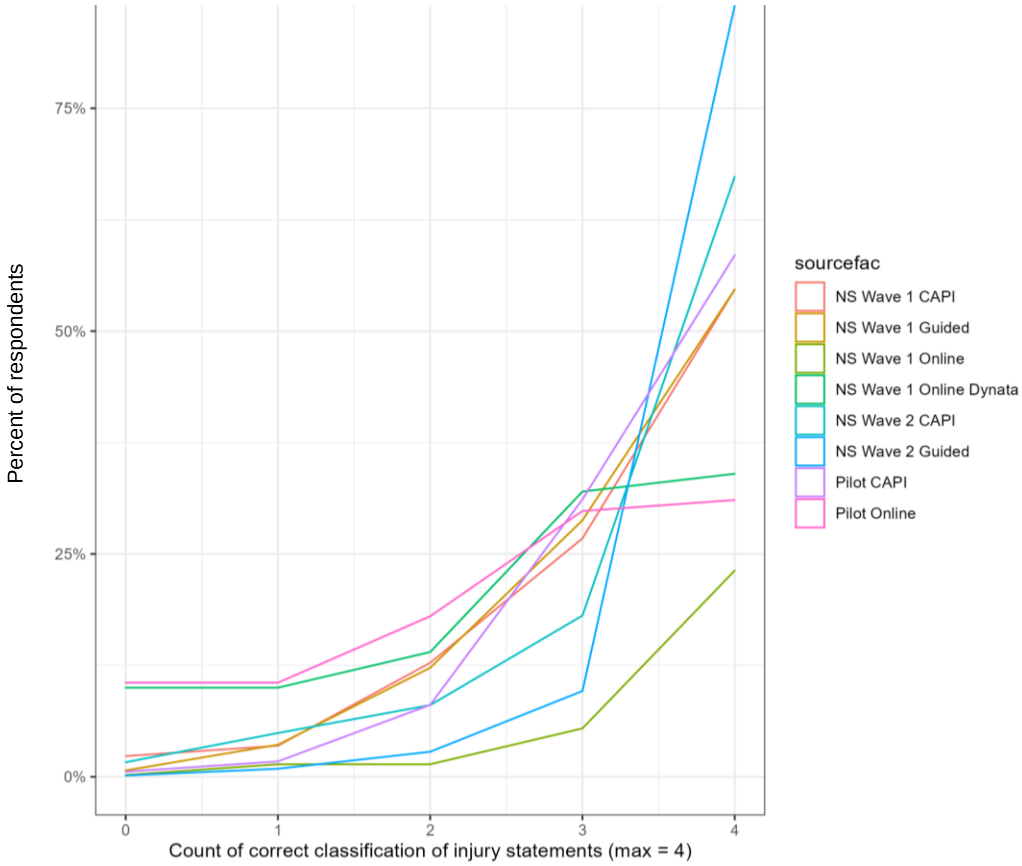
Source: Deloitte Access Economics

4.2.2 Performance in knowledge tests

Not only were online respondents faster at completing the survey, these respondents also performed noticeably worse on knowledge tests (a form of data validation) included throughout the survey. For the knowledge tests, respondents were presented with four injury statements and required to classify each into one of the five injury categories defined earlier on in the survey questionnaire. In completing this task there was a divide observed between the understanding demonstrated by respondents from the self-complete online and face-to-face survey groups, seen in both the Pilot and Wave 1 surveys. In the Pilot, 17 of the 18 respondents who answered all questions incorrectly were from the online self-complete group, indicating this group had a considerably poorer understanding of the injury classifications overall.

As seen in Figure 4.2 below, the face-to-face and computer assisted personal interviews guided (CAPI) survey respondents performed better overall when categorising injury statements for both the Pilot and Wave 1 surveys. Over 50% of respondents from these groups correctly classified all four injury statements, contrasted with only 30% of online survey respondents. Comparing the performance of online respondents across the Dynata and Cint panels, only minor differences were observed. The overall performance of the self-complete online group was seen as a strong indicator of the relatively poor quality of self-complete online responses collected in the National Pilot and National surveys.

Figure 4.2: Classifications of injury statements



Note: The values for Wave 1 Online do not sum to 100, due to some survey variations that involved the removal of a question asking respondent to correctly classify injury statements

Source: Deloitte Access Economics

4.2.3 Straight-lining behaviour

The final criteria used to assess the performance of survey respondents was the prevalence of 'straight-lining'. Straight-lining refers to respondents who always choose either the left or right option in each of the choice tasks presented to them. Conceptually, if individuals do not carefully consider the choices presented in each task but rather are focused on completing the survey with as little time or effort as possible, this may provide for lower quality data and pose problems for the reliability of the analysis.

There is of course, a natural chance that all of the five preferred choices for an individual all lie on the left or right side despite randomisation. Given the probability that an individual's preferred choice lies on a specific side is 0.5 (e.g. it is equally likely to be on either side), the probability that an individual's preferred choice is located on the same side for each of the five tasks is equal to 3.125% (0.5^5). By symmetry, there is the same probability that the individual's preferred choice is on the other side for each question, meaning 6.25% of respondents in any given sample should be expected to be 'straight-liners' even if they are selecting their preferred choice from each choice set (assuming that there is an equal probability of an individual's preferred option being presented on either the left, or right side of the choice set).

Table 4.2 below shows that, in the National Pilot, the proportion of respondents making straight-lining choices was roughly equal to the expected proportion, particularly for the CAPI and online guided groups. In the Wave 1 sample, the number of respondents making straight-lining choices increased significantly, from 6.9% overall to 12.6% overall. For the online self-complete segment only, the increase in straight-lining was far more significant, and the number of respondents who made straight-lining choices was more than double the expected proportion.

Table 4.2: Proportion of respondents making straight-lining observations

Phase	Sample	Proportion of respondents making straight-lining choices
Pilot phase	Online self-complete	8.2%
	CAPI and online guided	6.2%
	Total	6.9%
Wave 1	Online self-complete	13.6%
	CAPI and online guided	9.9%
	Total	12.6%

Source: Deloitte Access Economics

4.2.4 Conclusion on online self-complete online respondents

The rapid pace at which online self-complete respondents completed the choice tasks, the difficulty in accurately completing the knowledge tests and increased presence of straight-lining behaviour all together highlight a pattern of poor performance among the group, especially when compared to face-to-face and online guided respondents. The poor performance was not a new observation, with similar issues having been identified during the National Pilot surveys. However, the relative quality of online self-complete responses further declined quite significantly during the Wave 1 survey.

It was also apparent that the poor performance of the online self-complete group was not the result of differences in the approaches taken by panel providers. Similar issues were observed across segments from both the Dynata and Cint panels. In contrast, the online guided surveys, which were trialled for the first time during Wave 1, had a much better performance and data quality. All self-complete online responses were excluded altogether.

4.3 COVID-19 related restrictions and interruptions

The COVID-19 pandemic created significant complications for the project and disrupted the survey delivery process for both Wave 1 and Wave 2 surveys. The National Pilot was conducted in 2019, and responses for this survey will not have been impacted by COVID-19 related issues. However, respondents' preferences may have changed before the commencement of the National Survey. The first wave of COVID-19 and lockdowns interrupted the delivery of Wave 1 of the National Survey, while Wave 2 experienced disruptions caused by the Delta variant and further subsequent lockdowns in 2021. The delays to Wave 2 were compounded by the exclusion of online self-complete surveys from Wave 1, as the online self-complete surveys were discontinued based on preliminary analysis.

COVID-19 also changed working arrangements globally, leading to many people working from home. This created difficulties in comparing survey responses collected during the Pilot with preliminary National Survey results, but also presented an opportunity to collect data on changes of the work habits and preferences of respondents between the Pilot Survey and Wave 1 responses. COVID-19 also complicated the survey process due to lockdowns and health concerns, particularly for the surveys undertaken face-to-face.

Consequently, the timeline of deploying the surveys was longer than expected, due to frequent changes in survey locations and platforms, and funding allocations. Surveying was paused during lockdowns to ensure that people who were surveyed were still travelling and therefore had relevant points of reference to the scenarios presented to them. Surveying was further complicated by a reduction in participant quality following COVID-19, with a marked impact on the performance of online self-complete respondents. Taverner, the company which carried out the surveying, noted a marked reduction in the amount of time and care taken in responses on all surveys fielded during this period, and responded by switching to only guided surveys. The National Pilot results were included in the final sample, as the choice questions and performance metrics were sufficiently similar to the National Survey.

The challenges brought on by COVID-19 caused delays in survey delivery and required thorough, careful monitoring, analysis, and adjustment to the planned approach throughout Wave 1 and Wave 2 of the National Survey. Changes in respondent preferences and structural challenges in fielding guided and face-to-face surveys meant the results had to be supplemented with data from the National Pilot. Analysis indicates that the results from the Pilot Survey and National Survey are similar which gives confidence that COVID-19 has not had an over-riding influence on the results. Despite this, it is likely that COVID-19 has affected people's travel preferences, as seen in Hensher et al. (2023) and Cherry et al. (2023). The nature and extent of the influence of COVID-19 is likely to vary based on recency of COVID-19 restrictions and location and as such vary between studies.

5. Data and modelling

5.1 Data

Initial sample and data cleaning

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, so an effort was made to utilise the pilot sample as much as possible, to bring the total sample closer to the target number. To make up for the shortfall, the 289 face-to-face interviews from the pilot phases were included and pooled with the results from Wave 1. This came to a cumulative 488 responses, bringing the number of responses to approximately 300 below the original target of 720.

The decision to complete surveys was informed by initial testing of the data collected, the testing indicated that the sample size achieved, while less than anticipated, was sufficient to achieve the required level of statistical significance in the data analysis. The initial model estimates also provided statistically significant results, even after the removal of the unreliable self-complete online surveys. Table 5.1 below shows the number of responses removed for use in the modelling and it can be seen that a significant number of surveys collected at the Pilot and Wave 1 of the National Survey stages (mainly online self-completed samples) were not used for the estimation of the final model and economic parameters. Through understanding and rectifying the issues with data quality for the self-complete surveys, Wave 2 of the National survey had a far fewer number of surveys removed from modelling.

Table 5.1: Cumulative respondent samples available for modelling

Phase	Number of surveys (people)	Number of responses used in modelling (people)
Pilot	508	289
National Survey – Wave 1	822	199
National Survey – Wave 2	3,442	3,356
Total	**4,772**	**3,844**

Source: Deloitte Access Economics

Some demographic segments were underrepresented in the sample, particularly for non-urban and business groups, such as non-urban business drivers with a trip duration of 15-30 minutes. Most segments reached the quota, however non-urban regions and business travel lagged behind for some.

Between the survey waves, some minor changes to the questions were made and therefore some differences to the data collected. For example, no questions about COVID-19 or working from home were originally included in the Pilot, due to the pilot being undertaken pre-COVID-19. Any analysis that includes questions asked about COVID-19 and COVID-19 related impacts therefore could only include the initial sample from the National Survey. Analysis was separated between the pre-COVID-19 sample, post-COVID-19 sample and combined to ensure that any changes due to the impacts of COVID-19 could be identified.

As the choice experiment required selection between two discrete options the core data used in the analysis was highly controlled and clean; however, some data, such as location details, required respondents to manually enter the responses, and was subsequently subject to errors. To clean the location data, each datapoint was manually inspected to determine whether commutes and locations were deemed to be 'reasonable'. For example, a 10-hour each way daily commute from Sydney to another capital city, would not be realistic in a 24-hour day. These errors most frequently occurred in suburbs with destination suburbs shared by other states: such as Paddington, NSW and Paddington, Queensland, or Kensington, which is the name of a suburb in every mainland state. These datapoints had to be selected on a case-by-case basis, as a long daily commute in regional areas may be more realistic than in the capital cities, where possible, this was manually corrected.

As outlined in Section 3.4.2 each respondent was allocated a corresponding crash exposure based on their most likely taken route. This was sufficient for most routes, however some routes were within the same zone, so these routes could not have a corresponding crash exposure calculated, there were also routes where no optimal route could be identified. Therefore, for these routes, the weighted average AADT of the three nearest traffic count stations was used as a proxy in which the weights are the inverse of the distances from the traffic count stations to the suburb centre.

5.2 Final sample size and composition used for modelling

In total 4,432 interviews were conducted, with 3,844 responses used in the final modelling. This was within the range that was estimated to obtain reliable and significant results. Due to the exclusion of the self-completed online responses from Wave 1, the total sample size did not reach the initial target of 4,500 responses, which was the number that was initially hypothesised to be ideal for statistically significant results, it was determined through preliminary modelling that 3,844 responses would provide statistically significant modelling results. The samples for regional, business traveller and passenger segments were lower than initially targeted. The incorporation of the National Pilot data brought the total number of responses to 3,844, as seen in Table 5.2 below.

Results were excluded from the final modelling for being self-completed online, having excessively long or short transport times, for reporting a toll cost on the most recent trip of over $30 and for completing the interview in less than 10 minutes. Survey responses reporting toll costs above $30 were removed because the cost was outside of the reasonable expected range for cars and may indicate that the respondent misunderstood the question.

Table 5.2: Total sample breakdown by geography

Location	Total location of all respondents	Total location of respondents used in modelling
NSW	1,224	1,116
QLD	1,113	918
VIC	1,169	1,003
WA	451	378
SA	332	297
Tas	69	61
ACT	41	41
NT	33	30
Location not provided	340	0
Total	**4,772**	**3,844**

Note: Total responses by geography are lower than the total responses by survey method as location was not asked in some early survey stages or respondents provided an invalid location

Source: Deloitte Access Economics

Table 5.3: Overall sample collected in the survey by trip purpose

Passenger type	Trip purpose - Total			
	Commuting	Business	Non-work	Total
Driver	858	876	992	2726
Passenger	300	245	653	1198
Total	**1158**	**1121**	**1645**	**3924**

Note: Total responses by trip purpose are lower than the total responses by survey method as trip purpose was not given in some early survey stages

Source: Deloitte Access Economics

5.3 Demographic representation

The survey collected data on income, gender, trip distance, and the location where the respondents' trip began and ended. Quotas for respondents' demographic compositions were based on the 2016 Census, which recorded commuting trip distance and income, however newer data has since been released through the ABS 2021 Census. The 2021 Census was conducted after the quotas were first set, so for the purpose of this survey the results from the 2016 Census were retained for consistency. Some quotas, such as trip length should only be considered against the values from the 2016 Census, as the 2021 Census was undertaken when the Eastern States were in lockdown, which was likely to have distorted the outcomes.

The comparison of the sample data to the 2021 Census is given in Table 5.4 below. The results met the quotas set on geographic representation across states and regions, although respondents were more likely to have a higher income and take longer trips than would be expected in the overall population. Short trips were particularly under-represented in rural areas.

Table 5.4: Profile of the sample compared to the adult population of Australia (a)

Variable	National Survey profile mean/percentage	2021 census
Number of adults in household	2.1	1.9
Number of children in household	0.8	0.7
Number of cars in household	1.86	1.8
Personal income ($/week)	1393.46	805
Age (year)	45.69	38
Interview Duration (minutes)	59.9	NA
Employed full time	42.8%	34.2%
Employed part time	16.4%	19.1%
Employed casually (b)	9.7%	NA
Not working for pay	1.0%	2.0%
Full time home keeper	7.9%	16.4%
Regular volunteer worker	2.9%	3.4%
Retiree	12.9%	17.0%
Unemployed	3.7%	3.1%
Other working situation	5.3%	4.8%
Highest level of education is any high school	26.1%	29.5%
Highest level of education is a Diploma	19.4%	25.5%
Highest level of education is a Bachelor degree	27.2%	26.3%
Highest level of education is a Postgraduate degree (c)	15.0%	NA
Highest level of education is Other	5.1%	18.7%
Gender is Male	32.7%	49.3%
Gender is Female	59.9%	50.7%
Gender is Other	0.3%	Not recorded
Declined to answer gender/was not asked	7.1%	NA

Notes:

a) *Due to rounding some totals may not sum to 100.*
b) *Census employment data is bracketed by hours worked and does not show casual status on contract*
c) *The Census only records highest educational attainment up to the Bachelor degree and above, so this figure is inclusive of both postgraduate and Bachelor degrees*

Source: Deloitte Access Economics and ABS Census

5.4 Comparison of sample to other studies

When deciding upon the sampling strategy for the National Survey, several past studies undertaken in Australia and internationally, were taken into consideration. The full sample size was informed by the pilot, however there were three factors highlighted at the outset: the sample size, segmentation, and recruitment method. Notably, there have been no national studies in the literature that covered all the WTP components explored in this survey: travel time, reliability, and safety. The studies discussed below are not an exhaustive list of sampling strategies undertaken in national studies, however they do provide useful context for comparing the final survey sample to comparable surveys previously undertaken.

Overall, the sample for the National Survey was larger and more comprehensive than previous local studies. Australian studies often used regional or state-based surveys and did not necessarily apply a WTP methodology framework. While there were larger samples in some international studies, the delivery of these surveys to the population were commonly conducted online. The National Survey also had a more detailed breakdown of traveller types than any previous surveys, which is expected to have improved the accuracy of the WTP results. However, this study did not address the value of a statistical life, noting that this is not the same as the WTP value for a fatal crash.

5.4.1 Australian studies

The travel time parameter values in the ATAP (2016) guidelines were based on the literature survey in Austroads (1997). The report recommended a VTTS for business purposes set at average hourly earnings including all overheads but excluding payroll tax. The recommended VTTS for private purposes was 40% of average hourly earnings.

In 2008, the NSW RTA (now Transport for NSW) conducted 213 face-to-face interviews to estimate a WTP value for risk reduction. The sample was split according to the NSW urban-rural ratio, with 142 urban participants from Sydney and 71 non-urban participants from Bathurst. Compared to the ratio of urban to regional respondents in the National Survey's NSW respondent group, the NSW RTA sample had greater representation of regional Australia, with a 2:1 urban-rural ratio, compared to 3:1 in the National Survey. Nationally, the distribution evened out, reaching a 2.14:1 urban-rural split, however the regional group remained underrepresented compared to the RTA study.

In the context of comparing human capital versus WTP approaches to estimating the social cost of road crashes, the 2015 Austroads report (*Social cost of road crashes in Australia*) reviewed and collated results from stated choice studies undertaken in Australia and around the world. Across the studies examined, this review found an overall preference for stated preference methods involving choice modelling techniques and mixed logit empirical models as opposed to relying on human capital models. However, the methods used to collect the data varied; individual interviews with data being subsequently entered into a computer, online surveys, and CAPI were all used.

In 2016, there were several studies undertaken which attempted to quantify VTTS or provide frameworks for estimating VTTS for NSW. These include assessments by Douglas Economics (2016) and Deloitte Access Economics' scoping study, the latter of which provided valuable background for the current report. The Douglas Economics study used a stated preference approach to estimate VTTS for NSW car users, based on data from 613 car users across Sydney, Newcastle, and Wollongong. The surveys were conducted face-to-face, with respondents being required to complete a set of choice tasks evaluating travel time, reliability, and cost. The results of this study were similar to NSW transport appraisal guidelines at the time, however the updated guidelines recommended using a higher reliability ratio. The current study implemented the surveys at even more locations within NSW, so the results are considered to be more accurate at both a regional and national level.

5.4.2 International studies

Miller and Guria (1991), conducted as part of the NZ Ministry of Transport's Household Travel Survey (HTS), similarly applied a WTP approach aimed at estimating the value of a statistical life, similar to the value of risk reduction estimated in the National Survey. Households were given questionnaires, with 25% asked WTP questions, the survey received 568 responses. To represent the country's population, the survey was split across two segments: main urban areas, and the remainder of New Zealand. The sample was geographically stratified and randomly sampled at four different stages across urban areas to achieve the appropriate split. Guria et al. (1999) used a similar approach this time with 1,051 respondents and stratifying the country into 14 local government regions with samples for each region proportional to its population. In line with this method, the National Survey also divided the sample based on state population, seen in Table 5.2.

In 2019, a value of travel time and reliability study was undertaken in the United Kingdom (Batley et al, 2019), aimed at developing revised national average values of in-vehicle travel time savings, reliability, and time-related quality. The study used WTP methods for a range of modes covering both business and non-work travel purposes and delivered variation in values based on characteristics of travellers and the trip. In total there were 8,263 responses, segmented by travel purpose and mode of travel. Business travel was split into 'employee's business' and 'employer's business' subsegments. This allowed VTTS for business-related travel to be estimated from the employer's perspective, offering a greater level of granularity than in the National Survey.

An earlier version of the UK study (Arup, 2015) also indicated an 80-20 target split for intercept and telephone responses respectively, along with the use of a web-based survey. The intercept approach allowed the team to target specific samples that were difficult to recruit and adjust the sample where elements of the population were not well represented. The National Survey attempted a similar approach; however, the approach was made more difficult to implement by COVID-19. Disruptions over the course of the pandemic prevented the ability to fully correct the sample target, and some segments ultimately failed to reach the initial target. Given many national VTTS studies use arbitrary approaches to decide overall sample and segment size, there is no specific value which would have been a completely appropriate target for the National Survey, particularly after taking budgetary considerations into account.

The literature indicated significant variation in approaches adopted by studies in different countries, so it is difficult to use these studies to set an accurate comparable benchmark for the National Survey. If not for the shocks caused by the COVID-19 pandemic, the National Survey sample would have been able to more accurately represent the Australian population. A full list of VTTS and VOR results from past studies are given in Table 5.5 overleaf:

Table 5.5: VTTS and VOR parameter values: national studies

Study	Data collection period	Location	Sample size	Unit of measurement	Value of travel time savings	Value of reliability	Reliability ratio
Axhausen et al (2006)	2002	Switzerland	1,188	CHF/hr	Commute: 21.4 Shopping: 18.1 Leisure: 12.3 Business: 32.5	n/a	n/a
Department for Transport (2015)	2014-15	United Kingdom	3,025	GBP/hr	Commute: 11.7 Non-work: 4.91 Business: 16.74	n/a	Commute: 0.3 Non-work: 0.35 Business: 0.42
Borjesson & Eliasson (2014)	2007-08	Sweden	1,440	EUR/hr	Short commute: 9.8 Short other purpose: 6.1 Long all purpose: 11.7	n/a	n/a
Fosgerau et al (2007)	2004	Denmark	2,669	DKK/hr	Non business (IVT): 67 Congested time: IVT*1 Parking search time: IVT*1.5	n/a	n/a
Gerstorf & Schupp (2015)	2012-13	Germany	3,071	EUR/hr	Business travel: 8.4 Leisure: 4 Shopping: 4.31 Commute: 4.75	Business travel: 8.4 Leisure: 3.42 Shopping: 3.88 Commute: 3.63	n/a
Wardman et al (2016)	2011	The Netherlands	1,430	EUR/hr	Commute: 9.25 Non-work other: 7.5 Business employee: 12.75 Business employer: 13.5	Commute: 9.25 Non-work other: 7.5 Business employee: 14.5 Business employer: 13.5	Commute: 0.4 Non-work other: 0.6 Business: 1.1
Eliasson (2004)	n/a	Sweden	600	SEK/hr	Morning: 68 Afternoon: 58 Business: 120	n/a	Morning: 0.95 Afternoon: 0.59 Business: 0.32
Hensher (2001)	1999	New Zealand	198	NZ$/hr	8.7	5	0.6
Lam and Small (2001)	1997-98	United States of America	332	US$/hr	22.9	Male: 15.1 Female: 31.9	Male: 0.7 Female: 1.4
Li, Hensher & Rose (2010)	2008	Brisbane, Australia	280	AU$/hr	Commuters: 28.28 Non-commuters: 12.31	Commuters: 40.39 Non-commuters: 21.91	Commuters: 1.4 Non-commuters: 1.7

Li, Tu and Hensher (2016)	2014	China	309	AU$/person hr	n/a	n/a	0.75
Meunier and Quinet (2015)	2010	France	n/a	EUR/hr	Business: 17.5 Commute: 10 Other: 6.8	n/a	n/a
Noland et al (1998)	n/a	United States of America	543	US$/st. dev.	n/a	n/a	1.27
Significance (2013)	2011	The Netherlands	1,430	EUR/hr	Commute: 9.25 Business: 26.25 Other: 7.50	Commute: 3.75 Business: 30 Other: 4.75	Commute: 0.4 Business: 1.1 Other: 0.6
Small et al (1999)	1995	United States of America	n/a	US$/hr	3.9	12.6	3.2
Brownstone & Small (2005)	1999-2000	United States of America	548	US$/hr	Revealed preference: 21.5 Stated preference: 11.9	Revealed preference: 19.6 Stated preference: 5.4 per incident	Revealed preference: 0.9
Shires & de Jong (2009)	2003-04	Netherlands	n/a	EUR/hr	n/a	n/a	1.24
Fowkes (2007)	2003-04	United Kingdom	49	GBP/min/tonne	n/a	n/a	Shippers: 0.38 Own account: 0.19
Halse et al (2010)	n/a	Norway	736	NOK/hr	n/a	n/a	Shippers: 1.2 Carriers: 0 Overall: 0.11
de Jong et al (2016)	2010	The Netherlands	812	EUR/hr	Freight: 38	Freight: 14	Shippers: 0.9 Carriers: 0.28 Overall: 0.37

Source: Deloitte Access Economics

5.5 Data weighting

As described in 5.3, the proportions of survey respondents in terms of income and trip distance were different from the proportions in the population. Some of this was done intentionally, so that results could be found for high income groups and long trip distances, without sample size being too small. For the final modelling, a representative sample in terms of income and trip distance was desired. As such, a weighting process was used that gave higher weights to short trips and low-income respondents and lower weights to long trips and high-income respondents to approximate the WTP values for the entire population. The full process of weighting is described below.

Both income and trip distance were included in the model to estimate the impacts of trip length and income on VTTS. The length of trips given to participants in the choice experiment was based on the responses given to the length of typical trips, and the impact of trip length on VTTS was estimated by an inclusion of a log transformation of travel time, in addition to its linear form. The costs given to participants were correlated with reported income (e.g., high income travellers tend to use toll roads more and hence having a higher travel cost than low-income travellers), and thus, it is important to account for the possible impact of income on the willingness-to-pay in the final model. The impact of income on WTP was estimated in the final model by an inclusion of an interaction term between travel cost and income, alongside the travel cost itself (linear effect).

The raw survey data required reweighting to obtain the WTP for use in appraisal (i.e., values that represent the WTP of the population). There are two re-weighting methods, that exist in the literature to obtain the population-level WTP from discrete choice models. The first method includes the sample weights (also known as sample expansion factors) in the model so that the behavioural values derived from the model parameters represent the population values. The second method uses a ‘sample enumeration’ approach, which involves the calculation of WTP value for each observation in the sample, followed by applying the sample weights to ensure national representativeness. This calculation is expressed mathematically as follows:

$$\bar{v} = \frac{\sum_i w_i v(z_i)}{\sum_n w_i}$$

Where $\bar{v}$ is the weighted average WTP, $i = 1, \dots, N$ is the i^{th} observation (respondent) in the sample, w_i is the weight (i.e., expansion factor) carried by the observation i^{th}, and $v(z_i)$ is the individual WTP derived from the model as a function of a vector of covariate z_i (e.g., income, trip length).

Using sample expansion factors is different to sample enumeration, as sample expansion factors weights within the model estimation, while sample enumeration weights after the model estimation. The econometric literature recommends the *sample enumeration* approach, which this modelling and report has followed, because this method avoids inflating the variance of the model parameter estimates (significance level) and avoids adding considerable complexity to the variance estimation (Bollen et al., 2016; Batley et al, 2019). In addition, it is argued that weighting the sample expansion factors, would bias the model parameters towards the behavioural values of the underrepresented groups. For example, in Figure 5.1 below, long trips were purposely over-sampled to obtain enough observations for estimating the variation of WTP by trip length. If the sample weights were applied within the model estimation, the long trip observations, whose weights are less than 1, would carry less impact on the behavioural values than the raw data would suggest. By contrast, the short trip observations, whose weights are larger than 1, would carry more impact. Consequently, the behavioural values obtained from such models, may not be representative of either group.

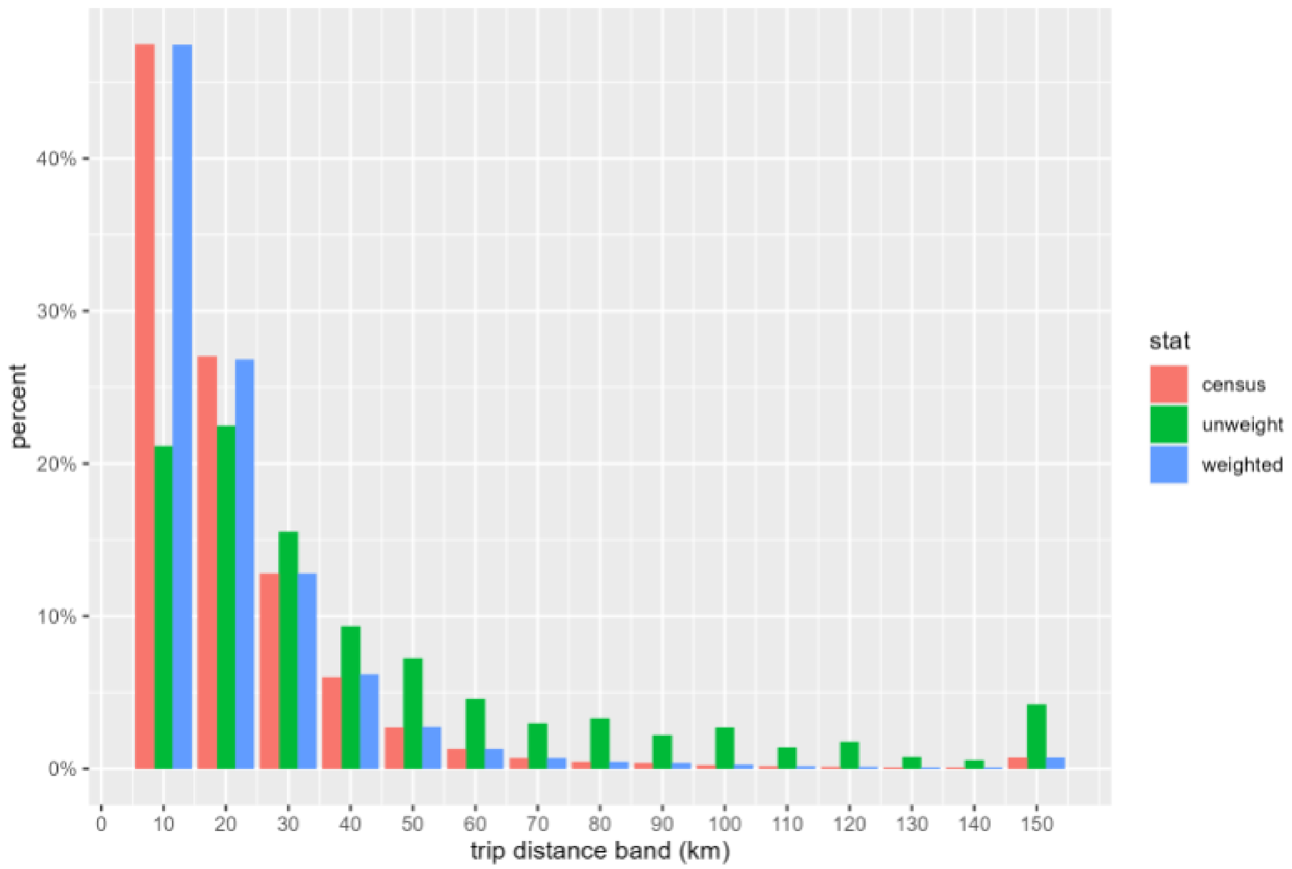
To obtain the WTP reported herein, the sample was weighted for each respondent/trip pair after the model estimation using the sample enumeration approach (Batley et al, 2019). This resulted in WTPs that represent the population values accurately in terms of income, trip length, setting and the interaction between trip length and setting.

The weighting was conducted based on typical trip distance and income, as these variables theoretically had the largest impact on WTP estimates. The unweighted sample was skewed toward larger trip distances, with the number of 10 km trips heavily underrepresented. Beyond the 20km length, the census data showed a noticeably smaller number of trips than the sample datapoints suggested, with a spike in 150 km length trips. Longer trips could have increased the mean travel time for the sample, potentially reducing the value of travel time savings and reliability.

Applying the sample weights to the data produced a sample closely resembling the 2016 Census Journey for Work for trip length and 2021 Census for income, seen in Figure 5.1 and Figure 5.2: below. The 2016 Census data was used for trip length as the 2021 Census was undertaken during COVID-19 lockdowns in the Eastern States, so would not provide results typical representative trip. The weighting process produced results that are nearly identical to trip distance in the 2016 Census, as shown by the similarity of the weighted and Census bars in Figure 5.2 and Figure 5.3. These weights were applied to account for differences in rural/urban trip lengths.

The distribution of these weights is given in Appendix A.6.

Figure 5.1: Samples weighted for trip length

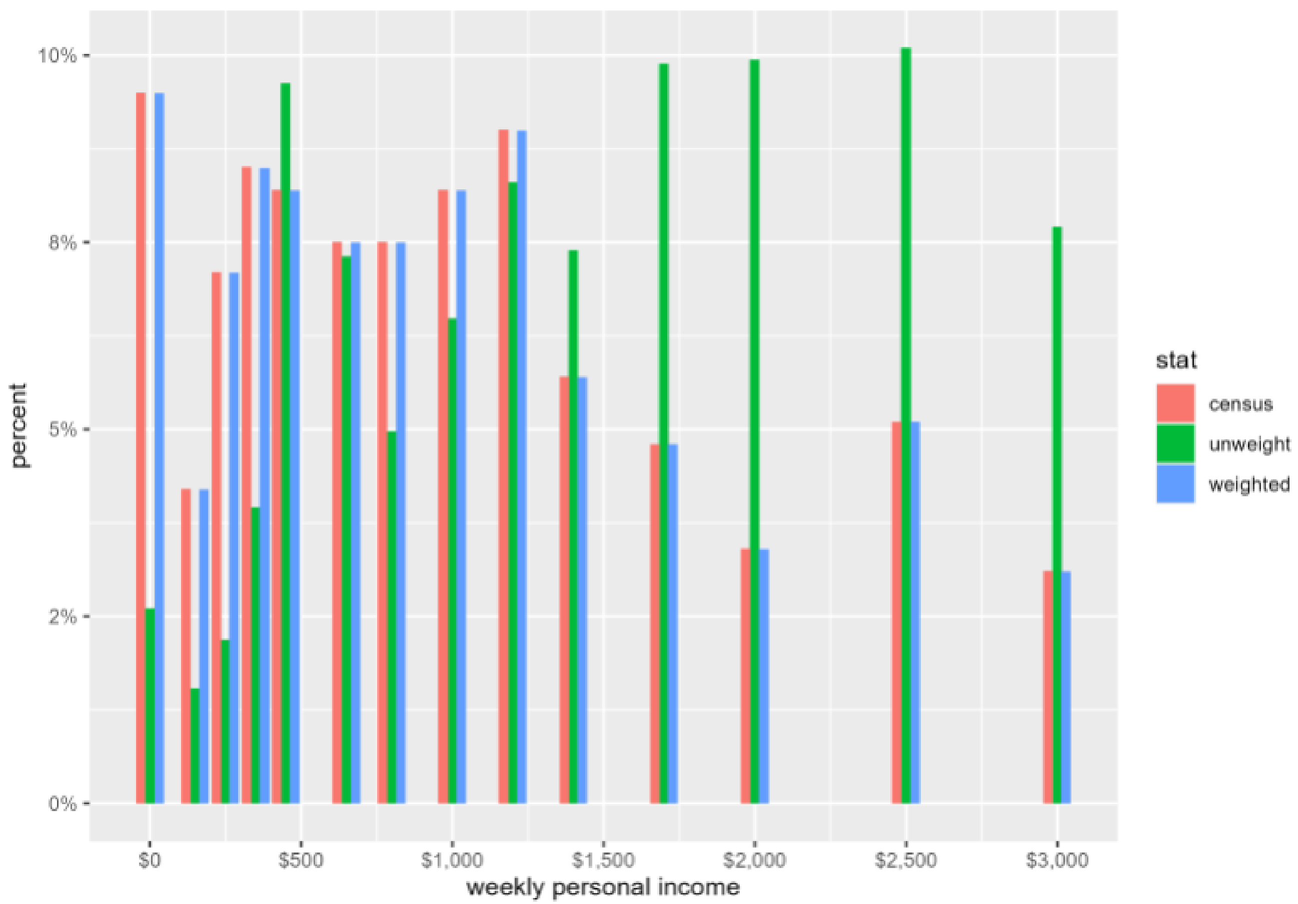


Source: Deloitte Access Economics

Similarly, the proportion of respondents with higher personal incomes (above $1,500 per week) were greatly overrepresented in the raw sample data (Figure 5.2 below). Estimating WTP for travel time savings or reliability based on higher average personal incomes would have inflated the expected value of the estimate.

After weighting, the sample distribution matched that seen in the 2016 Census, with a greater proportion of respondents earning between $0 to $1,000 per week.

Figure 5.2: Samples weighted for income



Source: Deloitte Access Economics

5.6 Model definitions

The model made use of a utility function (outlined in section 3.4.1) which simultaneously provides measurements for the three different WTP measures (VTTS, VOR, VRR), split across two travel conditions (free-flow and congested), and the three travel purposes (commuting, non-work, and business). Separated WTPs for saving travel time in free-flow conditions (FF), and congested conditions (CG) were estimated from the modelling parameters, with the weighted WTP for saving total travel time (FF + CG) calculated as the weighted average WTP for FF and CG time. Note that for each trip, car users may spend some percentage of the time in congested conditions, with the balance of time under free-flow conditions. For model identification, only two of the three travel time components (FF, CG, Total) could be included in the model specification (including all 3 variables will result in perfect collinearity because Total time = CG + FF). These percentages were used to weigh up the Value of Travel Time saving (VTTS) for free-flow and VTTS for congested time to obtain the weighted VTTS for total time. That is, the VTTS for FF and CG were estimated directly from the model run for each trip, while the VTTS for total travel time for each trip is computed as the weighted average VTTS where the weights are the average percentages of time the corresponding trip was under FF and CG condition, respectively. This weighted average VTTS, which varies across trips because the percentage of time under FF and CG conditions are different for each trip, was then entered the enumeration formula shown in Section 5.5 above as to obtain the population representative VTTS by travel purpose.

The WTP for each response in the sample, the average WTP and confidence intervals representative of the population values were obtained through the Wald procedure, which weighs up the sample to match the population in terms of income band and trip distance, which involves the weighting described in Section 5.5 (i.e., this process is the same for all WTP values). The Wald procedure used 40 functions of the final model parameters to obtain average WTP and confidence interval. As some variables such as FF and CG times enter the utility function as non-linear (e.g., the linear for short trip vs. linear plus log-transformation for longer trip), the Wald procedure accounts for the proportion of short vs long trip in the sample before weighting up the sample WTP to obtain WTP for an average trip in the population. Additional checks were undertaken to assess demographic composition.

In previous modelling, the influence of being a passenger and a driver was studied. Whether someone was a driver or passenger was ` to have a significant effect on any of their WTP responses.

The model is outlined in the following way:

- WTP for saving travel times are in $/hour. They vary by travel condition (Free-flow (FF) vs congestion (CG): red text) and trip purpose (Light blue text: Business (B) vs Commuting (C) vs Nonwork (N)). These are obtained in the same model run.
- Value of reliability (VOR measured by standard deviation of total travel time) are in $/hour. They vary by travel purpose.
- Values of risk reductions (VRR) are estimated directly and are in $million/crash. The WTP to reduce risk of crash varies by crash type (black text):
    - Property damage only
    - Minor injury
    - Major injury
    - Incapacitating injury
    - Fatal crash

These variables are then calculated and presented with a corresponding value in $AUD, a z-value and confidence interval. The final functional form of this model estimating the observed utility, is expressed in Equation 3.2. An expanded version of the definitions, including the components used to calculate specific variables in, can be found in Appendix A.2.

Table 5.6 below provides the abbreviations and the expanded definitions for the variables that are used in the models that are presented in Chapter 6. An expanded version of the definitions, including the components used to calculate specific variables in, can be found in Appendix A.2.

Table 5.6: Definitions used throughout the modelling

Variable	Meaning
VTTSFFC	Value of Travel Time Saving Free-Flow - Commute
VTTSFFB	Value of Travel Time Saving Free-Flow - Business
VTTSFFN	Value of Travel Time Saving Free-Flow - Nonwork
VTTSCGC	Value of Travel Time Saving Congested - Commute
VTTSCGB	Value of Travel Time Saving Congested - Business
VTTSCGN	Value of Travel Time Saving Congested - Nonwork
WVTTSC	Weighted Value of Travel Time Saving - Commute
WVTTSB	Weighted Value of Travel Time Saving - Business
WVTTSN	Weighted Value of Travel Time Saving - Nonwork
VORC	Value of reliability - Commute
VORB	Value of reliability - Business
VORN	Value of reliability - Nonwork
WTPPRO	Willingness-to-pay for reducing property damage
WTPMIN	Willingness-to-pay for reducing minor injury
WTPMAJ	Willingness-to-pay for reducing major injury
WTPINC	Willingness-to-pay for reducing incapacitating injury
WTPFAT	Willingness-to-pay for reducing fatality

Source: Deloitte Access Economics

The model takes a discrete choice form based on random utility theory, with WTP values delivered from the model parameters estimated from the survey data. This is done using a mixed multinomial logit model, also known as random parameter model, where some model parameters (such as travel time and reliability) were specified to follow a statistical distribution such as normal distribution or a constrained triangle distribution (see Hensher and Green 2003). The full equation for this is shown in 3.4.1.

The value of risk reduction for crashes at each severity level was found by using the crash probabilities in the survey response questions as the dependent variables. The number of crashes per annum along the route of a trip in the questions presented to survey respondents were converted to probabilities by division of the annual crash exposure. Exposure was taken as the distance-weighted AADT for the optimal route of the trip times 365, estimated using AADT data as explained in section 3.4.

6. Results

6.1 Final sample results

The VTTS results were given in $/hour, and varied by travel condition, trip length (log transformation of travel time) and trip purpose. The VOR was also given in $/hour, by travel purpose, while the value of risk reduction (VRR), was estimated directly and given in $ million/crash. The WTP for reducing the risk of a crash varied by crash type, while trends can be seen in the VTTS and VOR values around trip purpose and traffic conditions. All of the results are statistically significant, with the exception of the VTTS for non-work travel in congested conditions. Table 6.1 below outlines the WTP values derived from the modelling, along with the standard error, z scores, and confidence intervals of each WTP value.

The insignificance of VTTS for non-work in congested conditions could be explained if sampled residents considered some level of congestion as ‘normal’. This interpretation is supported by the relation between the WTP for CG, FF, and total time (TT) where the CG and TT time is very close, which indicates non-work trips spent very little time in congestion. Very little time spent in congestion means that the sample size in these conditions is low, which could contribute to low significance. The rationale behind this would be that people intentionally delay their non-work travel to times with low congestion as non-work travel is typically more flexible.

Table 6.1: Final WTP results

Variable	WTP	Standard Error	z	Prob z>Z*	95% Confidence Lower	95% Confidence Upper
VTTSFFC	15.75***	2.02	7.79	0.00	11.78	19.71
VTTSFFB	17.59***	2.19	8.01	0.00	13.29	21.90
VTTSFFN	21.56***	1.71	12.64	0.00	18.22	24.90
VTTSCGC	62.90***	6.67	9.43	0.00	49.83	75.98
VTTSCGB	66.47***	6.08	10.94	0.00	54.56	78.38
VTTSCGN	9.89***	2.44	4.05	0.00	5.10	14.68
WVTTSC	31.10***	2.26	13.77	0.00	26.67	35.53
WVTTSB	33.53***	2.27	14.76	0.00	29.08	37.98
WVTTSN	18.81***	1.35	13.89	0.00	16.15	21.46
VORC	35.50***	2.39	14.87	0.00	30.83	40.18
VORB	36.87***	2.70	13.67	0.00	31.59	42.16
VORN	31.35***	1.86	16.88	0.00	27.71	35.00
WTPPROP	0.016***	0.003	4.98	0.00	0.010	0.022
WTPMIN	0.025***	0.008	3.05	0.00	0.009	0.041
WTPMAJ	0.50***	0.09	5.78	0.00	0.33	0.67
WTPINC	1.45***	0.11	13.34	0.00	1.24	1.67
WTPFAT	3.66***	0.28	13.12	0.00	3.11	4.21

*Note: ***, **, * represents significance at 1%, 5%, 10% level respectively.*

Source: Deloitte Access Economics

6.2 Value of travel time savings and reliability

Table 6.2: Journey by purpose parameter values

WTP ($/hour)	Commuting traveller		Business traveller		Non-work traveller	
	Coeff.	**z-value**	**Coeff.**	**z-value**	**Coeff.**	**z-value**
Value of travel time savings – free-flow	15.75***	7.79	17.59***	8.01	21.56***	12.64
Value of travel time savings - congested	62.90***	9.43	66.47***	10.94	9.89***	4.05
Value of travel time saving – weighted average	31.10***	13.77	33.53***	14.76	18.81***	13.89
Value of reliability	35.50***	14.87	36.87***	13.67	31.35***	16.88

*Note: *** represents significance at the 1% level*

Source: Deloitte Access Economics

The VTTS and VOR were separated by trip purpose, with different willingness-to-pay values assigned to commuting travellers, business travellers and non-work travellers. All results that vary by trip purpose are significant at the 1% level. Overall, non-work travel was assigned a lower value than work commutes or business travel, with a more acute difference under congested traffic conditions. This is expected since the overall value in congested traffic is higher than under free-flow traffic conditions. A similar trend can also be observed in the VOR results, with reliability valued the most for commuting, followed by business travel, with reliability in non-work travel not perceived to be as valuable.

In free-flow traffic, commuters were willing to pay $15.75 per hour of travel time saved, and business travellers were willing to pay $17.59 per hour, while non-work travellers were willing to pay $21.56 per hour. Interestingly, business travellers placed a lower value on travel time saved than those undertaking non-work trips, however these values had a larger standard error. This indicates a greater degree of uncertainty about the result, which may suggest more variability in the value of travel time saved. This segment was an outlier in terms of the relationships between results based on travel purpose, with business travel assigned a higher value than non-work travel for all other variables.

For congested traffic conditions, the VTTS was much larger for work-related travellers, with commuters willing to pay $62.90 per hour saved, and business travellers willing to pay $66.47 per hour saved. The VTTS for non-work travellers in congestion, at $9.89 per hour, was below the VTTS in free-flow conditions, suggesting traffic congestion was less of a concern for this group compared to the others.

A rationale for the congested VTTS being below the free-flow VTTS for non-work trips might be that non-work travellers see congestion as inevitable; however, they have an ability to avoid traffic congestion by selecting off-peak hours to travel and/or locations that are not very congested. For example, many types of non-work trips such as appointments with health and other professionals, university lectures and events have a set arrival time but can be scheduled flexibly. Hence, they would not be prepared to pay much for reducing congested time (such as by using a toll road) because they can choose a less congested time/place for non-work trips. Flexibility, either in time of day or activity location, is not widely available to business travellers and commuters. The data collected supports this interpretation because many travellers for non-work purposes reported a lower congested time (23.5% of total time), relative to business travellers (32.6%) and commuters (32.5%).

A further explanation for the difference in VTTS between congested conditions and non-congested conditions would be that many non-work respondents will experience very little variation in congestion because they choose to time non-work trips out of peak times, meaning that there is little-to-no congestion for all choices. For example, non-work travellers can schedule a trip to a doctor or the supermarket outside of typical commuting hours, while a common non-work trip that would be expected to be undertaken in congested conditions is a school pick-up. If these respondents are fundamentally different, then it could result in a VTTS for congested conditions that does not reflect all respondents.

The weighted average values of travel time savings (WVTTS) are shown in Table 6.2 above for each of the three trip purposes. The WVTTSs for commuters and business travellers are almost identical, at $31.10 and $33.53 respectively.

Typically, we would expect the willingness-to-pay for business travel to be higher than the willingness-to-pay for commuters, and as such, having them be close in value is unexpected. However, much of the research that looks at the relationship between these two variables has been conducted before the COVID-19 pandemic, and associated changes in travel that came with that. Much of the surveying for this study was done during the COVID-19 pandemic, and as such would be influenced by the change in commuting patterns.

A change that was observed during COVID-19 was an increase in the willingness-to-pay to avoid commuting time (Hensher, 2021). Additionally, an increase in the use and availability of video communications in business environments provides an alternative to business travel. Hensher (2021) found that, based on data from the Greater Sydney Metropolitan Area (GSMA), a percentage adjustment should be made to pre-COVID-19 measures of commuter WTP. As such, the low difference between commuting and business is understandable, and, further, no percentage adjustment needs to be made.

The VORs for commuters at $35.50 per hour and business travellers at $36.87 per hour were above the VOR for non-work travellers at $31.35, possibly due to the regularity of work commitments compared with non-work activities.

The reliability ratios, calculated by dividing the VOR by VTTS, were similar for commuter and business trips, at 1.14 and 1.10 respectively, however, considerably higher for non-work, at 1.67. The higher value for non-work trips may be due, in part, to the fact that many non-work trips are for purposes which have a set arrival time but can be scheduled flexibly such as appointments with health and other professionals, commencement times for school classes, university lectures and events. It may be possible to schedule non-work trips outside of typical congested periods, which results in a reduced VTTS, but inflexibility of arrival times for all trips results in VOR being similar. Non-work trips have a lower baseline for VTTS, which means they have a higher reliability ratio if VORs are similar.

Based on these results, the key observations were that the WTP to reduce travel time was significantly higher for commuter and business travel than for non-work travel. When comparing VOR, the difference between these categories was not as large. The reliability ratios were between 1.1 to 1.7, consistent with international findings. Cost was a non-linear parameter, and a function of personal income, therefore the WTP estimates also varied by income group, however the impact of income was small and statistically insignificant.

6.3 Value of risk reduction

The estimated WTP for crashes, measured as the value of risk reduction, was split into the five injury categories described in the survey, with the results shown in the last five rows of the results table and are all positive and statistically significant. The WTP was measured in millions of dollars per crash, estimated off a respondent's marginal choice on a trip over the course of a year.

The value of safety increased with the severity of crash, as was expected, which was consistent with the original KPIs. All values of safety were significant at the 1% level and positive.

Table 6.3: Willingness-to-pay coefficients for VRR

	Coeff.	z-value
Willingness-to-pay to avoid property damage ($m/crash)	0.016***	4.98
Willingness-to-pay to avoid minor injury ($m/crash)	0.025***	3.05
Willingness-to-pay to avoid major injury ($m/crash)	0.50***	5.78
Willingness-to-pay to avoid incapacitating injury ($m/crash)	1.45***	13.34
Willingness-to-pay to avoid fatality ($m/crash)	3.66***	13.12

*Note: *** represents significance at the 1% level*

Source: Deloitte Access Economics

Based on the results, travellers were willing to pay $16,000 to prevent a crash which only caused damage to the vehicle. This increased to $24,660 for crashes resulting in minor injuries, and increased significantly, to $500,010 for crashes resulting in major injuries. Since a minor injury is expected to require treatment from a doctor, while a major injury is expected to require hospital treatment, the large difference in WTP estimates was expected. For an incapacitating injury, the WTP per crash increased to $1.45 million, and respondents indicated that they would pay $3.66 million to prevent a fatal crash.

The WTP value represents the impact of a crash on occupants themselves, their family and friends and not necessarily other road users beyond any psychological damage caused. Therefore, the cost of a car crash is the sum of the VRR for all involved, and not the VRR given for the injury of maximum severity in the crash. The exact details of the crashes that occur in each stated choice experiment was not given to the survey participants.

Overall, the results align with expectations and international evidence, with travellers willing to pay larger amounts to prevent more severe crashes.

6.4 Income and the value of travel time

Income was an important factor to consider in analysing the results. Being a key driver of differences in WTP values, the analysis involved applying a different VTTS and VOR to travellers from different income groups. The final income range for the National Survey was representative of the national population, so the values obtained in Table 6.1 and Table 6.4 reflect an income profile equivalent to the whole of Australia. As such, the results reflect the representative Australian's WTP, and income does not need to be directly added as a control.

The final model includes the impact of income group by interacting personal income with travel costs presented. That is, the impact of income was included in the model as an interaction variable with cost to pick up possible variation in WTP across the range of incomes. From the theoretical viewpoint, higher income respondents may be less sensitive to travel cost than lower income respondents. The model required that the interaction between income and travel cost follow a constrained triangle distribution. The model delivered a negative parameter for the interaction as expected but the impact was not statistically significant (Table 6.4 below).

From Table 6.4 below, it is observed that the parameter for travel cost multiplied by income is not significant. This means that WTP does not vary statistically and meaningfully across income groups. Low income and high-income commuters also have a similar WTP. Ordinarily, it would be expected that higher income commuters have a higher VTTS (Abrantes & Wardman, 2011). Some simulations by income group are included in Appendix A.13. Testing this against a log transformation of income did not deliver a statistically significant result, although income is limited by being reported in bands so not all transformations are viable.

Table 6.4: Results before dividing by income

Choice	Coefficient	Standard Error	z	Prob z>Z*
BETA_CGC	0.17***	0.03	5.55	0
BETA_CGB	0.19***	0.03	6.42	0
BETA_CGN	0.07***	0.02	2.94	0.003
BETA_FFC	0.08***	0.01	5.29	0
BETA_FFB	0.04***	0.01	3.72	0
BETA_FFN	0.04***	0.01	3.65	0
BETA_FFC (log)	1.46**	0.59	2.48	0.013
BETA_FFB (log)	0.12	0.53	0.23	0.817
BETA_FFN (log)	-0.68	0.51	-1.34	0.181
BETA_CGC (log)	-2.94***	0.64	-4.6	0
BETA_CGB (log)	-2.95***	0.62	-4.79	0
BETA_CGN (log)	0.80	0.51	1.56	0.118
BETA_Travel Cost	-0.25***	0.01	-17.06	0
BETA_Travel Cost * Income	**-0.45**	**0.82**	**-0.55**	**0.583**
BETA_VORC	-0.15***	0.01	-14.23	0
BETA_VORB	-0.10***	0.01	-11.77	0
BETA_VORN	-0.08***	0.01	-12.65	0
BETA_PROP	-0.06***	0.02	-3.5	0.001
BETA_MIN	-0.16***	0.05	-3.41	0.001
BETA_MAJ	-0.10***	0.02	-4.68	0
BETA_INC	-0.29***	0.02	-12	0
BETA_FAT	-0.48***	0.05	-9.65	0

*Note: ***, **, * represents significance at 1%, 5%, 10% level respectively.*

Source: Deloitte Access Economics

It is unexpected that income would be unrelated to VTTS or VRR. There is not a strong precedent for this identified in the literature, and typically VTTS would be positively associated with income (Börjesson et al, 2012). There is literature that suggests that income has a non-linear impact on VTTS, with the effect of income becoming progressively smaller as income increases (Jara-Diaz, 2007; Wardman, 2001), however these do not suggest that there is no relationship. Fournier and Christofa, 2021 found that income has a weak effect on VTTS, which is dominated by travel distance, which increases exponentially at a rate that is 3.61 times higher per mile (1.6km) of distance than $10,000 of income. In particular, the VTTS for the $75,000-$99,999 income bracket was lower than the VTTSs for those in the $25,000-49,999- and $50,000-74,999-income brackets.

There are speculative explanations as to why income was found to be insignificant in this survey, and these include:

- The distribution of income within the sampled data may not be sufficient to create a clear relationship between WTP and income. The sampled motorists show an income distribution that is not representative of the entire population (i.e. skewed towards high income level - see Fig. 5.3), leading to an unclear/insignificant relationship between WTP and income. Noted that a large proportion of respondents chose a “prefer not to say” option for income questions (7.6%), leading to missing income levels. In modelling, these missing values were recorded as the sample average income level, which by construct have no ‘statistically significant’ impacts on WTP (allowing the impact of income to be identified by those who provided income levels).
- Motorists with higher incomes might already use toll roads or express lanes which provide faster and more direct routes. Once a certain level of convenience and time-saving is achieved via the current use of toll roads, the marginal utility of further time savings diminishes, making the relationship between WTP and income less pronounced.
- While time-saving is a significant factor for some motorists, others may prioritise cost savings, comfort, or flexibility. Personal income may not be the primary determinant of WTP when other preferences are considered, particularly cost savings.
- High income could be associated with a more expensive vehicle, which is more comfortable and has more features to reduce driver stress and fatigue, and this reduces the disutility from increased travel time. An association between higher perceived comfort and lower VTTS has been found for public transport (Bouscasse et al, 2019), however, there is a lack of literature on this relationship for light vehicles.
- High income could be associated with living in a location that has higher quality roads, which increases driving comfort. This would apply most strongly on local roads, where councils with high income residents would be most able to raise rates to maintain roads. Better maintained roads may also attract high income residents to an area and raise land values. Factors such as lane width, number of lanes, road curvature and road surface have all been found to impact value of travel time savings and are not necessarily randomly distributed with income (Flügel et al, 2022; Wardman et al, 2008; Hensher & Sullivan, 2003).

None of these hypotheses can be tested on the outcomes of the modelling to determine if they are true, so all or none of these may contribute to income not being associated with VTTS.

Results were tested against age and education and no significant relationship was found between them and the WTP values.

6.5 Results by trip distance

The value of travel time saving could hypothetically differ by trip distance as transport economic theory and empirical evidence suggesting that VTTS increase with trip length. The value of reliability is already controlled by trip distance, as it is measured by the standard deviation of total travel time which increases with trip length.

Caution needs to be taken when separating by trip distance as this may require slicing the data too thinly which poses a risk of reducing statistical significance. This is apparent for long trips, which had fewer usable samples, particularly for commuting and business purposes. Therefore, when separating by trip distance it was determined that this should only be split into short trips (less than 30 minutes) and medium to long trips (more than 30 minutes), as splitting it further reduces sample size, which causes the results to lose significance. VTTS estimates weighted by traffic conditions (WVTTS) and VOR estimates for the two categories of trip distance are shown in Tables 6.5 and 6.6 and a comparison of the two trip distance categories in Figure 6.1.

WVTTS increases with trip length for commuter and business trips by only small, statistically insignificant, amounts. The slight downward difference with trip length for non-work trips is not at all statistically significant. The increase for commuter and business trips is consistent with current literature, such as Jara-Diaz:

> *"Also, note that SVTTS [subjective VTTS] increases with [travel time], which means that the (marginal) subjective valuation of travel time increases with trip length. This is an important point as some claim that one additional minute in a short trip should be perceived as more valuable than one additional minute in a long one; this fallacy ignores the fact that what is valuable to an individual is leisure time, which is the complement of [travel time]. Thus, what matters is the importance of one minute relative to leisure, which diminishes as leisure increases or increases with travel time. It is important to note that this is the result usually obtained in empirical studies."*

Source: Jara-Diaz (2007)

However, the small size of the increase, lacking statistical significance, is not in line with other research, this may be due to sample size constraints, or a change in preferences.

Table 6.5: Results for VTTS and VOR for trips up to 30 minutes

Variable	WTP	Standard Error	z	Prob z>Z*	95% Confidence Lower	95% Confidence Upper
WVTTSC	29.85***	2.13	14.04	0.00	25.68	34.02
WVTTSB	32.88***	2.23	14.75	0.00	28.51	37.25
WVTTSN	18.91***	1.34	14.10	0.00	16.28	21.54
VORC	35.66***	2.37	15.02	0.00	31.00	40.31
VORB	37.03***	2.69	13.77	0.00	31.76	42.30
VORN	31.49***	1.83	17.16	0.00	27.89	35.08

*Note: *** denotes significance at the 1% level.*

Source: Deloitte Access Economics

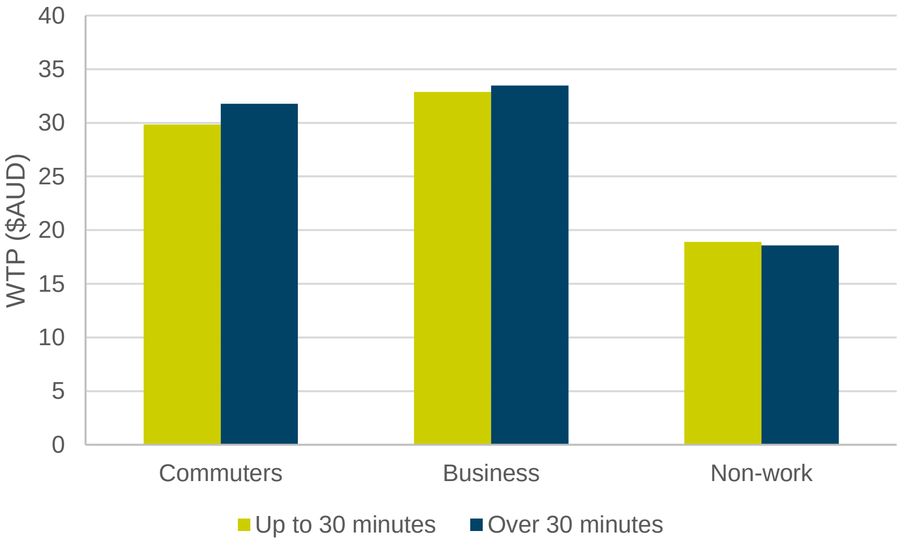
Table 6.6: Results for VTTS and VOR for trips over 30 minutes

Variable	WTP	Standard Error	z	Prob z>Z*	95% Confidence Lower	95% Confidence Upper
WVTTSC	31.79***	2.35	13.53	0.00	27.19	36.40
WVTTSB	33.49***	2.31	14.52	0.00	28.97	38.01
WVTTSN	18.59***	1.36	13.68	0.00	15.92	21.25
VORC	35.42***	2.40	14.75	0.00	30.71	40.12
VORB	36.78***	2.71	13.58	0.00	31.47	42.10
VORN	31.28***	1.88	16.65	0.00	27.60	34.96

*Note: ***,* denotes significance at the 1% level.*

Source: Deloitte Access Economics

Figure 6.1: Willingness-to-pay for travel time saving (weighted) separated by trip distance



Source: Deloitte Access Economics

6.6 Comparison with Key Performance Indicators

The project developed a range of key performance indicators (KPIs) to allow for a quantitative assessment of the performance throughout the survey process (Table 6.7).

The KPIs were related to survey implementation, participants' understanding and perceptions of the survey as well as the statistical and practical properties of the parameter estimates (such as reliability, sign, and magnitude).

Table 6.7: Key performance indicators for survey

	Target
Recruiting proceeds according to plan	
• Non-metro respondents are adequately represented	≥ 30%
• Each jurisdiction is adequately represented within a reasonable range of the population share	within ±5% of population share
• Intercept recruitment rate achieves budget plan	$25 per day per location
• Intercept follow through rates are acceptable	≥ 50%
• Survey completion rates reach targets	200 per week in Wave 1; 350 per week in Wave 2
Respondents stated neutral, agree, or strongly agree for the following questions:	

• Thinking about the scenarios, I could understand the information presented about my different travel options	≥90%
• The injury descriptions were easy to understand	≥90%
• The injury diagrams were easy to understand	≥90%
• Overall, I was comfortable with completing the survey online	≥90%
Parameter estimates should have the expected sign	100%
Parameter estimates should be significant at the 5% level of	≥95%
Parameter estimates should have the correct relative values	
• Marginal WTP for avoiding an injury should be higher for more severe injuries	100%
• VTTS for business related travel is expected to be higher than VTTS for non-business travel	100%
Parameter estimates should have absolute values within reasonable ranges of past results	
• VTTS for commuter travel should be within a reasonable range of the relevant average hourly wage	30%-150%
• The estimated reliability ratio should be within the range seen in overseas studies	0.3-3.0
• The Marginal WTPs for reducing crash risk should be comparable with values obtained in the 2008 study, allowing for inflation	50%-200%

Note: Hourly wage is based on "Earnings; Persons; Full Time; Adult; Ordinary time earnings; New South Wales"; in May 2020 of $1,748.90. Assuming 40 hours worked per week this gives an hourly value of $43.72.

Source: Deloitte Access Economics

In general, performance against the KPIs was strong for Wave 1, with 12 out of 15 KPI targets met, with the exception of the following:

- Intercept recruitment rate did not achieve the budget plan.
- Survey completion rates did not reach targets.
- The marginal WTPs for risk reduction were not comparable with values obtained in the RTA 2008 study, allowing for inflation.

Intercept recruitment was lower than the target of 25 per day for each location since the survey method was adjusted to guided interviews on the spot rather than a mix of guided and recruit for self-complete. As a result, intercept followed by self-complete was also not implemented in practice, meaning the intercept follow-through rates were no longer applicable as a KPI.

The survey completion rates were expected to reach 200 per week for Wave 1, and 350 per week in Wave 2, however these targets were not met. Due to COVID-19 and other complications such as the exclusion of online self-complete responses, the survey completion rate only reached 90 per week. Even if the online self-complete responses had not experienced issues, COVID-19 is still expected to have adversely impacted completion rates.

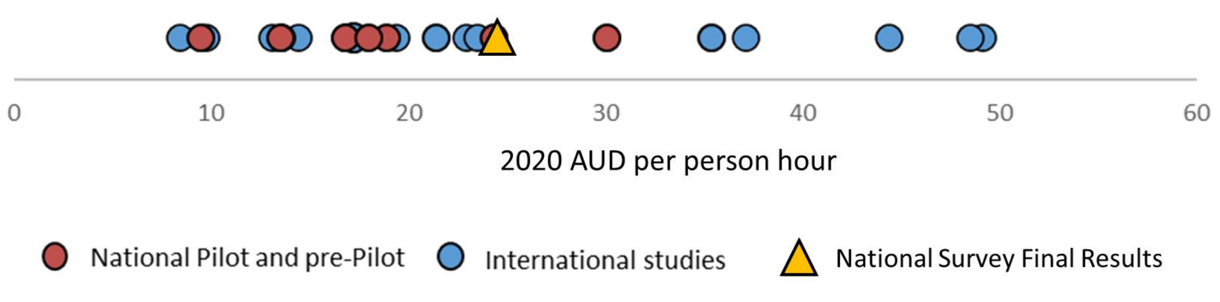
In terms of accessibility, respondents in both waves generally understood the different scenarios presented to them. The Wave 2 survey was entirely guided and presented online, and the questions asked of the respondents were slightly different, however the relevant KPIs were considered to have been met. When asked about the ease of completing a question about crash experience and safety, over 98% of respondents were neutral, agreed, or strongly agreed. A similar proportion of responses were also received regarding the question about personal details, such as vehicle ownership. Almost 96% of respondents had a positive experience of the survey, defined as rating it 6 or higher on a scale of 1 to 10. Based on these modified indicators, the KPIs relating to the understanding of the questions were considered to have been comfortably reached.

The final results provided were statistically significant WTP estimates for VTTS, VOR and VRR. The KPI was for a 5% level of significance. A 1% level was achieved in nearly all cases. The value of risk reduction also increased based on the severity of the injury, as was expected. The reliability ratios for commuters, business travellers and non-work travellers were 1.14, 1.10 and 1.67 respectively. These values sit well within the range of 0.3 to 3.0 seen in overseas studies, so the KPIs for parameter estimates were all comfortably achieved.

The VTTS for business travel is not significantly higher than the VTTS for commuting, which marginally contradicts the idea that business travel should have a much higher VTTS than non-business travel. It is not consistent with previous studies undertaken by the UK Department for Transport (2015) and New Zealand Transport Agency (2023) among others, which found that business travel has a higher VTTS than commuting. This may reflect changes brought on by the COVID-19 pandemic, which increased the value travel time savings for commuting, due to the large increase in working from home (Hensher, 2021).

Figure 6.2 below presents a comparison of the average final VTTS estimates for total time against the results from Wave 1 and the National Pilot, and results from international studies. The estimate was taken as the average of the commuting, business, and non-work traveller VTTS – total time results in Table 6.2. After incorporating the Wave 2 survey, the WTP estimates valued lower estimates taken after averaging the Wave 1 and the Pilot survey results. The current results were more closely aligned with those from the National Pilot and remained well within the range of international estimates.

Figure 6.2: Comparison of VTTS estimates with National Pilot and international studies



Note: Pre-pilot and pilot were surveys conducted in 2017 and 2018 respectively. International studies were conducted at various times, with a full list available in Table 5.5. VTTS for the national survey is the weighted average of all travel types, weighted by the proportion of travel movements in Greater Sydney.

Source: Deloitte Access Economics.

Comparing the final VOR estimates with the results from Wave 1 and the pilot surveys (Figure 6.3), respondents were willing to pay much more to ensure reliability. The $26.16 VOR estimate was at the higher end of the National Pilot and pre-pilot results, however this was still comfortably within the estimates provided by international studies. Though these values have been adjusted for inflation, a periodic review of survey values may be useful in understanding the impact of high inflation on estimated VTTS and VOR results.

Figure 6.3: Comparison of VOR estimates with National Pilot and international studies

Note: Pre-pilot and pilot were surveys conducted in 2017 and 2018 respectively. International studies were conducted at various times, with a full list available in Table 5.5. VTTS for the national survey is the weighted average of all travel types, weighted by the proportion of travel movements in Greater Sydney.

Source: Deloitte Access Economics.

6.7 Disability weights and value of safety

Disability weights are a numerical measure for the severity of an injury. This is defined by the World Health Organisation (WHO) *as "a weight factor that reflects the severity of the disease on a scale from 0 (perfect health) to 1 (equivalent to death)"* (World Health Organisation, 2013). Table 6.8 shows the disability weights given for each injury classification, and the estimated WTP per crash associated with each injury category.

Disability weights have been provided to support interpolating between WTP values to obtain values for specific injuries. WHO provides weights for specific injuries and illnesses. For example, the disability weight of a crush injury is 0.145 in 2010 figures. Therefore, the WTP figures can be used to calculate the WTP to avoid a crush injury as opposed to a generalised injury category given on the survey.

The disability weights presented in the pilot report, which was finalised in 2018, were updated in 2019 by the WHO. Therefore, both the 2010 and 2019 weights have been provided here for consistency with past reports. The method of calculating the disability weights is provided in Appendix 5 which uses the 2010 figures. The most notable changes between 2010 was an increased weight given to spinal cord lesions, leading to a 9% higher incapacitating injury weight, and decreased weighting given to a fractured tibia, fractured pelvis, and chest injuries, leading to a 28% lower weight given to major injuries.

Table 6.8: Disability weights

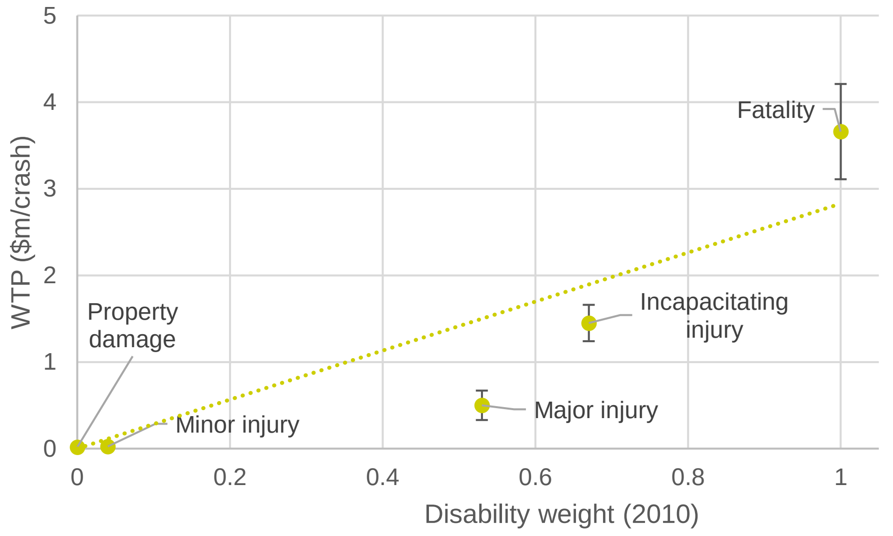
Item	Disability weight (2010)	Disability Weight (2019)	WTP ($m/crash)
Property damage only	0.00	0.00	0.016
Minor injury	0.04	0.05	0.025
Major injury	0.53	0.38	0.50
Incapacitating injury	0.67	0.73	1.45
Fatality	1.00	1.00	3.66

Note: The wording of neck pain, which was used to calculate the minor injury classification was changed between 2010 and 2019, with 2019 using neck pain, mild and 2010 using neck pain: acute, mild for the disability weights

Source: Deloitte Access Economics and World Health Organisation

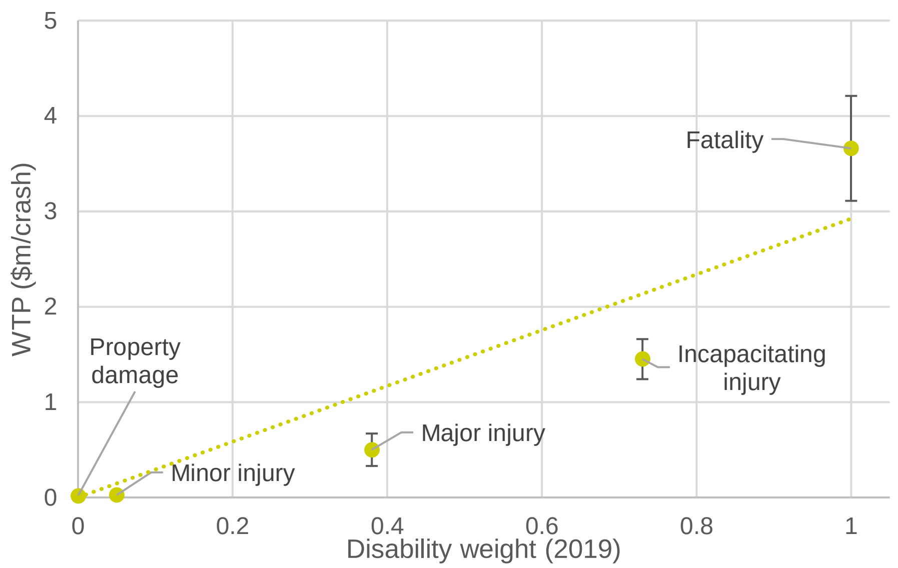
Figure 6.4: and Figure 6.5: show simple regressions of disability weights against WTP, with the intercept set to the origin, in line with the analysis in the pilot report. A linear relationship was decided upon to ensure that VRR would not decrease as disability weights increase, and so that it does not create a large overestimate for VRR for a fatality. If this is used to interpolate between disability weights, then it should be noted that respondents may not fully understand the severity at the disability weight level, and should not necessarily use a linear regression, but instead should consider what modelling technique is most appropriate for their use. The values for incapacitating and major injury are below the trendline, particularly for the 2010 figures. The confidence intervals given are the confidence intervals for each WTP, which increases with severity (due to lower incidence of severe crashes on Australian roads and this translates to a smaller variation in the data which in turn results in a wider CI for more severe crashes). Property damage does not intersect with the trendline, which would be associated with a confidence interval that passes through zero, though could be considered a special case, as respondents are going to have a non-medical reason to want to avoid property damage.

Figure 6.4: 2010 Disability weights fitted to WTP for various crash profiles



Source: Deloitte Access Economics and the World Health Organisation

Figure 6.5: 2019 Disability weights fitted to WTP for various crash profiles



Source: Deloitte Access Economics and the World Health Organisation

Appendix A.5 provides additional details on the particular crashes in the survey instrument and values for three other measures of injury severity in addition to the disability weight measure.

7. Future Developments

7.1 Incorporation in ATAP guidelines

The findings from the survey and modelling enable updating of a number of parameter values in ATAP Guidelines Part PV2, Road parameter values. Some of the changes will likely be significant. The WTP values for travel time savings and safety differ significantly from the values currently in use. Reliability benefits from urban road projects are likely to be significant and have rarely been included in cost–benefit analyses to date. For the purpose of estimating time and reliability benefits, commuters will be treated as a separate group from non-work travellers.

Inclusion of all three: time, reliability, and safety in the one survey, is unprecedented and carried some risks. However, it more accurately reflects the choices road users have to make, compared with surveys that only address time and reliability, or time and safety. The risks were managed by undertaking a lengthy, multi-step process of trials and reviews before launching the National Survey. The initial survey design was tested on focus groups, a group of Deloitte Employees and reviewed by an overseas academic expert. The survey instrument was tested through four pilot surveys and 10 cognitive interviews (the report for the results of the focus groups is located in appendix B.2) and subjected to an independent peer review (this peer review is summarised in appendix B.1.)

The sample size for the National Survey was large by the standards of stated preference surveys, A range of experts on stated preference surveys were consulted. To ensure the survey was representative of the entire Australian population, the sample was drawn from a variety of survey locations, with metro and regional locations spanning across all states and territories. The results were weighted to ensure demographic applicability to the Australian population.

The values from modelling of survey data that can feed into the ATAP Guidelines are shown in Table 7.1.

The WTP values from the survey with 95% confidence intervals are presented in tables 7.2 and 7.3. All the values shown are statistically significant at the 1% level.

The values of travel time savings for non-work and business travellers in Table 7.2 are lower than those currently in use based on before-tax average earnings for business travellers and a proportion of this for non-work travellers. While these changes will reduce overall travel time savings benefits in CBAs, there may be an impact in the opposite direction from separating out commuters, currently categorised as non-work travellers, and assigning them a value of travel time savings at practically the same level as for business travellers.

Table 7.1: Updated parameters and associated 95% confidence intervals

Variable	WTP	95% Confidence Lower	95% Confidence Upper
Value of travel time savings weighted for all conditions ($/hour) - Commuting	31.10	26.67	35.53
Value of travel time savings weighted for all conditions ($/hour) - Business	33.53	29.08	37.98
Value of travel time savings weighted for all conditions ($/hour) – Non-work	18.81	16.15	21.46
Value of reliability ($/hour) - Commuting	35.50	30.83	40.18
Value of reliability ($/hour) - Business	36.87	31.59	42.16
Value of reliability ($/hour) – Non-work	31.35	27.71	35.00
Value of safety – property damage only ($crash)	16,000	9,710	22,300
Value of safety – minor injury ($/crash)	24,660	8,820	40,500
Value of safety – major injury ($/crash)	500,010	330,410	669,610
Value of safety – incapacitating injury ($/crash)	1,454,850	1,241,060	1,668,650
Value of safety – fatal crash ($/crash)	3,663,910	3,116,530	4,211,280
Reliability ratio (VOR/WVTTS) – Commuting	1.14	-	-
Reliability ratio (VOR/WVTTS) – Business	1.10	-	-
Reliability ratio (VOR/WVTTS) – Non-work	1.67	-	-

Source: Deloitte Access Economics

There was found to be no significant relationship between VTTS and income or for VRR and income. The implication for this is that the behavioural VTTS and equity VTTS are the same. This means that benefit estimation in CBAs and forecasting can be done with the same VTTS figures, which are the central figures given in Table 7.1. This also means that there is no need to calculate an equity WTP for safety, as these should be the same no matter the income.

The ratio of the value of reliability to the value of time is known as the reliability ratio. Table 7.2 shows the ratios for the three trip purposes. The ATAP Guidelines will specify reliability ratios, not values of reliability, leaving it to analysts to multiply the value of travel time savings by the reliability ratio to obtain the value of reliability.

It is recommended not to include the values for separated congested and free-flow travel in the guidelines, as the definition of free-flow and congested conditions were explained but ultimately left to respondents' interpretation, and therefore may not align with measurable definitions of congested and free-flow within transport models. This is further discussed in section 3.1, and full results including results split by free-flow and congested conditions are published in section 6.1.

If use of the willingness to pay values requires weighting across all trip purposes, then the specific expected proportion of travel purposes should be used on the route taken. If this cannot be obtained, then the trip purposes across the most relevant geographic area should be found, for example, the Household Travel Survey for the GSNA (Transport for NSW, 2020). Care should be taken when using such data that is gathered between 2020 and 2021, given the lockdowns severely impacting travel purposes. Additional considerations should be made with data before 2020, as the COVID-19 pandemic has seen an increase in working from home, and therefore a change in travel purposes (Hensher, 2023).

The WTP values of travel time savings from the present survey are not strictly comparable with values from stated preference surveys that omit reliability. Values of travel times savings from surveys that omit reliability are likely to be affected by perceptions by survey respondents that greater trip time, especially in congested conditions, correlates to some extent with greater unreliability. They therefore may be inflated by an allowance for WTP for reliability. Since the present survey distinguished between time and reliability, the estimated values of time are 'pure' in the sense that they abstract from reliability. In effect, the values of travel time savings in Table 7.1 assume perfect reliability in trip times.

The WTP value for fatal crashes is quite low compared with typical values from WTP studies and the value currently in use. It is important to note that the WTP values for risk reduction obtained by the survey do not represent the full social cost of a crash. First, survey respondents can only be expected to consider impacts on themselves. They could not be expected to consider costs of crashes borne by governments such as loss of tax receipts associated with loss of income by crash victims, medical expenses funded by governments, costs of emergency services and so on. Nor would survey respondents consider the costs of traffic delays that crashes impose on other road users. It is argued in the supplementary report that survey respondents inadequately estimate the present value of forgone future consumption in their consideration of crash risks. Hence, the WTP values derived from the survey cover only the pain, grief and suffering component of the cost of crashes. The costs of crashes to be published in ATAP Part PV2 Road parameter values will be the full social costs of crashes and will be higher than the values in Table 7.2.

7.2 Maintaining parameter values

7.2.1 Indexation

Developing an indexation approach is outside the scope of the current project, however, some international experience in similar surveys and current practice in Australia, has been outlined below. These existing approaches may be used to guide a future approach for indexation.

Currently, the value of travel time savings in Australia for private and business trips is set equal to, and therefore indexed to average weekly earnings (AWE). For private trips, the VTTS is 40% of the AWE, and for business trips, the VTTS is 129.8% of the AWE, both of which change over time. Using a WTP measure for the VTTS means that the value no longer has a clear method of indexing, and the current AWE option should be considered against other options.

Maintaining an indexation against wages for the VTTS is a common practice internationally (US DOT, 2016), however there are other methods of indexing. The UK uses real GDP per capita to index the value of transport, and this method is recommended by the World Bank as the method of indexation for the VTTS (Gwilliam, 1997). Conversely, New Zealand uses CPI (NZTA, 2023), though none of these methods of indexation has a strong theoretical backing. For example, in 1997, the New Zealand Transport Agency suggested that by finding the differences of WTP between people with varying working hours, unemployment status, retirement status and participation status (particularly for women) through tracking these time series variables could be used to index WTP if these are significantly associated with a change in WTP. Finding the differences with these groups may be feasible with some of data collected and Australia's time series data, it would require a frequent review process to the parameters, or a complex formula for indexing to be used alongside further analysis. Additionally, this process could be stronger with repeated studies, to see how preferences change over time.

In Australia, the economic cost of car crashes was previously indexed using 4 indexes. As it took a human capital approach for valuation, each cost was split into different components, which could be separately indexed. For medical services components of car crashes, CPI: medical was used (e.g. for the ambulance costs associated with a car crash); quality of life and workforce components were indexed by the wage price index (WPI); damages to the car were indexed by CPI: motor vehicle repairs and servicing; and other components, such as funeral costs and insurance were indexed to CPI: general. As the WTP approach does not split the cost of car crashes into its component costs using four separate indexes is not advisable. Of the current indexes, those reflecting quality of life and labour force costs are those most likely to be captured by the WTP to avoid car crashes, and therefore, it could be considered that using the WPI is the most appropriate way to maintain the parameters for the VRR.

Internationally, few countries separate the economic cost of crashes from the value of a statistical life (VSL), particularly when utilising a WTP measure.

Both New Zealand and the US use a VRR approach to estimate their VSL, so these indexation methods are relevant to the indexation of Australia's VRR. New Zealand indexes the VSL by the GDP per capita. The US indexes the VSL using the formula:

$$VSL_T = VSL_0 \times \left(\frac{P_T}{P_0}\right) \times \left(\frac{I_T}{I_0}\right)^{\varepsilon}$$

Where 0 is the original year the VSL was calculated in, *T* is the current year, P_T is the price index in year *T*, I_T is median wages in year *T* and ε is the income elasticity of VSL (US DOT, 2021). To index using this method, an estimate of the income elasticity of VSL would need to be calculated, however, from Section 6.4, income was found to not have a significant effect on travel times, meaning income elasticity can be assumed to be zero.

The majority of the responses were obtained in late 2021-early 2022. As such, the most appropriate date to index the findings to is to price levels as seen in December 2021. Particular care should be taken if indexing with CPI, as a period of high inflation followed the survey in 2022-2023, though inflation is unlikely to have impact on the difference between the National Pilot and Wave 1, conducted in 2019-2021 and Wave 2, conducted in 2021-2022. As there was found to be no significant impact of income on VTTS or VRR, it may be advisable to index the VTTS to CPI.

7.2.2 Updating the survey results

The materials that are required to re-run the survey have been provided to Austroads to allow for any future updates. Rerunning the survey will ensure that the results are the most accurate, as WTP may not implicitly align with inflation, as the prevalence of work from home, changes in technology and changes in societal expectations may shift the overall WTP for travel time savings, reliability, and risk reduction.

New Zealand re-ran a WTP study for travel time saving in 2015, 18 years after the original study in 1997. Aside from New Zealand, there is no international precedent for the frequency at which WTP studies are re-run. Other countries have re-run studies on the statistical value of a human life, using road safety, but often these are updating studies that are using a different method to find the VSL, such as labour market premiums. As such there is a lack of precedence and scope on how often the study should be updated.

Appendix A Expanded Results

A.1 Expanded definition of variables

Table A.1: Variables used in the final modelling (Table A.2) and their explanation

Variable	Meaning
VTTSFFC	Value of Travel Time Saving Free-Flow - Commute
VTTSFFB	Value of Travel Time Saving Free-Flow - Business
VTTSFFN	Value of Travel Time Saving Free-Flow - Nonwork
VTTSCGC	Value of Travel Time Saving Congested - Commute
VTTSCGB	Value of Travel Time Saving Congested - Business
VTTSCGN	Value of Travel Time Saving Congested - Nonwork
WVTTSC	Weighted Value of Travel Time Saving- Commute
WVTTSB	Weighted Value of Travel Time Saving- Business
WVTTSN	Weighted Value of Travel Time Saving- Nonwork
VORC	Value of reliability - Commute
VORB	Value of reliability - Business
VORN	Value of reliability - Nonwork
WTPPROP	Willingness-to-pay for reducing PRO- Passenger
WTPMIN	Willingness-to-pay for reducing MIN
WTPMAJ	Willingness-to-pay for reducing MAJ
WTPINC	Willingness-to-pay for reducing INC
WTPFAT	Willingness-to-pay for reducing FAT
VTTSFF	Value of Travel Time Saving Free-Flow
VTTSCG	Value of Travel Time Saving Congested
WTPMIN	Willingness-to-pay for reducing 1 minor crash/year
WTPMAJ	Willingness-to-pay for reducing 1 major crash/year
WTPINC	Willingness-to-pay for reducing 1 incapacitating crash/year

WTPFAT	Willingness-to-pay for reducing 1 fatal crash/year
WVTTS	Weighted Value of Travel Time Saving
VFFC	Value of travel time saving associated with a reduction in the linear part of the corresponding travel time component (only used in calculating the final VTTS) - Commuter
VFFB	Value of travel time saving associated with a reduction in the linear part of the corresponding travel time component (only used in calculating the final VTTS) - Business
VFFN	Value of travel time saving associated with a reduction in the linear part of the corresponding travel time component (only used in calculating the final VTTS) – Nonwork
VFFCL	Value of travel time saving associated with a reduction in the log part of the corresponding travel time component (only used in calculating the final VTTS) - Commuter
VFFBL	Value of travel time saving associated with a reduction in the log part of the corresponding travel time component (only used in calculating the final VTTS) - Business
VFFNL	Value of travel time saving associated with a reduction in the linear part of the corresponding travel time component (only used in calculating the final VTTS) – Non-work
PERCC	Percentage of sample that is commuters (used in calculation only and not a variable in the utility model)
PERCB	Percentage of sample that is business (used in calculation only and not a variable in the utility model)
PERCN	Percentage of sample that is nonwork (used in calculation only and not a variable in the utility model)
BTCP1	Parameter for cost interacted with personal income (used in calculation only and not a variable in the utility model)

Source: Deloitte Access Economics

Table A.2: The unedited nlogit output for the final model

WaldFcns	Function	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
PERCC	.32562	.....(Fixed Parameter).....				
PERCB	.32608	.....(Fixed Parameter).....				
PERCN	.23596	.....(Fixed Parameter).....				
BTCP1	-.36677***	.01238	-29.63	.0000	-.39104	-.34251
VFFC	17.0543***	2.69627	6.33	.0000	11.7697	22.3389
VFFB	19.5902***	3.04233	6.44	.0000	13.6273	25.5531
VFFN	26.9372***	2.62795	10.25	.0000	21.7865	32.0879
VCGC	58.3752***	7.21779	8.09	.0000	44.2286	72.5218
VCGB	63.3136***	6.85804	9.23	.0000	49.8721	76.7551
VCGN	22.4899***	3.70467	6.07	.0000	15.2289	29.7509
VFFCL	14.6207***	2.03718	7.18	.0000	10.6279	18.6135
VFFBL	16.5473***	2.08842	7.92	.0000	12.4540	20.6405
VFFNL	20.2409***	1.56053	12.97	.0000	17.1823	23.2995
VCGCL	66.7943***	7.19439	9.28	.0000	52.6936	80.8951
VCGBL	68.1256***	6.76331	10.07	.0000	54.8698	81.3815
VCGNL	6.80209**	2.97238	2.29	.0221	.97633	12.62785
VTTSFFC	15.7450***	2.02189	7.79	.0000	11.7822	19.7078
VTTSFFB	17.5940***	2.19689	8.01	.0000	13.2882	21.8999
VTTSFFN	21.5601***	1.70534	12.64	.0000	18.2177	24.9025
VTTSCGC	62.9047***	6.66954	9.43	.0000	49.8326	75.9767
VTTSCGB	66.4703***	6.07774	10.94	.0000	54.5581	78.3824
VTTSCGN	9.89258***	2.44470	4.05	.0001	5.10107	14.68410
WVTTSC	31.1009***	2.25865	13.77	.0000	26.6740	35.5278
WVTTSB	33.5318***	2.27150	14.76	.0000	29.0798	37.9839
WVTTSN	18.8070***	1.35431	13.89	.0000	16.1526	21.4614
VORC	35.5044***	2.38745	14.87	.0000	30.8251	40.1838
VORB	36.8740***	2.69687	13.67	.0000	31.5882	42.1598
VORN	31.3544***	1.85792	16.88	.0000	27.7129	34.9959
WTPPROP	.01600***	.00321	4.98	.0000	.00971	.02230
WTPMIN	.02466***	.00808	3.05	.0023	.00882	.04050
WTPMAJ	.50001***	.08653	5.78	.0000	.33041	.66961
WTPINC	1.45485***	.10908	13.34	.0000	1.24106	1.66865
WTPFAT	3.66391***	.27928	13.12	.0000	3.11653	4.21128

***, **, * ==> Significance at 1%, 5%, 10% level.

Source: Deloitte Access Economics

A.2 Expanded model equations

Equation A.1: The unedited nlogit input to produce the final model

```
Ui=
   bmcgtc*wmCGc  + bmcgtb*wmCGb + bmcgtn*wmCGn ?CG by purpose (c,b,n)
   +bmfftc*wmFFc + bmfftb*wmFFb + bmfftn*wmFFn ?FF by purpose
   +btriplfc*wmFFcl + btriplfb*wmFFbl + btriplfn*wmFFnl ? log(FF time)
   +btriplcc*wmCGcl + btriplcb*wmCGbl + btriplcn*wmCGnl? log(CG time)
   +btc*tcst+btcpinc*tcstpz? interact cost with annual personal income
   +bsdtimec*wsTTc + bsdtimeb*wsTTb + bsdtimen*wsTTn ?relia by purpose
   +bprop*ptypr + bmin*minpr+bmaj*majpr+bmaj*majpr+bincap*incpr +bfat*fatpr
   ?crash probability by severity (pty, minor, major, incap, fatal)
```

Source: Deloitte Access Economics

In order to produce the final WTP parameter estimates, the full way the variables are derived is shown below:

- ***Cost***

  Cost enters the utility function via two components: cost (*tcst*) and cost interacted with personal income, (*tcstpz)* with each component having its own parameter (*btc* and *btcpinc*, respectively). The formula used for this calculation is:

$$MU_{\cos t} = \frac{\partial V}{\partial \cos t} = btc + btcpinc \times pinc$$

- **FF_t: Free-Flow (FF) travel time**

  For each travel purpose (i.e., **c**ommuting, **b**usiness, and **n**on-work), the FF travel time has two components in the utility function: the linear and the log transformation of FF, with the latter activated for trips of 30 mins or longer (i.e., medium and long trips) to account for the impact of trip length on WTP. Taking commuting trip as an example, the FF time has two variables *wmFF**c*** and *wmFFcl*, each with its own parameter, namely *bmfftc* and *bmtriplfc*. Thus, the marginal utility of FF time for commuting purpose is calculated as follows:

$$MU_{FFc} = \frac{\partial V}{\partial FF_c} = bfftc + \frac{btriplfc}{triplfc} \text{ for medium and long trips (30 mins or longer)}$$

$$MU_{FFc} = \frac{\partial V}{\partial FF_c} = bfftc \text{ for trip shorter than 30 mins}$$

  Thus, the WTP for FF travel time is calculated separately for short and long/medium trips as follows:

$$WTP_{FFc}^{long} = \frac{MU_{FFc}}{MU_{\cos t}} = 60 \times \frac{bfftc + \frac{btriplfc}{triplfc}}{btc + btcpinc \times pinc} \text{ for medium and long trips}$$

$$WTP_{FFc}^{short} = \frac{MU_{FFc}}{MU_{\cos t}} = 60 \times \frac{bfftc}{btc + btcpinc \times pinc} \text{ for short trips}$$

  As the parameter of FF travel time, *bfftc* follows a constrained triangle distribution with two structural parameter estimates: the mean (*bmfftc*) and the spread (*bsdffc*). This random parameter produces individual WTP for FF, which can be obtained by simulating the distribution of random parameter and plugging it into the formula above. Specifically, the simulated parameter for FF time is obtained using this formula:

$$bfftc = bmfftc + T * bsdfftc \text{ where } T \text{ is a draw from a triangle distribution calculated as follows:}$$

$$\begin{cases} T = \sqrt{2v} - 1 \text{ if } v \le 0.5 \\ T = 1 - \sqrt{2(1-v)} \text{ if } v > 0.5 \end{cases} \quad where\ v = rnu(0,1) \text{ is a random draw from a uniform distribution}$$

  In cases where separate WTP for short vs. long/medium trips is not required, the weighted average WTP accounting for the percentage of short (percShort) and long/medium trip (percLong) is needed. This weighted average WTP for FF is computed as follows:

$$WTP_{FFc} = WTP_{FFc}^{long} \times percLong \ + \ WTP_{FFc}^{short} \times percShort$$

- **CG_t: congestion time**

  The WTP for CG are computed in the similar way as the WTP for FF described above. This is because the CG follows the same specification as the FF travel time. For clarity, the WTP for CG are computed as follows:

$$WTP_{CGc}^{long} = \frac{MU_{CGc}}{MU_{\cos t}} = 60 \times \frac{bcgtc + \dfrac{btriplcc}{trip\,1cc}}{btc + btcpinc \times pinc} \text{ for medium and long trips}$$

$$WTP_{CGc}^{short} = \frac{MU_{CGc}}{MU_{\cos t}} = 60 \times \frac{bcgtc}{btc + btcpinc \times pinc} \text{ for short trips}$$

$$WTP_{CGc} = WTP_{CGc}^{long} \times percLong + WTP_{CGc}^{short} \times percShort$$

- **Total travel time (TT)**

  Once the WTP for FF and CG have been calculated, the WTP for total time can be computed by weighting up the percentages of FF (*percFF*) and CG (*percCG*) to total time for each trip purpose.

$$WTP_{TTc} = WTP_{FFc} \times percFF_c + WTP_{CGc} \times percCG_c$$

$$WTP_{TTb} = WTP_{FFb} \times percFF_b + WTP_{CGb} \times percCG_b$$

$$WTP_{TTn} = WTP_{FFn} \times percFF_n + WTP_{CGn} \times percCG_n$$

- **Travel time reliability (VOR)**

  For each travel purpose, the reliability of travel time, represented by the standard deviation of total time ($wsTTc$, $wsTTb$, $wsTTn$) enters the utility function linearly. Note that the standard deviation of total travel time increases with trip length and hence, it makes no sense to include the log transformation for travel time reliability. The marginal utility of travel time reliability for commuting, business, and non-work purpose are calculated as follows:

$$MU_{wsTTc} = \frac{\partial V}{\partial wsTTc} = bsdtimec$$

$$MU_{wsTTb} = \frac{\partial V}{\partial wsTTb} = bsdtimeb$$

$$MU_{wsTTn} = \frac{\partial V}{\partial wsTTn} = bsdtimen$$

  The WTP for travel time reliability by trip purpose are then calculated as:

$$VoR_c = WTP_{wsTTc} = \frac{MU_{wsTTc}}{MU_{\cos t}} = 60 \times \frac{bsdtimec}{btc + btcpinc \times pinc}$$

$$VoR_b = WTP_{wsTTb} = \frac{MU_{wsTTb}}{MU_{\cos t}} = 60 \times \frac{bsdtimeb}{btc + btcpinc \times pinc}$$

$$VoR_n = WTP_{wsTTn} = \frac{MU_{wsTTn}}{MU_{\cos t}} = 60 \times \frac{bsdtimen}{btc + btcpinc \times pinc}$$

- **Probability of reducing risk of road crash**

  Probability of involving in a road crash, which results in a property damage, minor, major, incapacitating injury or fatality, enters the utility function as a linear function. The marginal utility of probability of involving in a road crash by type is derived from the utility function as follows:

$$MU_{pty} = \frac{\partial V}{\partial ptypr} = bprop$$

$$MU_{\min or} = \frac{\partial V}{\partial \min pr} = b\min$$

$$MU_{major} = \frac{\partial V}{\partial majpr} = b\,\mathrm{m}\,ar$$

$$MU_{incap} = \frac{\partial V}{\partial incpr} = binc$$

$$MU_{fatal} = \frac{\partial V}{\partial fatpr} = bfat$$

The willingness to pay to reduce the risk of involving in a crash by type are calculated as:

$$VRR_{pty} = WTP_{ptypr} = \frac{MU_{ptypr}}{MU_{\cos t}} = \frac{bprop}{btc + btcpinc \times pinc}$$

$$VRR_{\min} = WTP_{\min pr} = \frac{MU_{\min pr}}{MU_{\cos t}} = \frac{b\min}{btc + btcpinc \times pinc}$$

$$VRR_{maj} = WTP_{majpr} = \frac{MU_{\mathrm{m}ajpr}}{MU_{\cos t}} = \frac{bmaj}{btc + btcpinc \times pinc}$$

$$VRR_{incap} = WTP_{incpr} = \frac{MU_{incpr}}{MU_{\cos t}} = \frac{binc}{btc + btcpinc \times pinc}$$

$$VRR_{fat} = WTP_{fatpr} = \frac{MU_{fatpr}}{MU_{\cos t}} = \frac{bfat}{btc + btcpinc \times pinc}$$

A.3 Results by income band

Table A.3: Results restricted to only the low income band (<$800/week)

WaldFcns	Function	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
PERCC	.32562	.....(Fixed Parameter).....				
PERCB	.32608	.....(Fixed Parameter).....				
PERCN	.23596	.....(Fixed Parameter).....				
BTCP1	-.35843***	.01252	-28.62	.0000	-.38298	-.33389
VFFC	17.3493***	2.74602	6.32	.0000	11.9672	22.7314
VFFB	19.9291***	3.12500	6.38	.0000	13.8042	26.0539
VFFN	27.4031***	2.61995	10.46	.0000	22.2681	32.5381
VCGC	59.0352***	7.39544	7.98	.0000	44.5404	73.5299
VCGB	64.0716***	7.15279	8.96	.0000	50.0524	78.0908
VCGN	22.9212***	3.77935	6.06	.0000	15.5138	30.3286
VFFCL	14.8603***	2.09374	7.10	.0000	10.7567	18.9640
VFFBL	16.8169***	2.15978	7.79	.0000	12.5838	21.0500
VFFNL	20.5545***	1.54172	13.33	.0000	17.5328	23.5762
VCGCL	67.6458***	7.40400	9.14	.0000	53.1343	82.1574
VCGBL	68.9931***	7.11664	9.69	.0000	55.0447	82.9415
VCGNL	6.87652**	3.07953	2.23	.0256	.84075	12.91229
VTTSFFC	16.0102***	2.06689	7.75	.0000	11.9592	20.0612
VTTSFFB	17.8875***	2.26806	7.89	.0000	13.4422	22.3328
VTTSFFN	21.9037***	1.68478	13.00	.0000	18.6016	25.2058
VTTSCGC	63.6677***	6.85406	9.29	.0000	50.2340	77.1014
VTTSCGB	67.3001***	6.41397	10.49	.0000	54.7289	79.8712
VTTSCGN	10.0373***	2.53696	3.96	.0001	5.0650	15.0097
WVTTSC	31.5282***	2.35377	13.39	.0000	26.9149	36.1415
WVTTSB	34.0002***	2.43647	13.95	.0000	29.2248	38.7756
WVTTSN	19.1037***	1.34183	14.24	.0000	16.4738	21.7337
VORC	36.3122***	2.49040	14.58	.0000	31.4311	41.1933
VORB	37.7129***	2.81858	13.38	.0000	32.1886	43.2373
VORN	32.0678***	1.90717	16.81	.0000	28.3298	35.8058
WTPPROP	.01637***	.00329	4.97	.0000	.00991	.02282
WTPMIN	.02522***	.00827	3.05	.0023	.00901	.04143
WTPMAJ	.51138***	.08859	5.77	.0000	.33776	.68501
WTPINC	1.48795***	.11211	13.27	.0000	1.26823	1.70768
WTPFAT	3.37314***	.26009	12.97	.0000	2.86338	3.88290

***, **, * ==> Significance at 1%, 5%, 10% level.
Fixed parameter ... is constrained to equal the value or
had a nonpositive st.error because of an earlier problem.

Source: Deloitte Access Economics

Table A.4: Results restricted to only the medium income band ($800-$2000/week)

WaldFcns	Function	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
PERCC	.32562	.....(Fixed Parameter).....				
PERCB	.32608	.....(Fixed Parameter).....				
PERCN	.23596	.....(Fixed Parameter).....				
BTCP1	-.36677***	.01238	-29.63	.0000	-.39104	-.34251
VFFC	16.9784***	2.68435	6.32	.0000	11.7171	22.2396
VFFB	19.5030***	3.02883	6.44	.0000	13.5666	25.4394
VFFN	26.8173***	2.61659	10.25	.0000	21.6889	31.9457
VCGC	57.8299***	7.15714	8.08	.0000	43.8022	71.8576
VCGB	62.7566***	6.89467	9.10	.0000	49.2433	76.2699
VCGN	22.4243***	3.69898	6.06	.0000	15.1745	29.6742
VFFCL	14.5448***	2.03140	7.16	.0000	10.5633	18.5262
VFFBL	16.4601***	2.07974	7.91	.0000	12.3839	20.5363
VFFNL	20.1210***	1.55131	12.97	.0000	17.0805	23.1615
VCGCL	66.2490***	7.13535	9.28	.0000	52.2640	80.2341
VCGBL	67.5686***	6.79920	9.94	.0000	54.2425	80.8948
VCGNL	6.73653**	3.00361	2.24	.0249	.84956	12.62350
VTTSFFC	15.6691***	2.01141	7.79	.0000	11.7268	19.6114
VTTSFFB	17.5068***	2.18504	8.01	.0000	13.2243	21.7894
VTTSFFN	21.4402***	1.69511	12.65	.0000	18.1178	24.7625
VTTSCGC	62.3594***	6.60491	9.44	.0000	49.4140	75.3048
VTTSCGB	65.9133***	6.11813	10.77	.0000	53.9220	77.9046
VTTSCGN	9.82703***	2.47348	3.97	.0001	4.97909	14.67496
WVTTSC	30.8722***	2.23979	13.78	.0000	26.4823	35.2621
WVTTSB	33.2914***	2.27557	14.63	.0000	28.8314	37.7515
WVTTSN	18.7000***	1.35018	13.85	.0000	16.0537	21.3463
VORC	35.5044***	2.38745	14.87	.0000	30.8251	40.1838
VORB	36.8740***	2.69687	13.67	.0000	31.5882	42.1598
VORN	31.3544***	1.85792	16.88	.0000	27.7129	34.9959
WTPPROP	.01600***	.00321	4.98	.0000	.00971	.02230
WTPMIN	.02466***	.00808	3.05	.0023	.00882	.04050
WTPMAJ	.50001***	.08653	5.78	.0000	.33041	.66961
WTPINC	1.45485***	.10908	13.34	.0000	1.24106	1.66865
WTPFAT	3.66391***	.27928	13.12	.0000	3.11653	4.21128

***, **, * ==> Significance at 1%, 5%, 10% level.
Fixed parameter ... is constrained to equal the value or
had a nonpositive st.error because of an earlier problem.

Source: Deloitte Access Economics

Table A.5: Results restricted to only the high income band (>$2000/week)

WaldFcns	Function	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
PERCC	.32562	.....(Fixed Parameter).....				
PERCB	.32608	.....(Fixed Parameter).....				
PERCN	.23596	.....(Fixed Parameter).....				
BTCP1	-.38128***	.02626	-14.52	.0000	-.43276	-.32981
VFFC	16.3558***	2.77107	5.90	.0000	10.9246	21.7870
VFFB	18.7879***	3.09308	6.07	.0000	12.7255	24.8502
VFFN	25.8340***	3.05500	8.46	.0000	19.8463	31.8216
VCGC	55.8210***	7.58651	7.36	.0000	40.9517	70.6903
VCGB	60.5631***	7.46201	8.12	.0000	45.9378	75.1883
VCGN	21.5886***	3.80435	5.67	.0000	14.1322	29.0449
VFFCL	14.0157***	2.11198	6.64	.0000	9.8763	18.1551
VFFBL	15.8618***	2.17747	7.28	.0000	11.5941	20.1296
VFFNL	19.3949***	1.96882	9.85	.0000	15.5361	23.2537
VCGCL	63.9168***	7.76223	8.23	.0000	48.7031	79.1305
VCGBL	65.1903***	7.44112	8.76	.0000	50.6060	79.7746
VCGNL	6.50331**	2.90220	2.24	.0250	.81511	12.19152
VTTSFFC	15.0968***	2.13269	7.08	.0000	10.9168	19.2768
VTTSFFB	16.8684***	2.29516	7.35	.0000	12.3700	21.3668
VTTSFFN	20.6634***	2.13138	9.69	.0000	16.4860	24.8408
VTTSCGC	60.1765***	7.21696	8.34	.0000	46.0316	74.3215
VTTSCGB	63.5985***	6.85033	9.28	.0000	50.1721	77.0249
VTTSCGN	9.47511***	2.43659	3.89	.0001	4.69949	14.25073
WVTTSC	29.7755***	2.75032	10.83	.0000	24.3849	35.1660
WVTTSB	32.1064***	2.81215	11.42	.0000	26.5946	37.6181
WVTTSN	18.0234***	1.75725	10.26	.0000	14.5793	21.4675
VORC	34.1408***	3.05395	11.18	.0000	28.1551	40.1264
VORB	35.4577***	3.31366	10.70	.0000	28.9631	41.9524
VORN	30.1501***	2.56950	11.73	.0000	25.1140	35.1862
WTPPROP	.01539***	.00322	4.78	.0000	.00907	.02170
WTPMIN	.02371***	.00790	3.00	.0027	.00822	.03920
WTPMAJ	.48080***	.08819	5.45	.0000	.30795	.65366
WTPINC	1.39897***	.13507	10.36	.0000	1.13423	1.66371
WTPFAT	3.82201***	.37162	10.28	.0000	3.09364	4.55037

***, **, * ==> Significance at 1%, 5%, 10% level.
Fixed parameter ... is constrained to equal the value or
had a nonpositive st.error because of an earlier problem.

Source: Deloitte Access Economics

A.4 Complete survey questions

Introduction

The purpose of this survey is to understand what is important to road users when they are choosing a route for different types of trips.

This information will be used to help prioritise how funding should be allocated to improve existing roads and construct new roads.

During the survey we will ask you for information regarding a trip you took **within the last month** on roads in Australia.

We will then present you with several hypothetical scenarios. Each scenario will display two routes which will each have a different travel time, cost and recent history of crashes associated with it. Using this information, we will ask you to tell us which route you prefer.

Finally, we will ask you a series of questions regarding your perceptions of road rules and safety, your pre- and post- COVID19 work and travel habits and some more information about yourself.

Would you like to participate in this survey?

○ Yes
○ No

Next

In which location do you live?

- ○ Sydney
- ○ Other NSW
- ○ Melbourne
- ○ Other Victoria
- ○ Brisbane
- ○ Other QLD
- ○ Adelaide
- ○ Other SA
- ○ Perth
- ○ Other WA
- ○ Canberra
- ○ Other ACT
- ○ Hobart
- ○ Other Tasmania
- ○ Darwin
- ○ Other NT

What is your postcode?

Please type the four digit postcode in the box below.

[ ]

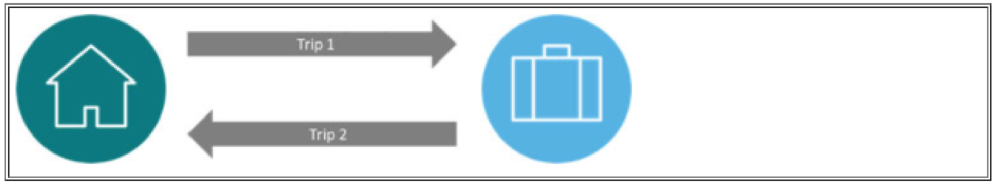
Previous | Next

Trip Definition

In the questions that follow, we are going to ask you about recent trips you took in the last month.

A trip is defined as time you spent in a car (not including taxi or Uber rides) either travelling to or from some destination.

When answering these questions, it is important you think about each time travelling from an origin to a destination as one trip. If your trip was a round trip (returning to the same place), we want you to focus on one direction only. For example, in the following diagram you should focus on **either Trip 1 or Trip 2, but not both**.



1. **In the last month**, have you travelled by car (excluding taxi and Uber rides), as either a driver or passenger, for any of following the purposes (you may select more than one answer).

- ☐ Going to work or Returning from work
- ☐ Shopping (e.g. groceries, household etc.)
- ☐ Education (e.g. school, college, university etc.)
- ☐ Social visits (e.g. visiting family, friends etc.)
- ☐ Other non-work related visits (e.g. sporting, recreational drive etc.)
- ☐ As part of working for your employer (e.g., travelling from work to a meeting, the airport or an off-site work location)
- ○ None of the above

Previous | Next

2. Thinking about the **most recent** trip for each trip purpose, were you the driver or the passenger?

Please select one answer per row.

	Driver	Passenger
Going to work or Returning from work	○	○
Shopping (e.g. groceries, household etc.)	○	○
As part of working for your employer (e.g., travelling from work to a meeting, the airport or an off-site work location)	○	○

Previous Next

3. Thinking about the **most recent** trip for each trip purpose, was the trip an urban trip or a non-urban trip?

Urban trip: An urban trip is one made entirely within a city or town.

Non-urban trip: A non-urban trip is one where some part of the trip occurs outside of a city or town (e.g. trips between towns/cities, to or from a town/city or trips entirely outside of towns or cities).

Please select one answer per row.

	Urban trip	Non-urban trip
Going to work or Returning from work	○	○
Shopping (e.g. groceries, household etc.)	○	○
As part of working for your employer (e.g., travelling from work to a meeting, the airport or an off-site work location)	○	○

Previous Next

4. Thinking about the **most recent** trip for each trip purpose, how long did each trip take?

Please select one answer per row.

	15 to 30 minutes	31 to 60 minutes	61 to 120 minutes	None of these
Going to work or Returning from work	○	○	○	○
Shopping (e.g. groceries, household etc.)	○	○	○	○
As part of working for your employer (e.g., travelling from work to a meeting, the airport or an off-site work location)	○	○	○	○

Previous Next

Business-related travel

The next series of questions relate to your last trip that was between **31 to 60 minutes**, for business-related purpose where you were the **driver** in a privately owned or business provided car (not taxis or Uber etc.). The trip was **an urban trip**.

Before we do however...

1. How many trips did you make by car last month to attend some employer business-related activities such as meetings, workshops, going to/from an airport, etc.?

Please count each leg of a journey separately (i.e., the trip to a meeting and the return trip from the meeting should be counted as 2 trips).

Meetings	
Workshops	
Travelling to/from airport	
Other	

Previous Next

1b. What was the specific purpose of your this trip that took between 31 to 60 minutes where you travelled by a **privately owned or business provided car** (not taxis or Uber etc.) as a driver on an urban trip roads.?

Please select one answer.

- ○ Meetings
- ○ Workshops
- ○ Travelling to/from airport
- ○ Other

Previous Next

Travelling to/from work

The next series of questions relate to your last trip that was between **31 to 60 minutes**, to or from work where you were the **driver** in a privately owned or business provided car (not taxis or Uber etc.). The trip was **an urban trip**.

Before we do however...

1. How many workplaces did you attend last **month** where you travelled by car to get either to or from work (some people work more than one workplaces/jobs for example)?

○ One
○ Two
○ Three or more

Previous | Next

Travelling for non-work purposes

The next series of questions relate to your last trip that was between **61 minutes to 2 hours** that you took to somewhere other than work where you were the **passenger** in a privately owned or business provided car (not taxis or Uber etc.). The trip was **a non-urban trip**.

Before we do however...

1. What was the main purpose of the trip?

○ Shopping
○ Education
○ Social visit (visit friends/family)
○ Other

Previous Next

Thinking about your most recent trip last month **either to or from** a business meeting/workshop/airport that took between 31 to 60 minutes where you travelled by a **privately owned or business provided car** (not taxis or Uber etc.) as a driver on an urban trip, please answer the following questions.

2a. What suburb did the trip **start**?

Please type a suburb name then select the suburb from the search result below. Please do not enter postcode to search for suburb.

Previous | Next

2b. What suburb did the trip **end**?

Please type a suburb name then select the suburb from the search result below. Please do not enter postcode to search for suburb.

Previous | Next

a) What time did the trip start and what time did the trip finish?

*Please enter in the boxes below. Please make sure the duration of the trip is between **31 to 60 minutes**.*

	HH	MM	
Starting time	0	0	AM/PM
Finishing time	0	0	AM/PM

b) Was the trip on a weekday or the weekend?

Please select an answer in each drop-down menu.

	b) Was the trip on a weekday or weekend?
Your most recent trip	Please select your answer

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What is the distance in kilometres for this trip by car? If unsure, please provide your best estimate.

Please enter in the box below.

____._ Kms

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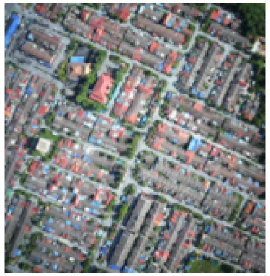
4. Of the total 1 hour(s) and 0 minutes, how much time would you estimate was spent in congested conditions?

<u>Congested conditions</u> refer to conditions where you are consistently braking and accelerating and can only change lanes if others let you in.

	Hours	Minutes
Enter numbers for hours and minutes spent in congested conditions 		

5. Of the total 1 hour(s) and 0 minutes you spent in a car travelling for this trip, what percentage would you estimate was spent driving in a built-up environment.

A built-up environment includes areas surrounded by housing or businesses. Roads in built-up environments generally have speed limits below 80 km/h, although some urban motorways through built-up environments have higher speed limits and some roads which do not travel through built-up environments have speed limits below 80km/h.



%

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6a. What, if any, was the cost of tolls for this trip?

Please enter 0 if no toll was paid. For your reference, you can click on this toll table for reference.

	Enter $ amount
 $	___.__

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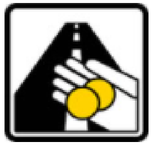
6b. Who paid the tolls for this trip?



- ☐ Me personally
- ☐ Someone else in the car
- ☐ The company I work for (either directly or reimbursed)
- ☐ Other
- ○ Don't know

Previous Next

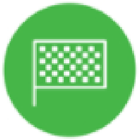
8. How many people (**including yourself**) were travelling during the trip (even if only for part of the trip)?

	Adults	Children (<15 years)
Enter numbers in the boxes		

10. Who paid for the fuel on the last purchase of fuel?

Please select your answer

11a. Did you make any stops on this trip (for example, to drop-off someone)?



○ Yes
○ No

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Example Scenario

In the coming screens, you will see **5 scenarios** similar to the example on the next screen. In each scenario you will be shown two route options described by different:

- Travel times and reliability considerations
- Costs and
- Number of crashes.

The example on the next screen will show you how the information is presented overall.

Please click on "Next" to continue.

Next

You can hover over the headings with the symbol to get further explanation.

Route A	Route B

Route A

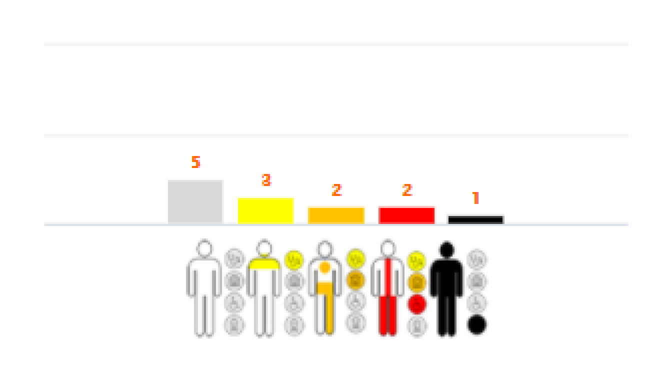
Travel outcomes over 20 trips

No. of occurrences	Total time	Minutes in congested conditions
2	1 hr 27 min	49
2	1 hr 12 min	40
7	1 hr 5 min	37
6	51 min	30
3	36 min	25

Vehicle operating and toll costs per trip

$11.47

Total number of car crashes over the last year.



Route B

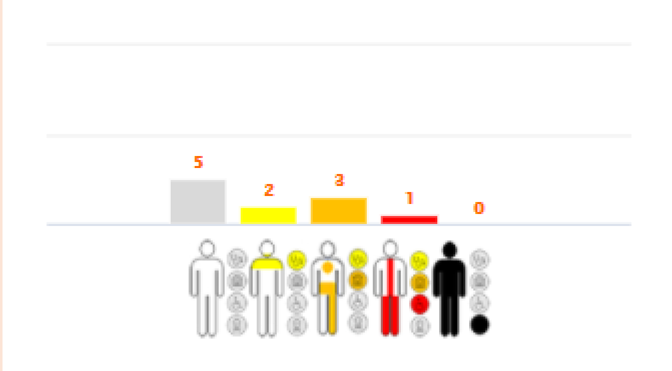
Travel outcomes over 20 trips

No. of occurrences	Total time	Minutes in congested conditions
2	1 hr 36 min	51
3	1 hr 12 min	47
6	1 hr 9 min	39
6	51 min	32
3	30 min	23

Vehicle operating and toll costs per trip

$9.56

Total number of car crashes over the last year.



If you need to check the meanings of injury classes, please click this link to open a pop-up glossary page for explanation.

Please choose one answer.

○ I prefer Route A

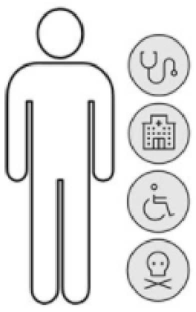
◉ I prefer Route B

Injury Definition

In the scenario questions which follow, you will be asked to take into account the number and severity of crashes which have occurred on each route during the last year.

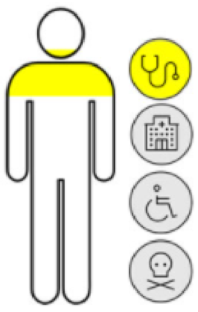
It is important that you understand the different injury types so that you can rank the safety of each route accurately.

Please read the following definitions carefully, you will be asked about them later in the survey.



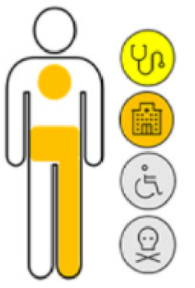
Mainly Property Damage

The crash mainly results in damage to the vehicle. Any injuries do not require medical treatment and are limited to issues such as mild bruising or muscle soreness.



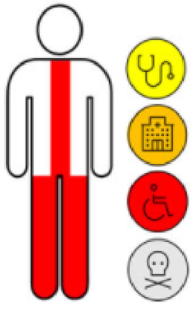
Visit to GP

Requires some minor medical treatment by a GP but **not** hospitalisation. For example, the injuries involve minor whiplash and a sprained shoulder. These require a trip to the GP. Recovery takes less than 4 weeks and does not require any major follow up.



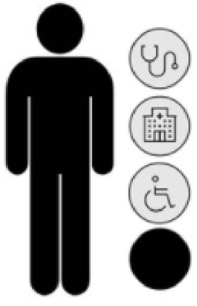
Hospital Needed

The injuries require hospitalisation. For example, a major chest injury and a broken leg and pelvis requiring hospitalisation for treatment. Recovery takes 12 weeks and requires physical therapy rehabilitation.



Incapacitating Injury

The injuries are permanent and incapacitating. For example, a spinal injury which results in permanent paralysis from the waist down requiring the use of a wheelchair for the rest of life.



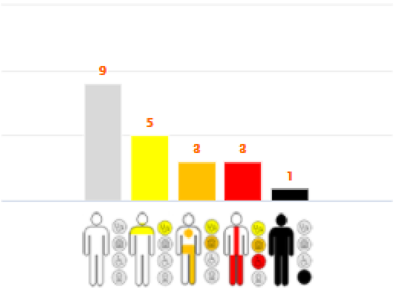
Fatal Injury

The injuries are severe and result in death during or shortly after the crash.

In each scenario you will see the number of car crashes on each route presented in a graph similar to the one on the right.

The total number of car crashes over the last year between each route are directly comparable - higher figures indicate a higher chance of that event happening.

Numbers of car crashes over the last year



Quiz

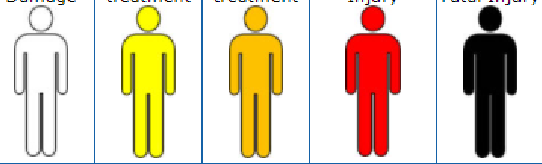
We are now going to ask you a question about the injury classifications explained in the previous slide.

This question is **not** in relation to your own personal experience.

This question presents four examples where you will be asked to classify the hypothetical injury into one of the five injury classifications.

Please select which injury category best describes the following:

Please select one answer per row.
If you need to check the meanings of injury classes, please click this link to open a pop-up glossary page for explanation.



	Property Damage	Minor Injury - Doctor treatment	Major Injury - Hospital treatment	Incapacitating Injury	Fatal Injury
The crash results in a herniated disc causing pain in the lower back. Treatment requires surgery in hospital and full recovery is achieved.	○	○	○	○	○
The crash results in a broken wrist that requires medical assistance but not hospitalisation.	○	○	○	○	○
The crash results in a major wound that requires hospitalisation for treatment and a blood transfer, full recovery takes a number of weeks.	○	○	○	○	○
The injuries involve a traumatic brain injury. After hospital, there are still permanent cognitive problems.	○	○	○	○	○

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Below is the result on whether you have answered correctly or not.

If you need to review the meanings of injury classes, please click this link to open a pop-up glossary page for explanation.

	Correct	Not Correct
The crash results in a broken wrist that requires medical assistance but not hospitalisation.	◉	○
The crash results in a major wound that requires hospitalisation for treatment and a blood transfer, full recovery takes a number of weeks.	◉	○
The crash results in a herniated disc causing pain in the lower back. Treatment requires surgery in hospital and full recovery is achieved.	◉	○
The injuries involve a traumatic brain injury. After hospital, there are still permanent cognitive problems.	◉	○

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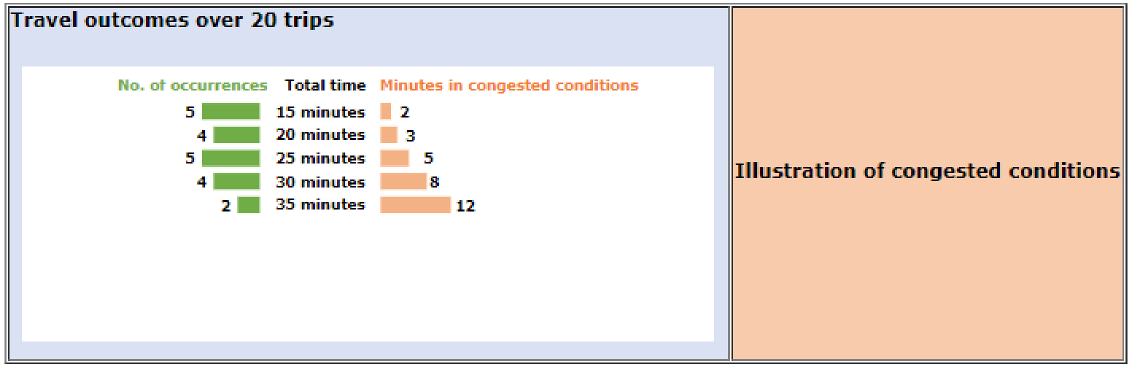
Travel Times and Reliability Considerations

In each scenario you will see travel times presented in a manner similar to the chart below.



The length of the bars on the left show how often different travel times would happen if you were to **repeat the exact same trip 20 times**.

In the example above, **5 times out of 20** the trip takes 15 minutes but **2 times out of 20** the trip takes 35 minutes and **4 times out of 20** it takes 30 minutes.

The length of the bars on the right show how much of the trip you would expect to spend in **congested conditions**.

For example, for **a trip that would take 35 minutes**, you would expect to spend **12 minutes** in congested conditions. For **a trip that would take 15 minutes**, only **2 minutes** of that time would be spent in congested conditions.

Please take the time to study the graph above in relation to the various times and probabilities before continuing the survey.

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Scenario 1 of 5

Thinking about your most recent trip from Padstow NSW 2211 to North Ryde NSW 2113 that you were the driver, we would like you to consider the following two route options. Each option offers different travel times, costs and levels of safety. Please carefully examine each option and tell us which of the two you prefer..

In evaluating each alternative and making a choice, it is important that you take into account the frequency of occurrence of each level of travel time (including the amount on congested time).

You can hover over the headings with the symbol to get further explanation.

Route A	Route B

Route A – Travel outcomes over 20 trips

No. of occurrences	Total time	Minutes in congested conditions
3	1 hr 39 min	49
4	1 hr 15 min	46
6	1 hr 0 min	37
4	57 min	32
3	42 min	23

Route B – Travel outcomes over 20 trips

No. of occurrences	Total time	Minutes in congested conditions
1	1 hr 27 min	49
2	1 hr 15 min	44
6	1 hr 5 min	35
7	51 min	28
4	39 min	23

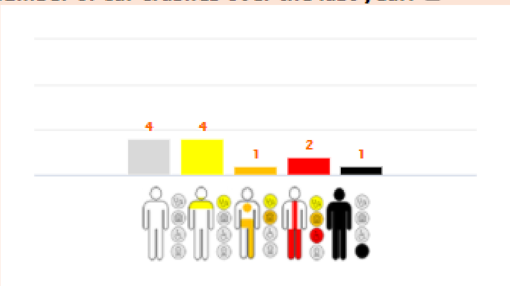
Route A – Vehicle operating and toll costs per trip

$9.56

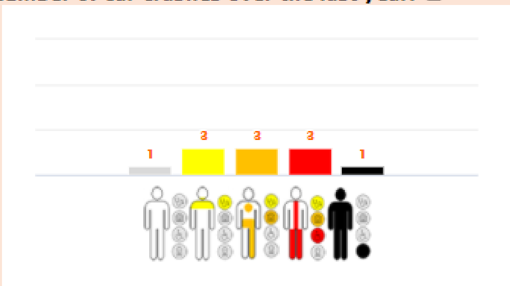
Route B – Vehicle operating and toll costs per trip

$9.56

Route A – Total number of car crashes over the last year.



Route B – Total number of car crashes over the last year.



If you need to review the meanings of injury classes, please click this link to open a pop-up glossary page for explanation.

Please choose one answer.

○ I prefer Route A ○ I prefer Route B

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Followed by four more tasks.

Scenario 5 of 5

Thinking about your most recent trip from Padstow NSW 2211 to North Ryde NSW 2113 that you were the driver, we would like you to consider the following two route options. Each option offers different travel times, costs and levels of safety. Please carefully examine each option and tell us which of the two you prefer.

In evaluating each alternative and making a choice, it is important that you take into account the frequency of occurrence of each level of travel time (including the amount on congested time).

You can hover over the headings with the symbol to get further explanation.

Route A

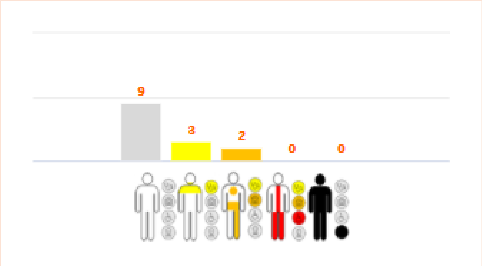
Travel outcomes over 20 trips

No. of occurrences	Total time	Minutes in congested conditions
2	1 hr 39 min	51
6	1 hr 21 min	42
7	1 hr 9 min	32
4	51 min	28
1	33 min	23

Vehicle operating and toll costs per trip

$7.65

Total number of car crashes over the last year.



Route B

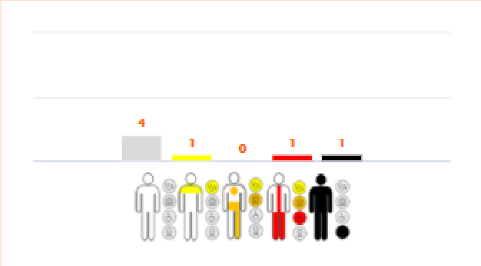
Travel outcomes over 20 trips

No. of occurrences	Total time	Minutes in congested conditions
1	1 hr 30 min	51
4	1 hr 15 min	46
6	1 hr 0 min	33
3	48 min	28
6	39 min	23

Vehicle operating and toll costs per trip

$7.65

Total number of car crashes over the last year.



If you need to review the meanings of injury classes, please click this link to open a pop-up glossary page for explanation.

Please choose one answer.

I prefer Route A

I prefer Route B

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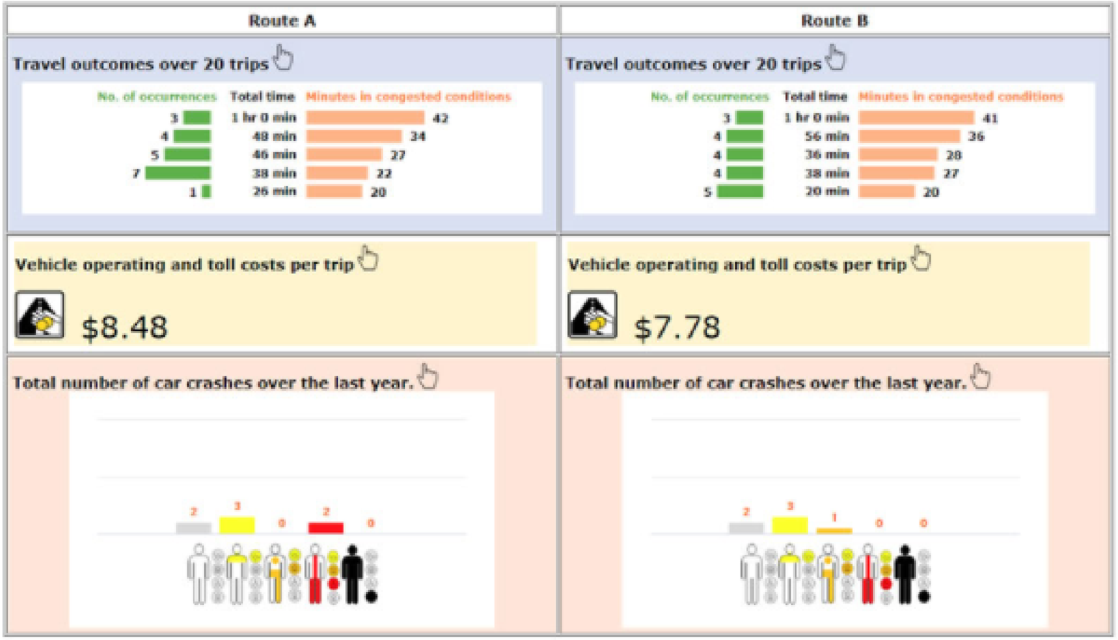
When you were completing the tasks, how important was each piece of information to you in making choices?

An example task is shown below for your reference.



Please choose one answer per row.

	Not important at all 1	2	3	4	5	6	Very important 7
No. of occurrences	○	○	○	○	○	○	○
Total time	○	○	○	○	○	○	○
The range of travel time	○	○	○	○	○	○	○
Minutes in congested conditions	○	○	○	○	○	○	○
Vehicle operating and toll costs per trip	○	○	○	○	○	○	○
Total number of car crashes over the last year	○	○	○	○	○	○	○

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Consideration of passengers

Which of the following best describes your thinking when you answered the last 5 scenarios?

○ I selected the preferred routes based solely on my behalf
○ I selected the preferred routes based on my preferences, assuming other car occupant(s) would share some of the costs
○ I selected the preferred routes based on my preferences with some consideration for other car occupants but assuming no cost sharing with them
○ I totally forgot my co-traveller(s) when selecting the preferred routes
○ I chose this route based on my preferences but knowing that someone not travelling with me will pay the full costs
○ I chose this route based on my preferences but knowing that someone not travelling with me will pay some of the costs

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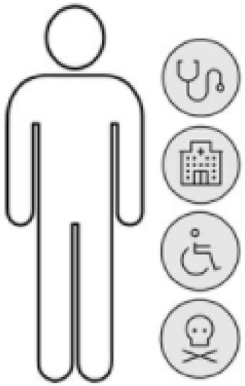
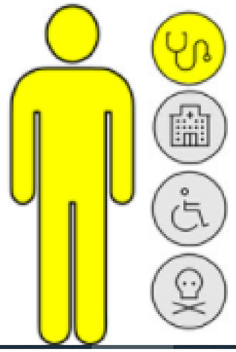
Crash experience

1. Have you ever been in a car crash (irrespective of who was at fault) in which you personally suffered...

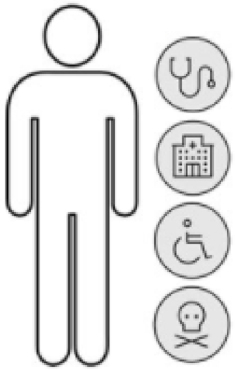
If you need to review meanings of these injury classes, please click this link to open a pop-up glossary page for explanation.

	Yes	No
Mainly Property Damage 	○	○
	Yes	No
Visit to GP 	○	○

Crash experience

2. Have you ever been in a car crash (irrespective of who was at fault) in which someone else suffered...

If you need to review meanings of these injury classes, please click this link to open a pop-up glossary page for explanation.

	Yes	No
Mainly Property Damage 	○	○

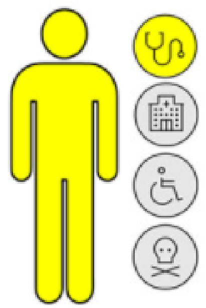
	Yes	No
Visit to GP 	○	○

Crash experience

3. Has someone you know ever been in a car crash where **you were not present** in the car, in which they suffered...

If you need to review meanings of these injury classes, please click this link to open a pop-up glossary page for explanation.

	Yes	No
Mainly Property Damage 	○	○

	Yes	No
Visit to GP 	○	○

1) During a typical week, how many days do you work and of these, how many days do you spend working-from-home (WFH)?

Please choose one answer in each drop-down box.

	Pre-COVID	Now
Days working	Please select your answer	Please select your answer
Days WFH	Please select your answer	Please select your answer

2) Describe your main mode of transport during a typical week (i.e. the number of days you commute using each of the following mode(s))?

Please choose one answer in each drop-down box.

	Pre-COVID	Now
Public Transport	Please select your answer	Please select your answer
Car	Please select your answer	Please select your answer
Other	Please select your answer	Please select your answer

3) During a typical week, how many non-work related trips do you make (e.g. trips which are not to or from work or for business-related purposes)?

Please enter a number in each box.

	Pre-COVID	Now
Number of trips		

4) How well do you think digital communication methods substitute for face-to-face time in your work (e.g., Microsoft Teams, Zoom, Skype etc.)?

Please select one answer.

- ○ Digital is much better
- ○ Digital is a little better
- ○ They're about the same
- ○ Face-to-face is a little better
- ○ Face-to-face is much better

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About You

1. What is your year of birth?

2. What is your gender?

Please select one answer

- Male
- Female
- Other

3. Including yourself, how many adults (18 years or older) and children (younger than 18 years) are there in your household?

Please enter a valid number in each box.

	Adult	Children
Number of people in household		

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4. What is the highest level of education you have completed?

Please select your answer

5. What is your personal income (before tax)

Please select your answer

6. What best describes your current occupation?

Please select all that apply.

- ☐ Student full time
- ☐ Student part time
- ☐ Employed full time
- ☐ Employed part time
- ☐ Casually employed
- ☐ Not working for pay
- ☐ Full time homemaker
- ☐ Regular volunteer worker
- ☐ Retired/Pensioner
- ☐ Unemployed & seeking
- ☐ Other (please specify) ____________

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7. How many vehicles are parked at your household?

Please enter a number in the relevant box.

Cars	
Motorbikes	
Motorscooters	
Trucks	

Or

☐ I don't have any vehicles

8. Which driving licences do you currently hold to drive **cars**?

- ○ Full license
- ○ Red-Plates
- ○ Green-Plates
- ○ Learners permit
- ○ Probationary license
- ○ None

8. Which driving licences do you currently hold to drive **motorbikes/scooters**?

- ○ Full license
- ○ Red-Plates
- ○ Green-Plates
- ○ Learners permit
- ○ Probationary license
- ○ None

9. What types of insurance do you currently have?

Please select all that apply.

Vehicle related insurance

- ☐ Compulsory Third Party Insurance (CTP)
- ☐ Motor Vehicle

Other insurance

- ☐ Consumer Credit
- ☐ Extended Warranty
- ☐ General Property, Home and Contents
- ☐ Home Warranty and Lenders Mortgage
- ☐ Income protection
- ☐ Life insurance
- ☐ Medical Indemnity Insurance
- ☐ Pet Insurance
- ☐ Private health insurance
- ☐ Professional Indemnity
- ☐ Other (please specify) ____________
- ○ None

10. Not including parking fines, have you received a fine or any other penalty for breaching the road rules in the last 2 years?

- ○ Yes
- ○ No

[Previous] [Next]

We are interested in how easy or difficult it was to complete this survey. Please select the appropriate response for each question below.

Please select one answer per row.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Sure
I understood the **purpose** of this survey	○	○	○	○	○	○
The questions about a **recent trip** I took were **easy** to complete	○	○	○	○	○	○
The **injury descriptions** were **easy** to understand	○	○	○	○	○	○
The **injury diagrams** were **easy** to understand	○	○	○	○	○	○
The **reliability diagrams** were **easy** to understand	○	○	○	○	○	○
Thinking about the **scenarios**, I could generally understand the information presented about my different travel **options**	○	○	○	○	○	○
Thinking about the **scenarios**, I could understand the information presented about **running costs and tolls**	○	○	○	○	○	○
Thinking about the **scenarios**, I could understand the information presented about **travel times and reliability**	○	○	○	○	○	○
Thinking about the **scenarios**, I could understand the information presented about **crashes and injuries**	○	○	○	○	○	○
I could **relate to the scenarios** presented	○	○	○	○	○	○
The questions about **crash experience** and safety were **easy** to complete	○	○	○	○	○	○
The questions about my **personal details** (including vehicle ownership) were **easy** to complete	○	○	○	○	○	○
There were **too many questions** after the scenarios	○	○	○	○	○	○

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Thinking about the injury diagrams, select all that apply.

- ☐ I didn't understand the diagram.
- ☐ The diagram was too complicated.
- ☐ There were too many categories.
- ☐ I didn't feel the examples reflected my experience.
- ☐ I understood the injury diagram
- ○ None of the above

I needed to review the injury descriptions and diagrams when answering questions and making choices.

- ○ Yes
- ○ No

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Overall, on a scale of 0 to 10 (where 0 is not good at all and 10 is excellent), I would rate my ability to understand and answer the questions in this survey as:

Please select an answer.

	Not good at all 0	1	2	3	4	5	6	7	8	9	Excellent 10
My experience of the survey is	○	○	○	○	○	○	○	○	○	○	○

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What other comments or feedback would you like to provide on the injury descriptions and diagrams?

Please type your comments in the box below.

What further comments or feedback would you like to provide on the survey?

Please type your comments in the box below.

Previous Next

Thank you for taking the time to participate in our survey.

Previous Next

A.5 Injury classifications and disability weight calculation method

Note: Disability weight calculations were completed in 2018, therefore the 2010 values of disability weights have been used, instead of the 2019 values which were also discussed in the report.

The figures here are an estimate only. Injury Severity Score (ISS) and New Injury Severity Score (NISS) are created using the Abbreviated Injury Score 2015 (AIS). These measures take a numerical ranking of severity of the injury and squares it, to create an exponentially increasing score of the severity. ISS and NISS are largely the same, unless two of the three most major injuries from a crash are on the same part of the body, in which case the NISS will be higher.

The AIS has injuries in 6 categories:

1. AIS 1 – Minor
2. AIS 2 – Moderate
3. AIS 3 – Serious
4. AIS 4 – Severe
5. AIS 5 – Critical
6. AIS 6 – Maximal (currently untreatable)

The formula for the ISS relies on the severity in the AIS of injuries sustained during a trauma. The equations are as follows:

$$ISS \text{ or } NISS = A^2 + B^2 + C^2$$

Where A, B and C are the AIS scores of the most severe injury in the three most severely injured ISS body regions. The NISS is largely the same, however, instead uses the AIS scores of the three most severe injuries sustained in the trauma, regardless of body region. Untreatable injuries that will result in death are given an automatic score of 75.

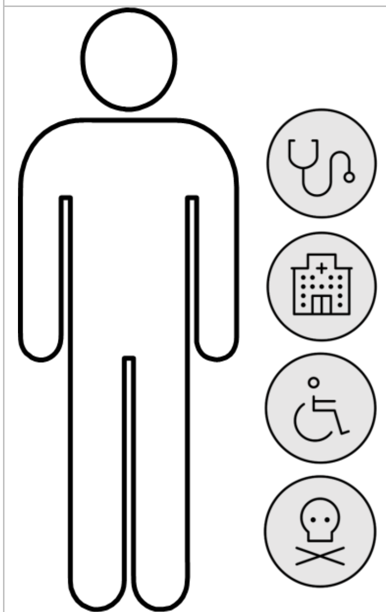
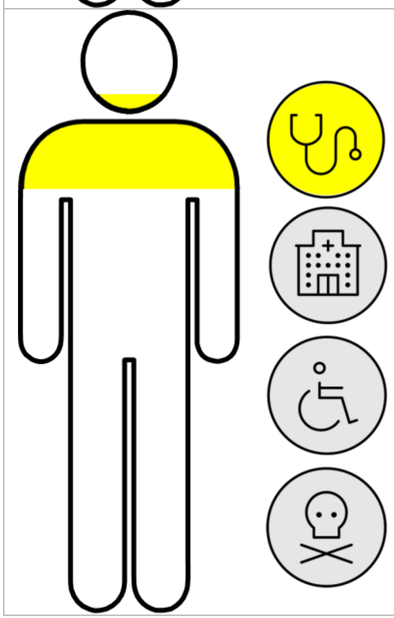
There are 6 body regions in which injuries can be assigned for the ISS (Gennarelli & Woodzin, 2016), which are:

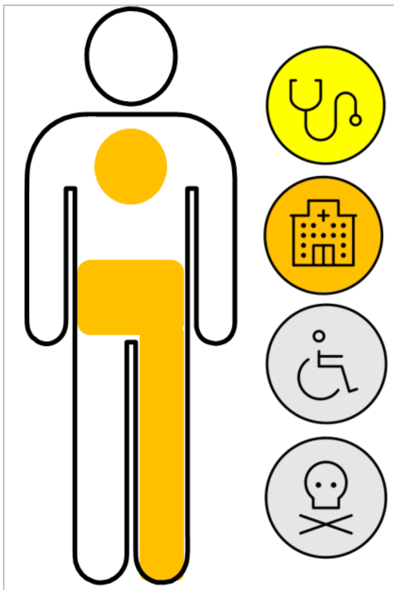
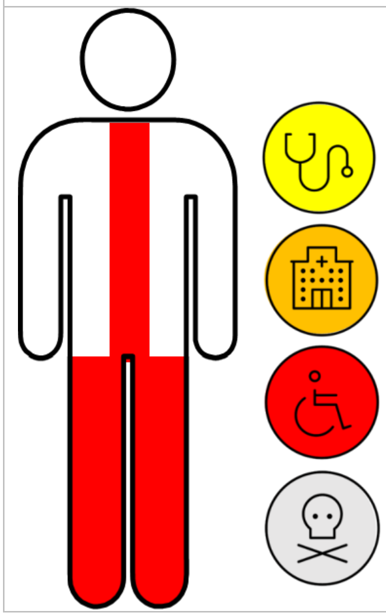
1. Head or neck injuries
2. Facial injuries
3. Chest injuries
4. Abdominal or pelvic contents injuries
5. Extremities or pelvic girdle injuries
6. External and other trauma injuries

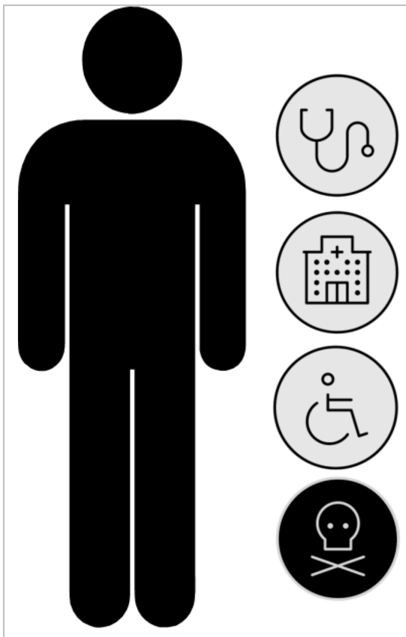
True figures may vary depending on a respondent's interpretation. This can be seen by the ICISS for major injury and incapacitating injury. The ICISS is meant to measure risk of death, which may be higher for a major injury than an incapacitating injury, however respondents may have a higher WTP to prevent incapacitating injury as it is associated with a lower quality of life in the case of survival. Similarly, the predicted Functional Capacity Index (pFCI) system assesses the functional limitations of patients which may not exactly match the ISS values. Care should be used when using the above values to quantify each injury, as each respondent's interpretation may differ greatly, and a range of severities could be used.

In the Australian National University (2022), a different classification was used. This had road crashes with serious injuries as one in which the AIS for any injury is no greater than 2. Road crashes with severe injuries here are defined as those with a maximum AIS (MAIS) of any injury of 3 or more. The below table does not present MAIS, as this would only reflect the MAIS in the example, and not necessarily a person's interpretation of the MAIS.

Table A.6: Associated disability weights and ICISS with each injury classification

Diagram	Wording	Disability weight, ICISS and ISS
	**Mainly Property Damage** The crash mainly results in damage to the vehicle with any injuries not requiring medical assistance of any kind. *General description for survey:* The crash mainly results in damage to the vehicle. Any injuries do not require medical treatment and are limited to issues such as mild bruising or muscle soreness.	*Estimated disability weight:* 0 *Estimated ICISS* 1 *Estimated ISS/NISS* 0
	**Minor injury** An injury that requires medical treatment but does not require hospitalisation. Examples include minor whiplash, minor cuts, or bumps. *General description for survey:* **Requires some minor medical treatment by a GP but not hospitalisation**. For example, the injuries involve minor whiplash and a sprained shoulder. **These require a trip to the GP**. Recovery takes less than 4 weeks and does not require any major follow up.	*Estimated disability weight:* Neck pain: acute, mild = 0.04 *Estimated ICISS* Injury of muscle and tendon at neck level = 1 *Estimated ISS/NISS* Skin/subcutaneous/muscle abrasion of neck 1

	**Major injury** An injury that requires hospitalisation. Hospitalisation can include day or overnight stay. Follow up care could also be required and may take the form of out of hospital treatments such as ongoing psychological support. Examples include major bleeding, major broken bones and ongoing psychological distress. *General description for survey:* The injuries require hospitalisation. For example, a major chest injury and a broken leg and pelvis requiring hospitalisation **for** treatment. Recovery takes 12 weeks and requires physical therapy rehabilitation.	*Estimated disability weight:* Fracture of patella, tibia or fibula, or ankle: short term, with or without treatment + Fracture of pelvis: short term + Severe chest injury: long term, with or without treatment = 0.0807+ 0.39 + 0.056 = 0.5267 *Estimated ICISS* Other fracture of shaft of tibia * Fracture of pelvis, part unspecified * Crushed chest = 0.9906* 0.8859 * 0.875= 0.7679 *Estimated ISS* Serious Tibia fracture NFS + laceration NFS of thorax = $2^2 + 1^2$ = 5 *Estimated NISS* Tibia fracture NFS + pelvic ring fracture + laceration NFS of thorax = $2^2 + 2^2 + 1^2$ = 9
	**Incapacitating Injury** An injury that causes permanent damage where normal functioning is permanently impaired. Examples include permanent brain injury or permanent paralysis. *General description for survey:* The injuries are permanent and incapacitating. For example, a spinal injury, which results in permanent paralysis from the waist down requiring the use of a wheelchair for the rest of life.	*Estimated disability weight:* Spinal cord lesion at neck: untreated = 0.673 *Estimated ICISS* Multiple fractures of cervical spine = 0.8592 *Estimated ISS/NISS* Complete spinal cord injury of the cervical spine= 5^2 = 25

	**Fatal Injury** Death within 30 days of crash *General description for survey:* The injuries are severe and result in death during or shortly after the crash.	*Estimated disability weight:* 1 *Estimated ICISS* 0 *Estimated ISS/NISS* 75

Source: Deloitte Access Economics

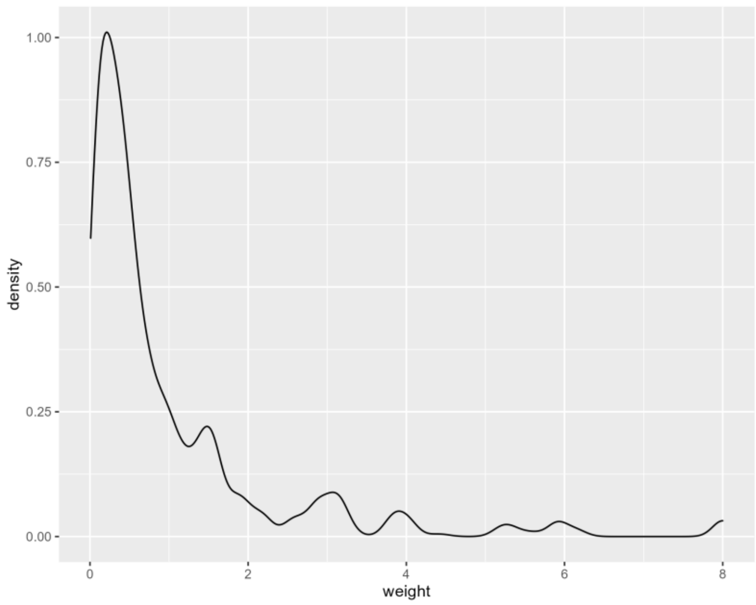
A.6 Distribution of the population weights used for weighting

Table A.7: The distribution of population weights used for weighting

Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum
0.009	0.210	0.466	1.000	1.200	8.000

Source: Deloitte Access Economics

Figure A.5.1 Distribution of the population weights used for weighting



Source: Deloitte Access Economics

A.7 Statistical properties of stated choice designs

A.7.1 Efficient choice designs

A statistically efficient design is a design that minimises the elements of the asymptotic (co)variance matrix, resulting in more reliable parameter estimates for a design with a fixed number of choice observations. The generation of an efficient experimental design therefore requires a priori knowledge as to the elements within the asymptotic (co)variance matrix of the model to be estimated, which in most instances will not be known prior to model estimation.

It therefore, becomes necessary to conjecture a set of priors that may be used to construct the asymptotic (co)variance matrix of different designs, which may then be compared in order to determine which design will provide the greatest level of statistical efficiency. A number of different measures of design efficiency have been postulated within the literature (see Rose and Bliemer, 2009, for example), all of which are derived from the work of McFadden (1974) on random utility theory (RUT) and summarised in a number of sources (e.g., Bliemer and Rose, 2010).

To explain the concept of RUT, consider a situation in which an individual is faced with multiple choice tasks involving a series of discrete choices made from a universal but finite number of alternatives. Let subscripts n and j refer to choice task n = 1, 2, …, N, and alternative j = 1, 2, …, J. The utility possessed by an individual for alternative j in choice task n may be expressed as:

$$U_{jn} = V_{jn} + \varepsilon_{jn}, \quad \text{(A.1)}$$

Where:

U_{jn} is the utility associated with alternative j in choice set n consisting of an observed component of utility for each alternative j in choice task n, V_{jn}, as well as a component, ε_{jn}, that is unobserved by the analyst.

The observed component of utility is assumed to be a linear additive function of several attributes with corresponding weights. These weights are the unknown parameters to be estimated. We distinguish between generic parameters and alternative-specific parameters. Generic parameters have the same value for all alternatives that the corresponding attribute appears in, in contrast to alternative-specific parameters that may be different for each alternative. Let the generic and alternative-specific parameters be denoted by $\beta_k^*, \; k=1,\ldots,K^*,$ and $\beta_{jk}, \; k=1,\ldots,K_j,$ respectively, with their associated attribute levels x_{jkn}^* and x_{jkn} for each choice situation n. The observed utility including both generic and alternative-specific attributes may be represented as equation (A.2).

$$V_{jn} = \sum_{k=1}^{K^*} \beta_k^* x_{jkn}^* + \sum_{k=1}^{K_j} \beta_{jk} x_{jkn}, \quad \forall j = 1,\ldots,J, \forall n = 1,\ldots,N. \quad \text{(A.2)}$$

The presence of subscript j in β_{jk} allows for the estimation of alterative-specific parameter estimates across the j utility specifications in a labelled choice experiment. The total number of parameters to be estimated is equal to $\bar{K} = K^* + \sum_j K_j$. Assuming that the unobserved components of utility, ε_{jn}, are independently and identically extreme value type I distributed, the probability, P_{in}, of choosing alternative i in choice set n becomes:

$$P_{in} = \frac{\exp(V_{in})}{\sum_{j=1}^{J} \exp(V_{jn})}, \quad \forall j = 1,\ldots,J, \forall n = 1,\ldots,N, \quad \text{(A.3)}$$

and the log-likelihood as a function of the parameters, becomes (assuming a single respondent)

$$\begin{aligned} L(\beta^*, \beta) &= \sum_{n=1}^{N} \sum_{j=1}^{J} y_{jn} \log P_{jn} \\ &= \sum_{n=1}^{N} \left[\sum_{j=1}^{J} y_{jn} \left(\sum_{k=1}^{K^*} \beta_k^* x_{jkn}^* + \sum_{k=1}^{K_j} \beta_{jk} x_{jkn} \right) - \log \left(\sum_{i=1}^{J} \exp \left(\sum_{k=1}^{K^*} \beta_k^* x_{ikn}^* + \sum_{k=1}^{K_j} \beta_{ik} x_{jkn} \right) \right) \right] \end{aligned} \quad \text{(A.4)}$$

where the vector y describes the binary outcome of all choice tasks, such that y_{jn} equals one if alternative j is chosen in choice task n and is zero otherwise. The asymptotic (co)variance matrix is related to the second derivative of the log-likelihood function. Allowing for alternative-specific and generic parameter estimates, this is set out in equation (A.5) (see Rose and Bliemer, 2009):

$$\frac{\partial^2 L(\beta^*, \beta)}{\partial \beta_{k_1}^* \partial \beta_{k_2}^*} = -\sum_{n=1}^{N} \sum_{j=1}^{J} x_{jk_1n}^* P_{jn} \left(x_{jk_2n}^* - \sum_{i=1}^{J} P_{in} x_{ik_2n}^* \right), \quad \forall k_1, k_2 = 1,\ldots,K^*, \quad \text{(A.5a)}$$

$$\frac{\partial^2 L(\beta^*,\beta)}{\partial \beta_{j_1 k_1} \partial \beta^*_{k_2}} = -\sum_{n=1}^{N} x_{j_1 k_1 n} P_{j_1 n} \left(x^*_{j_1 k_2 n} - \sum_{i=1}^{J} x^*_{ik_2 n} P_{in} \right), \quad \forall j_1 = 1,\ldots,J, k_1 = 1,\ldots,K_{j_1}, k_2 = 1,\ldots,K^*, \qquad \text{(A.5b)}$$

$$\frac{\partial^2 L(\beta^*,\beta)}{\partial \beta_{j_1 k_1} \partial \beta_{j_2 k_2}} = \begin{cases} \sum_{n=1}^{N} x_{j_1 k_1 n} x_{j_2 k_2 n} P_{j_1 n} P_{j_2 n}, & \text{if } j_1 \neq j_2; \\ -\sum_{n=1}^{N} x_{j_1 k_1 n} x_{j_2 k_2 n} P_{j_1 n} \left(1 - P_{j_2 n}\right), & \text{if } j_1 = j_2. \end{cases} \quad \forall j_i = 1,\ldots,J, k_i = 1,\ldots,K_{j_i}. \qquad \text{(A.5c)}$$

Equations (A.5a-c) do not rely on the outcomes, y. In addition, assuming M respondents, these second derivatives are multiplied by M. In case only generic parameters exist, only equation (A.5a) remains, which is similar to the result in McFadden (1974). In the case of only alternative-specific parameters, only Equation (A5c) remains.

The maximum likelihood (ML) estimates of (β^*, β) are found by maximizing the log-likelihood function, or alternatively, by setting the first derivatives equal to zero (since the log-likelihood function is concave). Denoting the ML estimates as $(\hat{\beta}^*, \hat{\beta})$ we have:

$$(\hat{\beta}^*, \hat{\beta}) = \arg\max_{(\beta^*,\beta)} L(\beta^*, \beta). \qquad \text{(A.6)}$$

Let $(\bar{\beta}^*, \bar{\beta})$ denote the true values of the parameters. McFadden (1974) showed that for the generic case, that the ML estimates $\hat{\beta}^*$ are asymptotically normally distributed with mean $\bar{\beta}^*$ and asymptotic (co)variance matrix, Ω, which is equivalent to the negative inverse of the Fisher information matrix. This result can be extended to the case of (a combination of generic and) alternative-specific parameters. The Fisher information matrix I is defined as the expected values of the second derivative of the log-likelihood function, that is:

$$I(\bar{\beta}^*, \bar{\beta}) = M \cdot \frac{\partial^2 L(\bar{\beta}^*, \bar{\beta})}{\partial \beta \partial \beta'}. \qquad \text{(A.7)}$$

Hence, the asymptotic (co)variance matrix becomes the following $\bar{K} \times \bar{K}$ matrix:

$$\Omega = -\left[I(\bar{\beta}^*, \bar{\beta}) \right]^{-1} = -\frac{1}{M} \left[\frac{\partial^2 L(\bar{\beta}^*, \bar{\beta})}{\partial \beta \partial \beta'} \right]^{-1}. \qquad \text{(A.8)}$$

Within equation (A.8), the presence of M suggests that the (co)variances become smaller with larger sample sizes. This also follows for the asymptotic standard errors, obtained by taking the square root of the diagonal elements (including M) of this matrix (i.e., variances). By taking the square root of M, one will observe diminishing improvements to the standard errors over increases in sample size. The asymptotic (co)variance matrix plays an important role when determining efficient experimental designs, as shown in the next section.

A.7.2 Measuring the statistical efficiency of stated choice experimental designs

To compare the statistical efficiency of SC experimental designs, a number of alternative approaches have been proposed within the literature (see e.g., Bunch, et al. 1994). The preferred measure within the literature is D-error, computed by taking the determinant of the asymptotic (co)variance matrix and applying a scaling factor to account for the number of parameters, $\bar{K}$. It is common in generating efficient designs to do so assuming a single respondent (i.e., M = 1) representative of all respondents, an assumption consistent with the MNL model form. Hence, we the D-error is computed as:

$$\text{D-error} = \left(\det \Omega\right)^{1/\bar{K}} = -\left(\det\left(\frac{\partial L^2(\bar{\beta}^*, \bar{\beta})}{\partial\beta\partial\beta'}\right)\right)^{1/\bar{K}}. \qquad \text{(A.9)}$$

The D-error measure of design efficiency may be used to distinguish between designs of the same dimension so that if the D-error is low, the (co)variances of the parameter estimates are also low. Two popular approaches exist within the literature for computing the D-error of a design. The first approach assumes that the analyst has no information, not even likely sign, of the true parameter values. This assumption results in what the literature has termed D_z-error in which the parameters are assumed to be all equal to zero. The D_z-error can be computed as:

$$\text{D}_z\text{-error} = -\left(\det\left(\frac{\partial L^2(0,0)}{\partial\beta\partial\beta'}\right)\right)^{-1/\bar{K}}, \qquad \text{(A.10)}$$

An alternative measure is the D_p-error, which assumes that the analyst has some prior knowledge in the form of prior parameter values $(\tilde{\beta}^*, \tilde{\beta})$, for at least one parameter. The D_p-error measure may therefore be computed as:

$$\text{D}_p\text{-error} = \left(\det\left(\frac{\partial L^2(\tilde{\beta}^*, \tilde{\beta})}{\partial\beta\partial\beta'}\right)\right)^{-1/\bar{K}}. \qquad \text{(A.11)}$$

For the purposes of this study, we assume non-zero priors and hence rely on the D_p-error criterion.

For designs of the same dimensions (i.e., number of choice sets, alternatives, attributes, and attribute levels), the design(s) with the lowest D-error is (are) termed the D-optimal design(s). Determining whether a design is D-optimal is difficult however, given the large number of possible attribute level combinations that may exist for a design of fixed dimensions. In general, for all but the smallest of designs, it will be unlikely that an analyst will be able to calculate the D-error for all possible design permutations. It is therefore more appropriate to label a design as D-efficient as opposed to D-optimal. Assuming not all possible permutations are to be examined, the literature has suggested a number of different strategies to determine which permutations should be examined and how (see e.g., Rose and Bliemer, 2009).

A.8 Understanding and interpretation of WTP for safety attributes

To begin to understand the interpretation of the WTP for the safety attributes, it is useful to provide some theoretical background to the meaning of the evidence. Assume a route is used by *N* users. If person *n* travels more than once in a reference period, say m_n times, this gives rise to m_n pseudo-members with a total population of $N = \sum_{n=1}^{N} m_n$, observations, i.e., the individuals of a population. This population exactly amounts to the flow on a route in a given period (say a year)[1]. We then define a route as a path connecting one origin-destination pair. A trip on a route provides a level of dissatisfaction (or disutility) given by a deterministic indirect utility function $V = V(r, c, t)$, where *r* stands for risk of a fatal crash or class of injury, *c* for the cost of travel and *t* for the travel time (mean and variability) on a route; there could be more attributes, of course.

Jones Lee (1994), focussing only on fatality, formally defined the value of risk reduction (*VRR*) as the value of avoiding one expected death, and this corresponds to the population (or sample) average of the marginal rate of substitution (also known as willingness-to-pay) between income and risk of death for person *n* (MRS_n) plus a covariance term that accounts for possible correlation between MRS and reduced risk (δr_n)[2]:

$$MRS_n = \frac{\partial V_n / \partial r}{\partial V_n / \partial c \,|_{V=\bar{V}}}, \qquad (1)$$

$$VRR = \frac{1}{N}\sum_{n=1}^{N} MRS_n + N \operatorname{cov}\left(MRS_n, |\delta r_n|\right). \qquad (2)$$

In empirical work, it is typically assumed that there is no correlation between WTP and δr in the population. Then, Equation (2) simplifies to Equation (3), below, and to estimate the *VRR* it is sufficient to have a suitable estimate of the *MRS* (or *WTP*). This assumption would be correct, for example, if δr were the same for every individual.

$$VRR = \frac{1}{N}\sum_{n=1}^{N} MRS_n \,. \qquad (3)$$

The *MRS* can be interpreted as an implicit value for the traveller's own life and averaging it over all individuals travelling on the route yields the *VRR*. The *MRS* clearly depends on personal risk perceptions according to the functional form of V_n. The same analysis can be carried out in terms of fatal crashes, *f*, (or injuries), instead of risks, *r*. However, in this case the *VRR* is derived differently (but yields the same value):

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[1] Population is a stock variable whereas a flow is not.

[2] $\operatorname{cov}\left(MRS_n, \delta r_n\right) = \sum_n MRS_n \delta r_n - \frac{1}{N}\sum_n MRS_n \frac{1}{N}\sum_n \delta r_n$

$$VRR = \frac{1}{e}\sum_{n=1}^{N}\frac{\partial V_n / \partial f}{\partial V_n / \partial c}\Big|_{V=\bar{V}} = \frac{1}{e}\sum_{n=1}^{N} SVCR_n \,, \qquad (4)$$

where *e* represents the number of fatalities or injuries (by class) per crash (effectively the information that relates to exposure to risk) and *SVCR* stands for the subjective value of fatal crash injury reductions (by class), and is a Lindahl price (Varian, 1992, chapter 23). Equation (4) embodies the definition of community WTP for a public good, road safety in this case, as the sum of individual marginal rates of substitution between income and number of fatalities and injuries (by class).

If we think in terms of a hypothetical tolled route whose operators were able to extract the full consumer's surplus, the *SVCR* would be the maximum toll increase due to a safety improvement for individual *n*, such that he is as well-off as before the improvement. If the *VRR* is higher than the cost of reducing one fatality or one injury (by class), the safety project should be desirable from the community standpoint; in what follows we will assume that *e* is equal to one.

We will now show one advantage of dealing with the variable number of fatal or injury crashes, rather than risk, in empirical work. From Equations (2) and (4), it follows that

$$VRR = \sum_{n=1}^{N} SVCR_n = \frac{1}{N}\sum_{n=1}^{N} MRS_n + N\,\mathrm{cov}\left(MRS_n, \left|\delta r_n\right|\right). \qquad (5)$$

In other words, estimating the *SVCR* and aggregating across individuals will yield the correct *VRR* irrespective of the value of the covariance and this follows from the definition of a public good; one statistical death reduction[3] (or injury class reduction) (per unit of time) on a particular route. This suggests that to elicit the *VRR*, rather than asking people to place a value on risk reductions, they should be asked to value a reduction in fatal or injury class crashes; it is also believed this task is far easier from the respondents' standpoint[4]. This is the basis of the WTP approach adopted in this study and reflected in the outputs derived from the choice model.

The model is made operational within a (binary) choice framework where the indirect deterministic utility of each available alternative *j* is

$$V_j = \alpha f_j + \eta MajI_j + \theta MinI_j + \varphi IncapI_j + \beta c_j + \gamma meant_j + \lambda stdevt_j + \text{other influences} \; (j = 1, 2) \qquad (6)$$

where *f* is the number of *fatalities*, *MajI* is the number of *major injuries*, *IncapI* is number of *incapacitating injuries*, *MinI* is the number of *minor injuries*, *t* is trip time and c is trip cost. The *SVCR* is equal to α/β for fatalities for every individual, η/β for major injuries, θ/β for minor injuries, and φ/β for incapacitated injuries for every individual.

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[3] A statistical death reduction means saving one life, on average, per unit of time (obviously the life saved is unknown).

[4] The two approaches are mutually consistent only when respondents have the correct aggregate flow in mind (i.e., they would value an extra fatal or serious injury crash per year different if they were to make the only trip on that road that year, then when millions of trips would be made on that road). In this sense although a formulation in terms of number of crashes may sound more natural and easy-to-understand than a formulation in terms of probabilities to most respondents, the cognitive burden may not become any lighter.

Also note that by computing γ/β, the behavioural value of travel time savings (VTTS) is obtained and λ/β is the value of reliability (VoR). The model form is expressed in the context of a specific trip context where travellers face travel times, travel costs and safety of the road environment (defined by a history of deaths and injuries). By varying the levels associated with different travel contexts (both within respondents through alternatives describing a pair of alternatives and five different scenarios of paired alternatives, and between respondents) we are able to gather a rich array of data that is the basis of identifying traveller preferences for each of attributes being investigated. Simply put, the rich array of variability in attribute level within packages of trip provides the necessary data to reveal, through choice model estimation, the contribution of each attribute (i.e., the marginal utility of disutility) to overall utility which is the representation of preferences, and by comparing the marginal (dis)utility of an attribute of interest (e.g., travel time) to the marginal (dis)utility of cost we are able to obtain an estimate of a WTP for a unit of the attribute of interest in dollars. This WTP estimate can be both a mean and a distribution (standard deviation and range) when a random parameter form is used.

For safety, the estimation of the choice model provides parameters for the safety attributes that are used to obtain the WTP to avoid a fatality or a class of injury in a road environment. Given that the number of deaths and injuries by category are estimated as random coefficients, it is necessary to calculate distributions of WTP within the sample data and calculate the mean of the distribution.

Given that the model produces WTP estimates per person per car trip for the relevant segment (e.g., drivers on a commuting trip), and we are interested in WTP/km, this can be obtained by knowing the number of kilometres of a car trip. It was suggested that this is calculated for each observation in the sample, knowing the actual kilometres travelled from data obtained in the survey outside of the choice scenarios for an actual experienced trip; and then an average is taken across the sample. This gives a more meaningful estimate than simply using the average kilometres of the sample to divide into the average WTP from the sampled distribution of WTP estimates.

Importantly the WTP/km for each safety attribute is an input into a final calculation (not undertaken herein) of the VRR. With a focus on specific car trips, we have to convert the individual WTP to a *driver population exposure risk measure*. The *exposure* of interest is reflected in the number of trips and associated kilometres undertaken by each driver in the population. To obtain the value of a reduction in risk of one fatality and one injury per each class, we use a converted WTP per person per kilometre, and then multiply this by the inverse of the chance of death or injury class to obtain an aggregated VRR. The data required to identify the chance of death or injury is usually obtained from a variety of sources. We need exposure data measured in terms of annual vehicle kilometres travelled by cars, and risk data in terms of the numbers of fatalities and injuries in each class per annum for persons travelling in a car (as a driver or passenger).

A.9 An overview of the mixed logit form model

Let U_{nsj} denote the utility of alternative *j* in choice set *s* perceived by respondent *n*. U_{nsj} may be partitioned into two components, an observed (by the analyst) component of utility, V_{nsj}, and an unobserved (and un-modelled) component, ε_{nsj}, such that:

$$U_{nsj} = V_{nsj} + \varepsilon_{nsj}. \quad (7)$$

The observed component of utility is typically assumed to be a linear relationship of observed attribute levels of each alternative, *x*, and their corresponding weights (parameters), β (as per Equation 6). It is possible for some or all of the parameter weights to vary with density $f(\beta \mid \Omega)$ over the sampled population. By allowing the parameter weights to vary between and not within respondents, the model accounts for the pseudo panel nature of SC type data. Under such an assumption, the observed components of utility may be represented as Equation (8).

$$V_{nsj} = \sum_{k=1}^{K} \beta_{nk} x_{nsjk}. \qquad (8)$$

Assuming that (some of) the parameters are randomly distributed over the population, the choice probabilities of the model therefore depend on the random parameters. In estimating the model, rather than calculate a single probability for each alternative, the choice probabilities for each random draw are taken from the assumed probability distribution(s). In this way, multiple choice probabilities are obtained for each alternative, as opposed to a single set of probabilities as obtained from the typical multinomial logit (MNL) model. It is the expectation of these probabilities over the random draws which are calculated and used in the model estimation process. The expected choice probabilities for the model are given in Equation (9).

$$E\left[P_{nsj}\right] = \int_{\beta} \frac{\exp\left(V_{nsj}\right)}{\sum_{i \in J_{ns}} \exp\left(V_{nsi}\right)} f\left(\beta \mid \theta\right) d\beta. \qquad (9)$$

Equation (9) represents the choice probability at the level of the alternatives. In the version of the model accounting for the panel format of SC data, the choice probability given in Equation (9), whilst calculated, is not of direct interest. Rather, what is of interest are the probabilities of observing the sequence of choices made by each respondent, not the probabilities that specific alternatives will be observed to be chosen. To this end, we define the probability P_n^* that a certain respondent *n* has made a certain sequence of choices $\{j \mid y_{nsj} = 1\}_{s \in S_n}$ with respect to the set of choice situations, S_n, by

$$P_n^* = \int_{\beta} \prod_{s \in S_n} \prod_{j \in J_{ns}} \left(P_{nsj}\right)^{y_{nsj}} f\left(\beta \mid \theta\right) d\beta, \qquad (10)$$

which is what is used in model estimation (Hensher et al. 2015).

The parameter distribution functional form for each of the random parameters has to be selected. There is a large amount of literature on this topic, and it is generally understood that selection of the distribution (e.g., normal, triangular, lognormal etc.) influences the parameter estimates, and hence the WTP estimates. Sometimes constrained distributions are used to try and reduce the extreme tails of the distributions that can produce estimates that are not behaviourally sensible. Since the distributions are nothing more than analytical assumptions, the analyst must undertake testing of various distributions to ensure there is some stability in the evidence and that is it not overly influenced by the distributional assumptions.

A.10 Results for Wave 1 and the Pilot Survey

Table A.8: Results full sample (online guided and face-to-face only)

Variable	Estimate	Standard Error	Z-statistic	P-value	95% Confidence Interval
Value of Congested Travel Time Savings	48.755***	4.470	10.91	0.000	39.994, 57.517
Value of Free-Flow Travel Time Savings	15.182***	3.245	4.68	0.000	8.822, 21.542
Value of Travel Time Savings - weighted	27.990***	3.021	9.27	0.000	22.075, 33.917
Value of Reliability	12.846***	4.300	2.99	0.003	4.418, 21.274
Willingness-to-pay – Property damage only	0.249***	0.050	5.03	0.000	0.152, 0.346
Willingness-to-pay – Minor injury	0.429***	0.125	3.42	0.001	0.183, 0.675
Willingness-to-pay – Major injury	0.614***	0.131	4.69	0.000	0.358, 0.871
Willingness-to-pay – Incapacitating injury	1.509***	0.140	10.8	0.000	1.235, 1.783
Willingness-to-pay – Fatality	2.964***	0.295	10.05	0.000	2.386, 3.542

*Note: ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.*

Source: Deloitte Access Economics

Table A.9: Results for commuters (online guided and face-to-face only)

Variable	Estimate	Standard Error	Z-statistic	P-value	95% Confidence Interval
Value of Congested Travel Time Savings	56.281***	18.197	3.09	0.002	20.616, 91.946
Value of Free-Flow Travel Time Savings	-2.799	15.190	-0.18	0.854	32.571, 26.974
Value of Travel Time Savings - weighted	18.902	11.608	1.63	0.103	-3.849, 41.653
Value of Reliability	11.445	9.313	1.23	0.219	-6.808, 29.698
Willingness-to-pay – Property damage only	0.184	0.116	1.59	0.112	-0.043, 0.411
Willingness-to-pay – Minor injury	0.498*	0.268	1.86	0.063	-0.027, 1.023
Willingness-to-pay – Major injury	0.638**	0.281	2.27	0.023	0.087, 1.19
Willingness-to-pay – Incapacitating injury	1.556***	0.491	3.17	0.002	0.594, 2.519
Willingness-to-pay – Fatality	3.448***	1.105	3.12	0.002	1.281, 5.614

*Note: ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.*

Source: Deloitte Access Economics

Table A.10: Results for non-commuters (online guided and face-to-face only)

Variable	Estimate	Standard Error	Z-statistic	P-value	95% Confidence Interval
Value of Congested Travel Time Savings	28.375**	12.434	2.28	0.023	4.004, 52.746
Value of Free-Flow Travel Time Savings	19.383***	7.386	2.62	0.009	4.906, 33.86
Value of Travel Time Savings - weighted	22.592***	6.853	3.3	0.001	9.16, 36.024
Value of Reliability	11.659	7.678	1.52	0.129	-3.39, 26.708
Willingness-to-pay – Property damage only	0.214***	0.068	3.15	0.002	0.081, 0.347
Willingness-to-pay – Minor injury	0.365*	0.194	1.89	0.059	-0.014, 0.745
Willingness-to-pay – Major injury	0.629***	0.205	3.07	0.002	0.227, 1.031
Willingness-to-pay – Incapacitating injury	1.400***	0.216	6.48	0.000	0.976, 1.823
Willingness-to-pay – Fatality	2.446***	0.415	5.89	0.000	1.632, 3.259

*Note: ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.*

Source: Deloitte Access Economics

Table A.11: Results for business (online guided and face-to-face only)

Variable	Estimate	Standard Error	Z-statistic	P-value	95% Confidence Interval
Value of Congested Travel Time Savings	65.169***	19.008	3.43	0.001	27.913, 102.425
Value of Free-Flow Travel Time Savings	8.094	6.981	1.16	0.246	-5.588, 21.776
Value of Travel Time Savings - weighted	31.483***	6.403	4.92	0.000	18.933, 44.033
Value of Reliability	20.432**	8.705	2.35	0.019	3.37, 37.494
Willingness-to-pay – Property damage only	0.449***	0.133	3.38	0.001	0.188, 0.709
Willingness-to-pay – Minor injury	0.415	0.303	1.37	0.171	-0.179, 1.008
Willingness-to-pay – Major injury	1.044***	0.315	3.32	0.001	0.427, 1.661
Willingness-to-pay – Incapacitating injury	1.826***	0.372	4.91	0.000	1.097, 2.556
Willingness-to-pay – Fatality	3.434***	0.812	4.23	0.000	1.843, 5.026

*Note: ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.*

Source: Deloitte Access Economics

Table A.12: Results for drivers, all purposes (online guided and face-to-face only)

Variable	Estimate	Standard Error	Z-statistic	P-value	95% Confidence Interval
Value of Congested Travel Time Savings	45.101***	7.704	5.85	0.000	30.001, 60.2
Value of Free-Flow Travel Time Savings	4.305	8.192	0.53	0.599	-11.75, 20.361
Value of Travel Time Savings - weighted	19.388***	6.246	3.1	0.002	7.145, 31.63
Value of Reliability	8.674	5.499	1.58	0.115	-2.105, 19.452
Willingness-to-pay – Property damage only	0.255***	0.061	4.15	0.000	0.134, 0.375
Willingness-to-pay – Minor injury	0.548***	0.163	3.36	0.001	0.228, 0.868
Willingness-to-pay – Major injury	0.676***	0.161	4.21	0.000	0.361, 0.99
Willingness-to-pay – Incapacitating injury	1.355***	0.176	7.71	0.000	1.011, 1.699
Willingness-to-pay – Fatality	3.014***	0.396	7.61	0.000	2.238, 3.79

*Note: ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.*

Source: Deloitte Access Economics

Table A.13: Results for passengers, all purposes (online guided and face-to-face only)

Variable	Estimate	Standard Error	Z-statistic	P-value	95% Confidence Interval
Value of Congested Travel Time Savings	36.263***	7.669	4.73	0.000	21.233, 51.293
Value of Free-Flow Travel Time Savings	20.124***	6.404	3.14	0.002	7.573, 32.675
Value of Travel Time Savings - weighted	26.869***	5.867	4.58	0.000	15.369, 38.369
Value of Reliability	20.871***	6.577	3.17	0.002	7.98, 33.763
Willingness-to-pay – Property damage only	0.141*	0.079	1.8	0.072	-0.013, 0.296
Willingness-to-pay – Minor injury	0.000	0.190	0	0.999	-0.371, 0.372
Willingness-to-pay – Major injury	0.569**	0.228	2.5	0.012	0.123, 1.015
Willingness-to-pay – Incapacitating injury	1.482***	0.214	6.92	0.000	1.063, 1.901
Willingness-to-pay – Fatality	2.561***	0.470	5.45	0.000	1.64, 3.482

*Note: ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.*

Source: Deloitte Access Economics
Results of the questions added after the pilot

Table A.14: During a typical week, how many days do you work and of these, how many days do you spend working-from-home (WFH)?

Days	Before COVID-19	Currently
0	69.1%	19.8%
1	4.4%	1.4%
2	3.1%	3.7%
3	1.8%	7.4%
4	0.9%	7.7%
5	1.8%	36.9%
6	0.3%	3.1%
7	0.8%	2.2%

Source: Deloitte Access Economics

Table A.15: Describe your main mode of transport during a typical week (i.e. the number of days you commute using each of the following mode(s))?

	Before COVID-19			Currently		
Days	Public Transport	Car	Other	Public Transport	Car	Other
0	59.0%	19.1%	74.7%	67.4%	17.7%	74.4%
1	3.9%	4.9%	1.9%	5.3%	8.3%	1.9%
2	4.1%	7.3%	1.2%	3.5%	9.0%	1.6%
3	4.6%	9.3%	0.9%	2.7%	10.6%	1.0%
4	3.3%	7.5%	0.6%	1.4%	8.3%	0.5%
5	6.6%	23.5%	1.0%	1.5%	18.0%	0.8%
6	0.2%	3.0%	0.1%	0.1%	2.8%	0.2%
7	0.4%	7.6%	1.7%	0.5%	7.4%	1.7%

Source: Deloitte Access Economics

Table A.16: During a typical week how many non-work related trips do you make (e.g trips which are not to or from work or for business-related purposes)?

Results	Before COVID-19	Currently
Mean	10.05	9.55
Standard Deviation	9.592	9.467
Percentile 25	4.00	4.00
Percentile 50	7.00	7.00
Percentile 75	12.00	12.00

Source: Deloitte Access Economics

Table A.17: How well do you think digital communication methods substitute for face-to-face time in your work (e.g. Microsoft Teams, Zoom, Skype, etc.)?

Variable	Proportion of respondents
Face-to-face is much better	28.9%
Face-to-face is a little better	14.8%
They're about the same	15.5%
Digital is a little better	9.7%
Digital is much better	13.4%

Source: Deloitte Access Economics

Appendix B External Reporting

B.1 Australian National University peer review

Dr Benjamin Phillips of the Social Research Centre recommended that additional cognitive testing be conducted as there are potentially flaws in the survey design that reflect poor audience understanding of the pilot. Phillips identified that the measures of travel time and reliability was not adequately described to ensure audience understanding, while safety only needed slight changes for complete understanding. This done was following the three pilots and National Pilot, and before the waves of surveys, where the questions were adjusted further, partially based on the feedback received from the peer review.

Understanding of injury could be tested, this was done and found an 80% understanding based on assigning scenarios to categories, which was deemed sufficient by Phillips. However, personal assessment of injury understanding was found to be higher than of travel speed and reliability, indicating that these two categories may have insufficient understanding.

In particular, Phillips identified that the survey design with two histograms to represent travel time and congestion time created high cognitive load for survey participants. This could mean that the results do not reflect the true preferences, undermining any statistical tests done on them. There were additional issues that went against typical survey design, including: overly complex language, ambiguity over the standardisation of injury profiles, position bias, excessive use of imagery and existing imagery setting an undesired baseline for participants. Additionally, the survey could be improved by adding a section to judge participants' understanding of the speed/reliability choices, similar to those done with injury. Philips suggested to go as far as dropping time spent in congestion, and only focusing on time differences.

Interviewer effects could bias the survey, as a relatively small number of face-to-face interviewers mean that a single interviewer could have a significant impact on results. Therefore, monitoring of both understanding and interviewers conduct could minimize bias. Philips was unable to assess the accuracy of sampling, response weights and weighting, as the methodology for the two was not provided in the review. In future reports these could be included for independent assessment of the validity of the survey.

Cognitive interviews were the principal recommendation of Philips, who suggested that a small sample be interviewed to see if they understand the information presented in the choice tasks. This would need to be done with a wide range of participants, such as older people and those with low levels of education.

B.2 Focus group report

Deloitte / Austroads Survey Design Groups
Topline Report

While the core choices presented and the overall current design does appear to work well in a self-completion environment (and would likely be successful in an interviewer-assisted scenario), there is a general need for a more user-friendly design here, including:

- ***More concise, day to day language***
- ***A greater use of bullet points***
- ***Fewer and simpler examples***
- ***A more all-encompassing question design… one that anticipates all driving conditions (e.g. driving solo, the avoidance of tolls, etc)***
- ***A more explanatory set-up of the scenario testing***
- ***Cleaner layout and design… where possible, fitting all of the contents of a question onto a single page, with clear demarcation of the different sections.***

1. Approach and Methodology

- Two focus groups were recruited by Deloitte and moderated by Antenna for this research, with a session being run in Melbourne on 27th February, and a second session in Sydney on 28th February. Each of these sessions ran for 2 hours, and comprised two sections – a self-completion exercise where our participants went through the questionnaire individually, noting any specific issues or problems with it as they went, and then a group discussion that walked through the questionnaire and explored the participants' reactions to this.
- Specific mention needs to be made of the testing methodology for our two sessions. In Melbourne, the questionnaire was administered in a paper form, and as a result, specific feedback was garnered within this session around the lack of piped responses (in particular, around Q.5 in the section labelled 'Travelling for non-work purposes'. Since the survey will ultimately be tablet or computer based, we've not included this commentary. In Sydney, the survey was administered on laptops, but using the Excel version of the survey rather than the online version. Similarly, commentary around the format of the Excel document has been excluded here.

2. Overall reactions to questionnaire design

- Across both of our sessions, there is a moderately positive response to the questionnaire. While some of our participants take a significantly longer time to complete the survey, none of our participants actively rejected the questionnaire design by dropping out, and there was little overt feedback from the sessions that the proposed design was unworkable.
- That said, there is a consistent theme in both of our sessions that the questionnaire design is unnecessarily wordy. Completion times vary between 13 minutes and 25 minutes, and the major theme in this variation looks to be the attention that our

participants paid when reading: as many of our faster, younger participants commented, "I just skimmed it." With this, there is an inherent risk of misunderstanding questions and the purpose, and so we'd strongly recommend a revision of the language to a simpler, easier to understand format.

- Similarly, there's a tendency in the survey to use complex words over simple ones, with a similar effect of our participants not reading the content properly. The tested versions referring to 'games' rather than scenarios is a more apparent example, but there is a natural tendency to use passive rather than active tenses throughout, and complex explanations over simple ones. A prime example can be seen in the introduction:

> *This survey is being undertaken on behalf of Austroads, a national body that coordinates many of the methods developed by State and Federal Governments.*
> *The overall purpose of the survey is to improve the ways in which road projects are evaluated, and hence ensure that those funded offer the best value for the tax payers' dollar.*
> *Users obtain many benefits from improvements in existing roads as well as the provision of new roads.*
> *The main benefits are associated with savings in travel time, improved reliability of travel times (especially reductions in traffic congestion and slowness due to poorly designed roads) and increased safety in the road environment.*
> *Through participation in this survey we are seeking to gather views and preferences from a sample of members of our community as to what matters to them when choosing alternative routes to use when undertaking a specific trip such as the trip to work, or to the shops.*
> *We will be asking you for information on a recent trip you made on roads in Australia, be that in the main cities, in regional centres or over a long distance.*
> *We will then be offering you choices of a number of alternative routes that you could take with different levels of travel times and travelling costs and recent history of accidents. The cost will include the running cost of your vehicle and any tolls on the route.We would like you to think about these trips and choose the one which you would prefer.*

A far simpler explanation could be used of the origin and purpose – one that delivers the same explanation is a much shorter format:

> *This survey is being run by Austroads, a Federal Government agency that coordinates road transport throughout Australia.*
>
> *We want to better understand how commuters decide the routes that they drive, and what is important to them when making those decisions. The results of this study will help us to design better road networks, reducing traffic congestion and increasing road safety.*
>
> *We'll be asking you about some of your recent travel by car, as well as showing you some different commuting situations and getting you to choose between them.*
>
> *If you have any questions about the survey – its purpose, or how to complete it - please ask your interviewer.*

3. Specific Sections

Survey Introduction

- Overall, the introduction for the survey is seen as overly wordy and complex, and as a result our participants generally skim through this, failing to capture the purpose of the study. A clear example of this could be seen at the end of the Melbourne session, where our participants were unable to tell the moderator who the study was for nor the purpose, despite it being written on the front page of the questionnaire. The critical information is being lost in the volume of commentary.
- To our minds, this commentary should be reduced to:
    - That this is a survey being run by Austroads, a federal agency that coordinates road transport throughout Australia
    - That this survey will help in building safer roads and reduce traffic congestion
    - That we'll be asking about their current behaviour, but also testing some scenarios.
- We've outlined a potential revision of this earlier in this document: we don't see any reasons for this explanation being longer than the 5 sentences that we've reduced this to.

Trips and Travel

- It's clear from our groups that this section is problematic in its design – the number of examples (especially the daily overview) increase cognitive strain for the reader, and flag an ongoing complexity of the survey overall.
- To our participants' minds, this explanation should be reduced to only one example (and ideally, the first, as the simplest form of example).
- It's also important to recognise that the current format of some of the questions and examples seem to exclude specific participants. Not all of our potential respondents work (or fly), and so it's important that examples are all-inclusive. We'd recommend changing the example from going to work to going to the shops here.
- While it wasn't a strong theme in our sessions, it's also important that our first question is obvious. We'd recommend a bold format (or boxing) to dial up the visibility of this question, along with clearer labelling (i.e. Q.1, not just 1.)

Trips and Travel

- Overall, this section works comparatively well – the questioning is largely straightforward, and the format works here.. That said, there are some areas that are problematic:
    - Question numbering starts again here – our first question should be Q. 2 not Q. 1 if Q.1 is on the previous page.
    - Q2a and 2b are often misinterpreted as being for postcode only, with participants asking *"what if I don't know the postcode?"*. Postcode and suburbs should both be bolded. Alternatively, an auto-completion feature could be added here.
    - Question 3 assumes that they work. Additionally, it implies that this is travel to work, but our introduction specifically excludes commuting to work.

ANTENNA STRATEGIC INSIGHTS

- The descriptions for open country side and built up environments don't fit to suburban driving. If I use a motorway, I would be driving at more than 80 km/h, but would not consider this to be open country. Similarly, our images don't match this. If we are solely looking for over/under 80km/h, we'd recommend removing the images and the references to built-up and open country.

Trips and Travel

- Our participants often struggle to estimate the tolls that they have paid here. It would be worth considering the value of adding location-specific calculators or explanation (e.g. Sydney Harbour Bridge - $4 peak time). Since we're capturing the postcodes of where they go to and from, we could use this to give them likely options for distance-calculated routes (e.g. M2).
- Many of our participants complained at this point that they had not and do not use toll roads. There needs to be a specific response at Q.6a for 'I didn't pay any tolls'.
- Q.7 implies that there was another person in the car. It would be worth adding 'I was the only person in the car' as an option, or moving Q.8 to be ahead of this

Scenario Testing Section

- The ordering of the three explanation pages – Car Travel and Road Accidents, Travel Time and Travel Time Reliability, and Example Scenario – is problematic. In not explaining why our participants need to understand the first two of these, we run the risk of the reader skimming over them and failing to capture what is important. Because of this, we'd recommend starting with the Example Scenario (with a new title), then the description slides.
- Our participants see no real challenge with the length of this section – the adding of 2-3 additional scenarios is not a problem to their minds.

a) Example Scenario

- While the explanation here works well, the title is confusing – we'd recommend relabelling this as something along the lines of 'Choosing Routes'.
- The explanations of the different components work well here. The only element we'd suggest adding is a total cost calculation – adding the running cost and the toll cost together.

b) Car travel and road accidents

- Like our example scenarios, this slide works well, especially with the use of the icons. But there's a lot of replicated content in each of the descriptions of conditions. We'd recommend that each scenario be reduced to a set of short and clearly differentiating explanations to dial up their comprehension, a potential change could be:

No injury	**Minor injury**	**Major injury**	**Permanent injury**	**Fatal injury**
The accident only results in damage to the vehicle with no physical injuries	An injury that requires treatment but not time in hospital, e.g. minor fractures, whiplash, cuts or bumps	An injury that requires time in hospital, e.g. major broken bones, or major bleeding	An injury causing permanent damage, e.g. brain injury or permanent paralysis	Death within 30 days of crash

ANTENNA STRATEGIC INSIGHTS

- Some participants also noted that the graph at the bottom of the page doesn't include numbers, like our later examples. These should be added.
- While it's not a design and usability consideration, we feel that it is important that we provide an opinion on the use of accidents as a variable in the survey. We're conscious that many of our participants focussed on this within their decision-making, but also confirmed that for most of their travel, they are not aware of the rate of accidents and injuries on the routes they choose. As a result, we are concerned that the inclusion of this as a descriptor introduces an artificially inflated metric when compared with the lack of safety information available in day-to-day decisions. Similarly, we note the use of absolute measures here, rather than relating it to the volume of traffic on a route (i.e. a percentage). This approach creates an artificial inference of a high rate of accidents in the absence of any measures of overall volume of traffic. In other words, 8 fatal injuries sounds a lot scarier than 0.00005%, and we're concerned that this will unfairly skew your resulting data toward this measure.

c) *<u>Travel times and travel time reliability</u>*

- The concepts explained in this slide are naturally complex, in particular the idea of travel time variance. So it's understandable that there is an innate complexity in what is being explained here. That said, none of our participants commented that this explanation and the bar chart were too complex to understand. Indeed, the explanatory text here works well to explain the idea.
- The only improvements we could recommend here would be the explanation of why the length of a trip may vary. Talking to peak hour and off-peak travel would be a good way of delivering this.
- Beyond this, there is also the mention of games here in the text – something that sounds to have been remedied in later versions of the questionnaire.

d) *<u>Scenario testing</u>*

- The main challenge to our participants in this scenario testing is that our scenarios are based on their recent travel, and that in many of these, tolls were not part of their trip (especially in Melbourne). We'd recommend altering the context of these to a more hypothetical scenario… *"Imagine you were travelling and had the choice of these two routes. Which would you choose?"*
- Additionally, we'd recommend a more visible labelling of the two options at the top – a clear bar at the top of each marked Option A and Option B.

<u>How did you choose the preferred routes</u>

- In line with our participants' comments around scenario testing, this question makes multiple (and potentially incorrect) assumptions about their recent travel - that they have paid tolls, and that there were other participants in the car with them. If we are looking to understand the drivers of choice in the scenario testing, then this needs to be more focussed around this, with a more direct line of questioning. If we're looking to understand the role of passengers in choosing routes, then this should be asked earlier when we're exploring their recent behaviour in Trips and Travel.

Accident Experience (pt. 1)

- The only issue we see with this page is the blocky look – our three questions aren't clearly demarcated, and as a result, this looks (at a first glance) to be one big question. We'd recommend shrinking the size of each of the icons, and creating a greater gap between each of the three questions.
- It may also be worth considering the use of consistent language here – while our icons refer to injury, our questions refer to suffering – not the same thing.

Accident Experience (pt. 2)

- The overall design of the question matrix works well here, but some attention is required in refining and clarifying some of the items – some of these statements are grammatically challenging, and are less easily understood as a result, e.g.

  Those who take chances and break the traffic rules
  are not any less safe than those who follow all the rules
- There's an inherent risk in this of misinterpretation, so it's worth considering reworking these to a more conversational tone.
- Similarly, some statements here are open to interpretation… as our participants commented on the statement 'Emergency excepted, using a mobile phone when driving should be banned', *"What constitutes an emergency?"* and *"Does this include hands-free?"*

Demographics

- This section looks to be relatively straightforward and understood. While some participants complained about being asked their household income, there was an equal number of comments that there was an option for 'prefer not to say'.
- The only alterations we would recommend would be:
  - Continuing the numbering from previous sections, rather than starting again at 1.
  - Changing the occupation question (Q.6) from a single response to a multiple response… a respondent could be a part time student and a part time worker.
  - Relabelling Motor Vehicle insurance in Q.9 to Comprehensive Insurance (as opposed to CTP), and putting this further up in the list.
    - Is there a need for this question to capture the different types of insurance our participants may have on their different vehicles? A respondent may have a car with only CTP, and another with CTP and comprehensive.

ANTENNA STRATEGIC INSIGHTS

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